NIOSH

Worker Deaths by Electrocution

A Summary of Surveillance Findings and Investigative Case Reports

U.S. Department of Health and Human Services
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WORKER DEATHS BY ELECTROCUTION

A Summary of NIOSH Surveillance and Investigative Findings

An abridged version of this document without the complete text of the FACE investigative reports is available from NIOSH as Publication No. 98-131.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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PUBLIC HEALTH SUMMARY

What are the hazards?

Based on data from the NIOSH National Traumatic Occupational Fatalities (NTOF) surveillance system, electrocutions were the fifth leading cause of death from 1980 through 1992. The 5,348 deaths caused by electrocutions accounted for 7% of all fatalities and an average of 411 deaths per year.

How can a worker be exposed or put at risk?

Electricity is present at most jobsites, and many American workers, regardless of industry or occupation, are exposed to electrical energy daily during the performance of their tasks. These hazardous exposures may exist through contact with an object as seemingly innocuous as a broken light bulb to an energized overhead powerline.

What recommendations has the federal government made to protect workers' health?

The Occupational Safety and Health Administration (OSHA) addresses electrical safety in Subpart S 29 CFR 1910.302 through 1910.399 of the General Industry Safety and Health Standards. The standards contain requirements that apply to all electrical installations and utilization equipment, regardless of when they were designed or installed. Subpart K of 29 CFR 1926.402 through 1926.408 of the OSHA construction safety and health standards contain installation safety requirements for electrical equipment and installations used to provide electric power and light at the jobsite. These sections apply to both temporary and permanent installations used on the jobsite. Additionally, the National Electrical Code (NEC) and the National Electrical Safety Code (NESC) comprehensively address electrical safety regulations. NIOSH recommendations focusing on prevention are included in this Technical Document.

Where can more information be found?

The references at the end of this document provide a useful inventory of published reports and literature. Additional information from NIOSH can be obtained by calling the following number:

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INTRODUCTION

Nancy A. Stout, Ed.D.

Many American workers are exposed to electrical energy daily during the performance of their tasks. This monograph highlights the magnitude of the problem of occupational electrocutions in the U.S., identifies potential risk factors for fatal injury, and provides recommendations for developing effective safety programs to reduce the risk of electrocution.

This monograph summarizes surveillance data and investigative reports of fatal incidents involving workers who contacted energized electrical conductors or equipment. The surveillance data were derived from the National Traumatic Occupational Fatalities (NTOF) surveillance system maintained by the National Institute for Occupational Safety and Health (NIOSH). The NTOF data are based on death certificates of workers 16 years or older who died from a traumatic injury in the workplace. The fatality investigations were conducted as part of the NIOSH Fatality Assessment and Control Evaluation (FACE) program. FACE is a research program for the identification and investigation of fatal occupational injuries. The goal of the FACE program is to collect information on factors that may have contributed to traumatic occupational fatalities using an epidemiologic approach, and to develop and disseminate recommendations for preventing similar events in the future.

Based on the NTOF surveillance data for the period from 1980 through 1992, 5,348 workers died from contact with electrical energy (an average of 411 deaths per year). Electrocutions were the fifth leading cause of death, accounting for 7% of all workplace fatalities. In the 12 year period from 1982 through 1994, NIOSH investigated 224 electrocution incidents which resulted in 244 worker fatalities.

Part I of this monograph provides: an overview of electrical hazards, including the effects of electrical energy on the human body; a comprehensive summary of the epidemiology of occupational electrocutions based on NTOF and FACE data which identifies common risk factors for fatal injury due to contact with electrical energy; and recommendations for elements of an effective electrical safety program for the prevention of workplace electrocutions. Part II includes a summary abstract for all 224 FACE electrocution investigative reports prepared by NIOSH for further information and reference.

Our hope is that this monograph will serve as a valuable resource for safety and public health professionals, safety and health trainers, researchers, and others who can affect the prevention of occupational electrocutions.

PART I

ELECTROCUTION-RELATED FATALITIES

OVERVIEW OF ELECTRICAL HAZARDS

Virgil Casini, B.S.

Electricity is a ubiquitous energy agent to which many workers in different occupations and industries are exposed daily in the performance of their duties. Many workers know that the principal danger from electricity is that of electrocution, but few really understand just how minute a quantity of electrical energy is required for electrocution. In reality, the current drawn by a tiny 7.5 watt, 120-volt lamp, passed from hand to hand or hand to foot across the chest is sufficient to cause electrocution.[1] The number of people who believe that normal household current is not lethal or that powerlines are insulated and do not pose a hazard is alarming. Electrocutions may result from contact with an object as seemingly innocuous as a broken light bulb or as lethal as an overhead powerline, and have affected workers since the first electrical fatality was recorded in France in 1879 when a stage carpenter was killed by an alternating current of 250 volts.[2]

The information in the following two sections (**DEFINITIONS** and **EFFECTS OF ELECTRICAL ENERGY**) is intended as a basic explanation of electricity and the effects of electrical energy. Unless otherwise indicated, information in these sections is derived from OSHA electrical standards,[3,4] the National Electrical Code (NEC),[5] and the National Electrical Safety Code.[6] Official definitions of electrical terms can be found in these same documents.

DEFINITIONS

Electricity is the flow of an atom's electrons through a conductor. ***Electrons***, the outer particles of an atom, contain a negative charge. If electrons collect on an object, that object is ***negatively charged***. If the electrons flow from an object through a conductor, the flow is called ***electric current***. Four primary terms are used in discussing electricity: voltage, resistance, current, and ground.

Voltage is the fundamental force or pressure that causes electricity to flow through a conductor and is measured in volts. ***Resistance*** is anything that impedes the flow of electricity through a conductor and is measured in Ohms. ***Current*** is the flow of electrons from a source of voltage through a conductor and is measured in amperes (Amps). If the current flows back and forth (a cycle) through a conductor, it is called ***alternating current (AC)***. In each cycle the electrons flow first in one direction, then the other. In the United States, the normal rate is 60 cycles per second [or 60 Hertz (Hz)]. If current flows in one direction only (as in a car battery), it is called ***direct current (DC)***.

AC is most widely used because it is possible to step up or step down (i.e., increase or decrease) the current through a transformer. For example, when current from an overhead powerline is run through a pole-mounted transformer, it can be stepped down to normal household current.

Ohm's Law (Current=Voltage/Resistance) can be used to relate these three elements mathematically.

A ***ground*** is a conducting connection, whether or not unintentional, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

EFFECTS OF ELECTRICAL ENERGY

Electrical injuries consist of four main types: electrocution (fatal), electric shock, burns, and falls caused as a result of contact with electrical energy.

Electrocution results when a human is exposed to a lethal amount of electrical energy. To determine how contact with an electrical source occurs, characteristics of the electrical source before the time of the incident must be evaluated (pre-event). For death to occur, the human body must become part of an active electrical circuit having a current capable of overstimulating the nervous system or causing damage to internal organs. The extent of injuries received depends on the current's magnitude (measured in Amps), the pathway of the current through the body, and the duration of current flow through the body (event). The resulting damage to the human body and the emergency medical treatment ultimately determine the outcome of the energy exchange (post-event).[7]

Electrical injuries may occur in various ways: direct contact with electrical energy, injuries that occur when electricity arcs (an arc is a flow of electrons through a gas, such as air) to a victim at ground potential (supplying an alternative path to ground), flash burns from the heat generated by an electrical arc, and flame burns from the ignition of clothing or other combustible, nonelectrical materials. Direct contact and arcing injuries produce similar effects. Burns at the point of contact with electrical energy can be caused by arcing to the skin, heating at the point of contact by a high-resistance contact, or higher voltage currents. Contact with a source of electrical energy can cause external as well as internal burns. Exposure to higher voltages will normally result in burns at the sites where the electrical current enters and exits the human body. High voltage contact burns may display only small superficial injury; however, the danger of these deep burns destroying tissue subcutaneously exists.[8] Additionally, internal blood vessels may clot, nerves in the area of the contact point may be damaged, and muscle contractions may cause skeletal fractures either directly or in association with falls from elevation.[9] It is also possible to have a low-voltage electrocution without visible marks to the body of the victim.

Flash burns and flame burns are actually thermal burns. In these situations, electrical current does not flow through the victim and injuries are often confined to the skin.

Contact with electrical current could cause a muscular contraction or a startle reaction that could be hazardous if it leads to a fall from elevation (ladder, aerial bucket, etc.) or contact with dangerous equipment.[10]

The NEC describes high voltage as greater than 600 volts AC.[5] Most utilization circuits and equipment operate at voltages lower than 600 volts, including common household circuits (110/120 volts); most overhead lighting systems used in industry or office buildings and department stores; and much of the electrical machinery used in industry, such as conveyor systems, and manufacturing machinery such as weaving machines, paper rolling machines or industrial pumps.

Voltages over 600 volts can rupture human skin, greatly reducing the resistance of the human body, allowing more current to flow and causing greater damage to internal organs. The most common high voltages are transmission voltages (typically over 13,800 volts) and distribution voltages (typically under 13,800 volts). The latter are the voltages transferred from the power generation plants to homes, offices, and manufacturing plants.

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Standard utilization voltages produce currents passing through a human body in the milliampere (mA) range (1,000 mA=1 Amp). Estimated effects of 60 Hz AC currents which pass through the chest are shown in Table 1.

Table 1. *Estimated Effects of 60 Hz AC Currents*

1 mA	Barely perceptible
16 mA	Maximum current an average man can grasp and "let go"
20 mA	Paralysis of respiratory muscles
100 mA	Ventricular fibrillation threshold
2 Amps	Cardiac standstill and internal organ damage
15/20 Amps	Common fuse or breaker opens circuit*

*Contact with 20 milliamps of current can be fatal. As a frame of reference, a common household circuit breaker may be rated at 15, 20, or 30 amps.

When current greater than the 16 mA "let go current" passes through the forearm, it stimulates involuntary contraction of both flexor and extensor muscles. When the stronger flexors dominate, victims may be unable to release the energized object they have grasped as long as the current flows. If current exceeding 20 mA continues to pass through the chest for an extended time, death could occur from respiratory paralysis. Currents of 100 mA or more, up to 2 Amps, may cause ventricular fibrillation, probably the most common cause of death from electric shock.[11] Ventricular fibrillation is the uneven pumping of the heart due to the uncoordinated, asynchronous contraction of the ventricular muscle fibers of the heart that leads quickly to death from lack of oxygen to the brain. Ventricular fibrillation is terminated by the use of a defibrillator, which provides a pulse shock to the chest to restore the heart rhythm. Cardiopulmonary resuscitation (CPR) is used as a temporary care measure to provide the circulation of some oxygenated blood to the brain until a defibrillator can be used.[23]

The speed with which resuscitative measures are initiated has been found to be critical. Immediate defibrillation would be ideal; however, for victims of cardiopulmonary arrest, resuscitation has the greatest rate of success if CPR is initiated within 4 minutes and advanced cardiac life support is initiated within 8 minutes (National Conference on CPR and ECC, 1986).[6]

The presence of moisture from environmental conditions such as standing water, wet clothing, high humidity, or perspiration increases the possibility of a low-voltage electrocution. The level of current passing through the human body is directly related to the resistance of its path through the body. Under dry conditions, the resistance offered by the human body may be as high as 100,000 Ohms. Wet or broken skin may drop the body's resistance to 1,000 Ohms. The following illustrations of Ohm's law demonstrates how moisture affects low-voltage electrocutions. Under dry conditions, Current=Volts/Ohms = 120/100,000 = 1 mA, a barely perceptible level of current. Under wet conditions, Current=Volts/Ohms = 120/1,000 = 120 mA, sufficient current to cause ventricular fibrillation. Wet conditions are common during low-voltage electrocutions.

High-voltage electrical energy quickly breaks down human skin, reducing the human body's resistance to 500 Ohms. Once the skin is punctured, the lowered resistance results in massive current flow, measured in Amps. Again, Ohm's law is used to demonstrate the action. For example, at 1,000 volts, Current=Volts/Ohms = 1000/500 = 2 Amps, which can cause cardiac standstill and serious damage to internal organs.

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CONCLUSIONS

Electrical hazards represent a serious, widespread occupational danger; practically all members of the workforce are exposed to electrical energy during the performance of their daily duties, and electrocutions occur to workers in various job categories. Many workers are unaware of the potential electrical hazards present in their work environment, which makes them more vulnerable to the danger of electrocution.

The Occupational Safety and Health Administration (OSHA) addresses electrical safety in Subpart S 29 CFR 1910.302 through 1910.399 of the General Industry Safety and Health Standards.[3] The standards contain requirements that apply to all electrical installations and utilization equipment, regardless of when they were designed or installed. Subpart K of 29 CFR 1926.402 through 1926.408 of the OSHA Construction Safety and Health Standards[4] contain installation safety requirements for electrical equipment and installations used to provide electric power and light at the jobsite. These sections apply to both temporary and permanent installations used on the jobsite.

Additionally, the National Electrical Code (NEC)[5] and the National Electrical Safety Code (NESC)[6] comprehensively address electrical safety regulations. The purpose of the NEC is the practical safeguarding of persons and property from hazards arising from the use of electricity. The NEC contains provisions considered necessary for safety and applies to the installation of electric conductors and equipment within or on public or private buildings or other structures, including mobile homes, recreational vehicles, and floating buildings; and other premises such as yards; carnival, parking, and other lots; and industrial substations. The NEC serves as the basis for electrical building codes across the United States.

The NESC contains rules necessary for the practical safeguarding of persons during the installation, operation, or maintenance of electric supply and communication lines and associated equipment. These rules contain the basic provisions that are considered necessary for the safety of employees and the public under the specified conditions. Unlike the NEC, the NESC contains work rules in addition to installation requirements.

EPIDEMIOLOGY OF ELECTROCUTION FATALITIES

Suzanne Kisner, B.S., Virgil Casini, B.S.

Occupational fatalities associated with electrocutions are a significant, ongoing problem. Data from the NIOSH National Traumatic Occupational Fatality (NTOF) surveillance system indicated that an average of 6,359 traumatic work-related deaths occurred each year in the United States from 1980 through 1989; an estimated 7% of these fatalities were due to electrocutions.[12] In 1995, the Bureau of Labor Statistics reported that electrocutions accounted for 6% of all worker deaths.[13] For the year 1990, the National Safety Council reported that electrocutions were the fourth leading cause of work-related traumatic death.[14]

A review of hazards in the farming industry showed that electrocutions accounted for about 7% of all agricultural work-related deaths.[15] The specific hazards involved in these electrocutions include internal wiring in farm buildings, buried electrical cables, and overhead powerlines.[15] A study of work-related electrocution deaths was conducted using data from the Occupational Safety and Health Administration (OSHA) Integrated Management Information System (IMIS).[16] This study identified 944 work-related electrocutions for the period 1984 to 1986; 61% of these fatalities were caused by contact with high-voltage powerlines. From 1980 through 1989, NIOSH reported an average of 15 electrocutions each year were caused by contact between cranes or some other type of boomed vehicles and energized, overhead powerlines.[17]

NTOF ANALYSIS

Methods

The National Traumatic Occupational Fatalities (NTOF) surveillance system is composed of information taken from death certificates for decedents 16 years of age or older with a positive response to the “Injury at Work?” item, and an external cause of death (International Classification of Diseases, Ninth Revision [ICD-9]; E800-E999).[18] Electrocutions which occurred from 1980 through 1992 were identified by selecting those cases which had an ICD-9 code of “E925-accident caused by electrical current.”

An initial manual review identified certain events that occurred with greater frequency. Based on this review, 17% of the cases with specific circumstances were grouped through keyword searches of the literal information from the death certificates. A keyword search was done for “crane,” “boom,” “hoist,” and “rigging” to identify electrocutions involving boomed vehicles. Electrocutions involving ladders and scaffolds were identified through a search for “ladders” and “scaffolds.” A keyword search was conducted for “short cir,” “faulty,” “shorted,” “defective,” “malfunctioning,” “short,” and “damaged,” to identify those electrocutions involving contact with a short-circuited, damaged, or improperly installed wire or equipment. Contacts with a truck or other vehicle were located using the keywords “truck” and “vehicle.” Electrocutions involving grain augers and elevators were found through a search for “auger” and “elevator.” Because of the level of detail contained on death certificates, specific circumstances surrounding most of the deaths were not as easily categorized. For most of the remaining cases, the circumstances surrounding the electrocutions were missing, incomplete, or vague. While these cases were not removed from the analysis, to assign them to specific groups would involve a much more detailed review, which is not possible with death certificate data alone.

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Industry was coded into division-level industry categories using the 1987 Standard Industrial Classification System.[19] Occupation was grouped into major occupation divisions according to the 1980 and 1990 Bureau of the Census Occupational Classification System.[20,21] Employment estimates used to calculate fatality rates were extracted from the Bureau of Labor Statistics' *Employment and Earnings* annual average employment data.[22] The employment data from *Employment and Earnings* are based on the annual averages from the Current Population Survey, a sample survey of the population 16 years of age and over.

A detailed description and the limitations of the NTOF surveillance system have been reported previously.[12] Because the amount of detail on death certificates is sometimes limited and death certificates are known to capture approximately 81% of all work-related deaths,[23] the number of electrocutions presented should be considered the minimum number of deaths.

Results

A total of 5,348 workers were electrocuted in 5,180 incidents from 1980 through 1992. One-hundred fifty-three (3%) of the fatal incidents resulted in multiple fatalities: 140 incidents involved 2 victims each, 11 incidents involved 3 victims each, and 2 incidents involved 4 victims each.

An average of 411 workers were electrocuted each year, with an average annual rate of 0.4 per 100,000 workers. Figure 1 provides the frequency and rate per 100,000 workers of electrocutions by year of death. The substantial decrease is noteworthy, but it varies by industry. While total work-related fatalities decreased 23% from 1980 to 1989,[24] the number of electrocution deaths have decreased by more than 50% from 1980 to 1992.

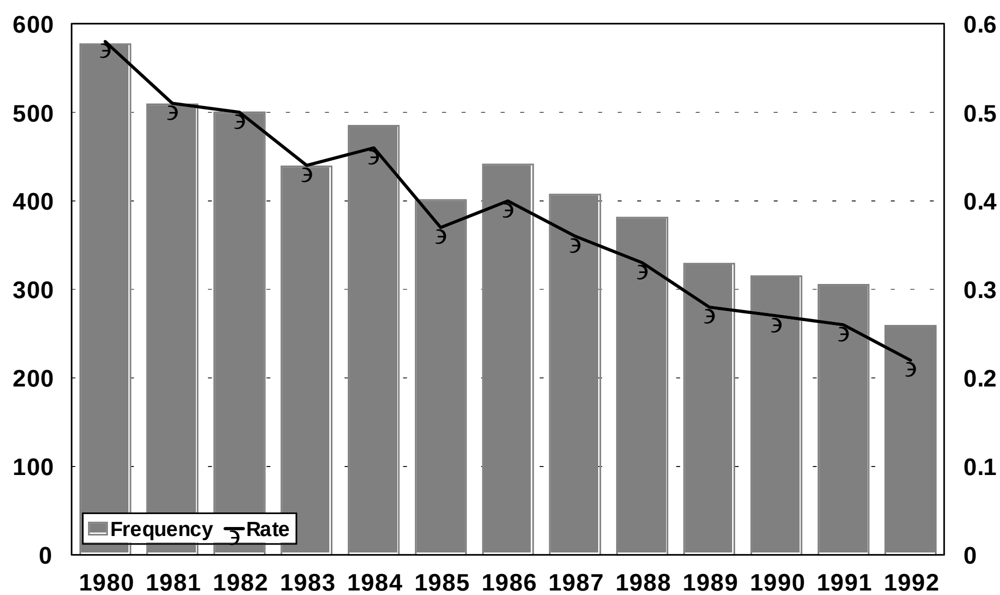

Figure 1. *Frequencies and Rates of Electrocution Deaths Identified by NTOF by Year, 1980-1992*

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Sixty percent of the electrocutions occurred to workers less than 35 years of age. Figure 2 provides frequencies and rates per 100,000 workers of electrocutions by age group.

Ninety-nine percent of the electrocutions occurred among men. Whites accounted for 86% of the electrocutions, followed by Blacks (7.1%), Hispanics (5.3%), Asians (0.4%), Native Americans (0.3%), and other and unknown races (0.8%).

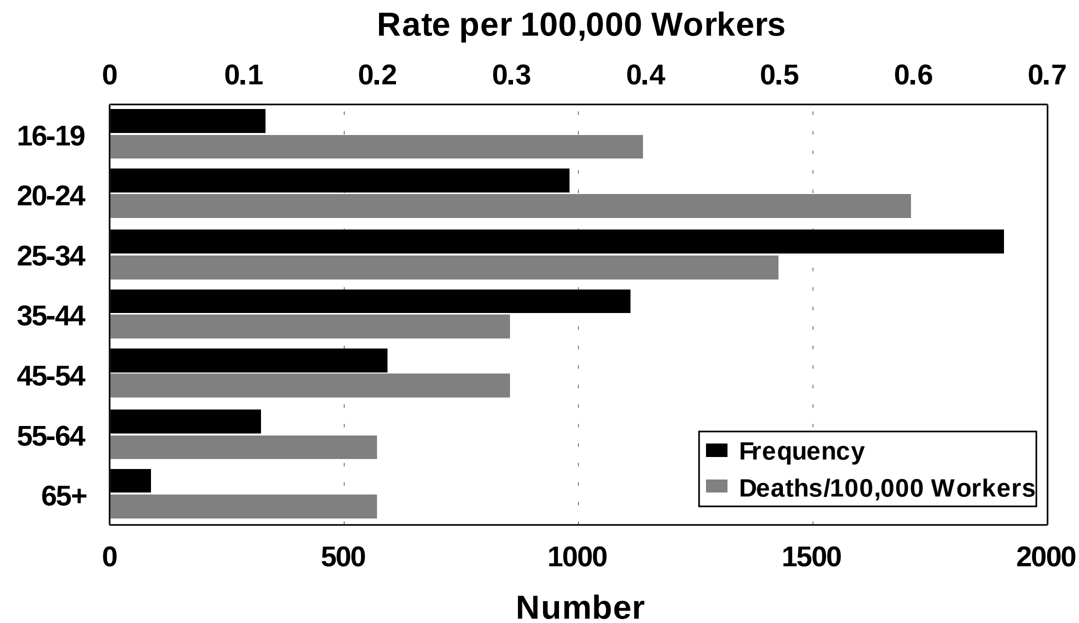

Figure 2. *Frequencies and Rates of Electrocution Deaths Identified by NTOF by Age Group, 1980-1992*

The industries with the highest percentage of electrocutions were construction (40%), transportation/ communication/public utilities (16%), manufacturing (12%), and agriculture/forestry/fishing (11%) (Figure 3). The construction industry had a rate of 2.4 per 100,000 workers, followed closely by mining which had a rate of 2.2 (Figure 3).

Over the 13-year period, 61% of the electrocutions occurred in two occupation divisions: 46% among craftsmen and 15% among laborers (Figure 4). These two groups also had the highest rates of electrocution death: 1.4 per 100,000 workers each (Figure 4).

Much of the information from death certificates for decedents involved in electrocutions is vague. However, certain circumstances were easily identifiable. Three-hundred thirty-seven (6%) of the victims contacted a boomed vehicle that was in contact with an energized power source. Two-hundred seventeen (4%) contacted a ladder or scaffold that was in contact with an energized power source. One-hundred fifty-three (3%) contacted short-circuited, damaged, or improperly installed wire or equipment. One-hundred twenty-nine (2%) contacted a truck or other vehicle, other than a boomed vehicle, which was in contact with an energized power source. Eighty-two (2%) contacted an energized grain auger or grain elevator. As previously described, the specific circumstances surrounding the electrocutions in the remaining 83% of the deaths were not categorized in these data.

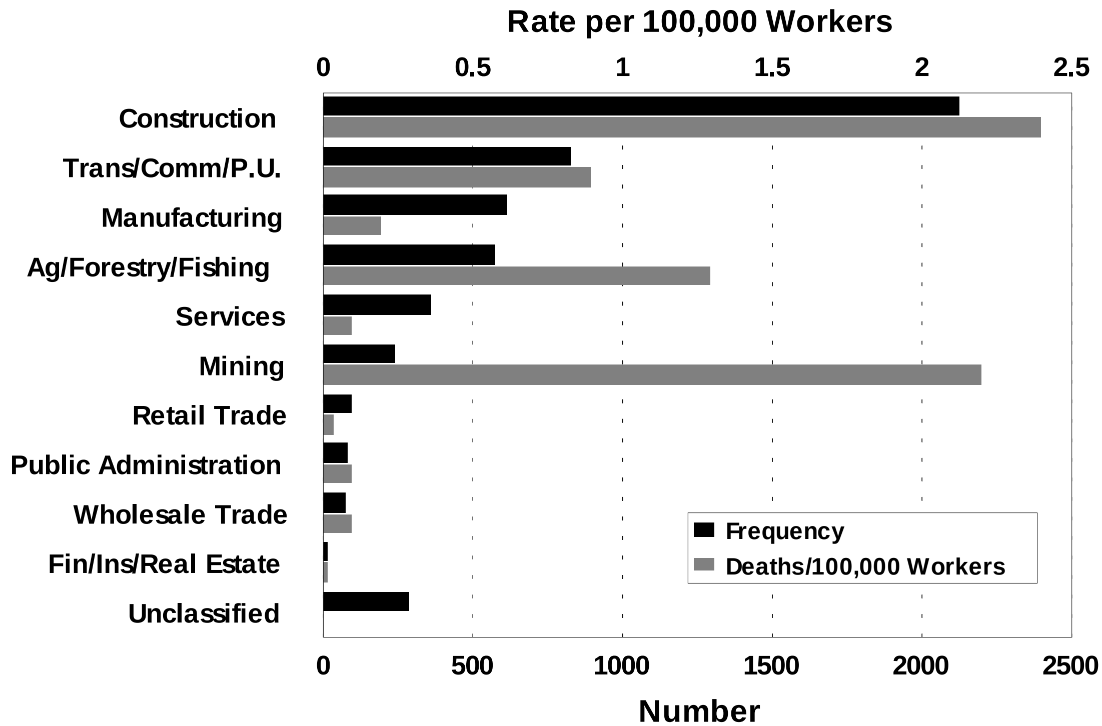

Figure 3. *Frequencies and Rates of Electrocution Deaths Identified by NTOF by Industry, 1980-1992*

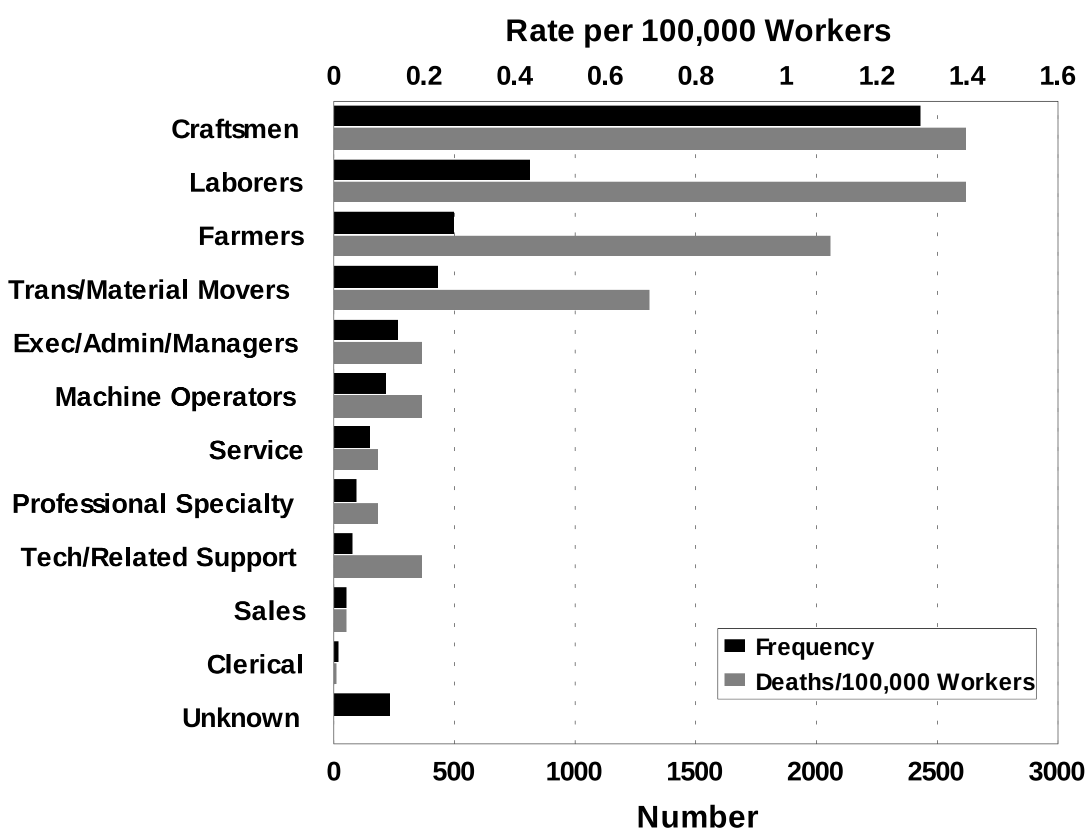

Figure 4. *Frequencies and Rates of Electrocution Deaths Identified by NTOF by Occupation, 1980-1992*

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FATALITY ASSESSMENT AND CONTROL EVALUATION (FACE) INVESTIGATIONS

Methods

During the period from November 1982 to December 1994, NIOSH investigated 224 electrocution incidents resulting in 244 occupational fatalities.[25] These investigations were undertaken as part of the Fatality Assessment and Control Evaluation (FACE) program conducted by (NIOSH). The FACE program was initiated in 1982 and directed from its inception by the NIOSH Division of Safety Research. FACE is a research program for the identification and investigation of fatal occupational injuries.

Derived from the research conducted by William Haddon, Jr. (the Haddon model), this approach reflects the public health perception that the etiology of injuries is multifactorial and largely preventable.[26] For each case, factors associated with the agent (mode of energy exchange), the host (the worker who died) and the environment are identified during the pre-event, event, and post-event time phases. These contributory factors are investigated in detail in each FACE incident, and are summarized in each FACE summary report, along with recommendations for preventing future incidents of a similar nature.

Investigators conducted investigations at the incident sites, evaluating each event's circumstances, including agent, host, and environmental characteristics. When an incident involved multiple fatalities, data were collected for each victim. Percentages presented here describe frequencies of incident characteristics. Rates could not be calculated due to the lack of comparable denominator data. Percentages do not necessarily reflect the risk to workers, but rather describe the problem's proportional magnitude.

Industry was coded into categories using the 1987 Standard Industrial Classification System[31] and occupations were grouped using the 1980 Bureau of the Census Occupational Classification System.[32]

Results

The victims (243 men and 1 woman) ranged in age from 17 to 70 years, and the mean age was 34 years. The loss of years of potential life before age 65 was substantial; for the 244 victims discussed in this analysis, the years of potential life lost (YPLL) equaled 7,903 years or an average of 33 years per victim. Sixty-four percent of the victims died prior to age 35 (Figure 5).

The industries with the highest number of electrocutions were Construction (121); followed by Manufacturing (40); Transportation, Communications, Public Utilities (30); and Public Administration (19) (Figure 6).

Figure 7 shows the 10 job classifications (occupations) with the highest number of fatalities. Although utility line workers (linemen) typically receive extensive training in electrical safety and the hazards associated with electrical energy, they had the highest number of fatal injuries. Twenty-six (55%) utility line worker fatalities were due to the failure to utilize required personal protective equipment (gloves, sleeves, mats, blankets, etc.). Laborers, who generally receive little or no electrical training, were the next highest classification.

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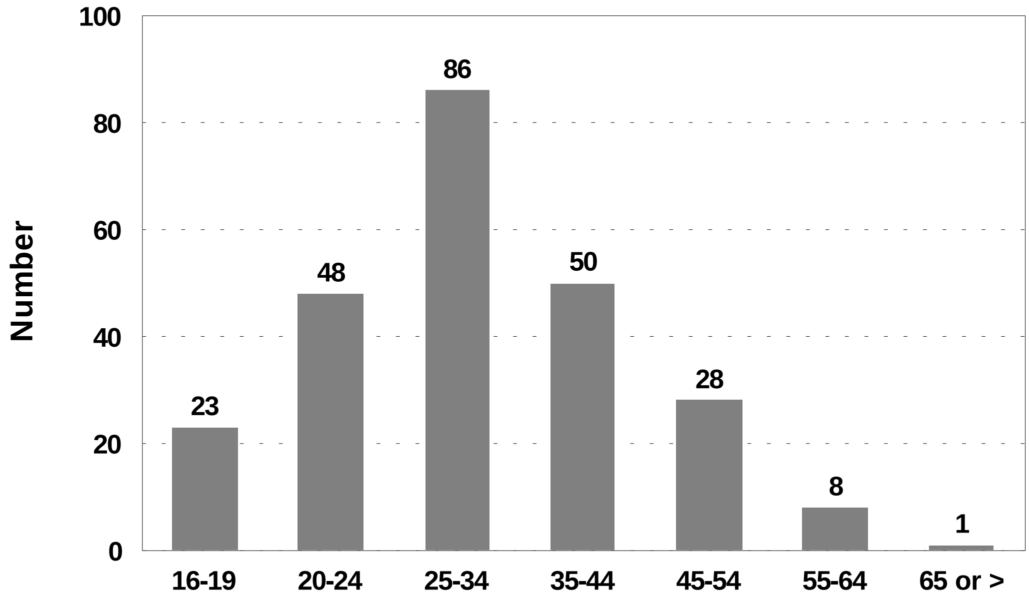

Figure 5. *Frequencies of Electrocution Deaths Identified by FACE by Age Group, 1982-1994*

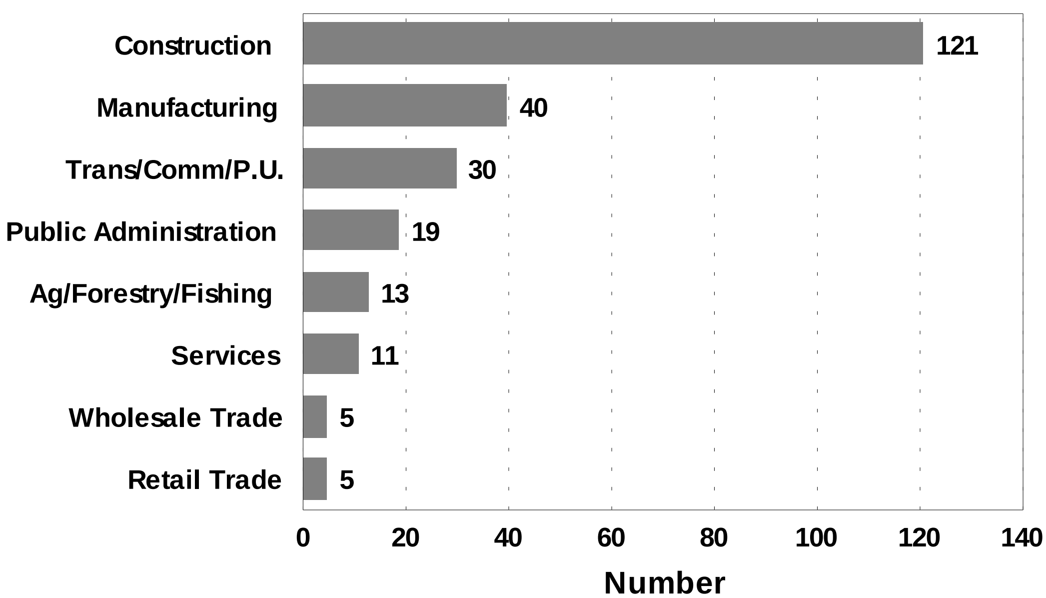

Figure 6. *Frequencies of Electrocution Deaths Identified by FACE by Industry, 1982-1994*

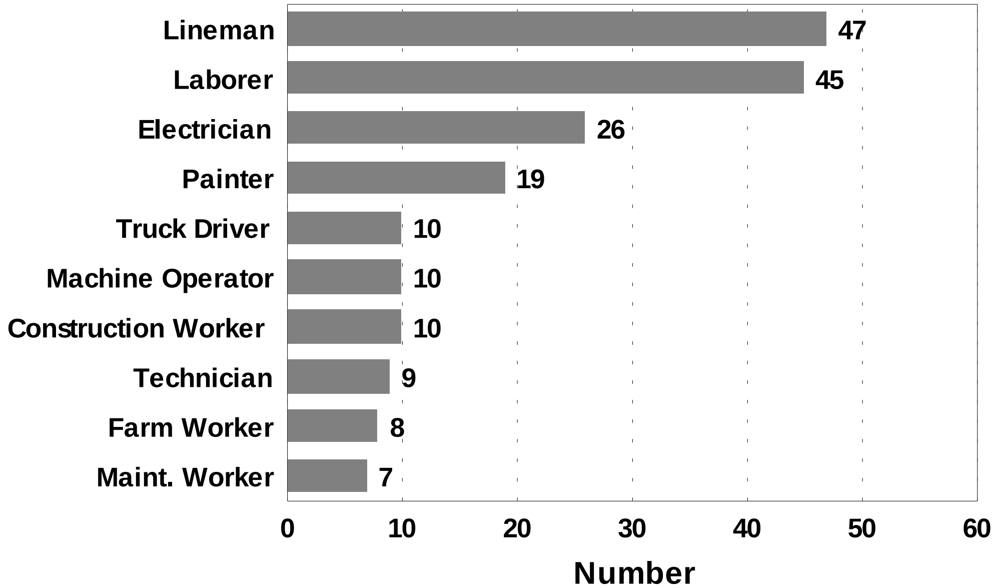

Figure 7. *Frequencies of Electrocution Deaths Identified by FACE by Occupation, 1982-1994*

The number of investigated electrocution incidents by month of occurrence are provided in Figure 8. The largest number of incidents occurred in months where weather conditions were most favorable for the highest level of outside activity.

In 79 (35%) of the incidents, no safety program or established, written safe work procedures existed.

Factors common to these incidents included the lack of enforcement of existing employer policies concerning the use of personal protective equipment, and the lack of supervisory intervention when existing safety policies were being violated. Supervision was present at the site in 120 (53%) of the incidents, and 42 victims were supervisors.

Of the 244 victims, 194 (80%) had some type of electrical safety training. On-the-job training, received by 102 victims, was the most common type of training. Thirty-nine victims received no training at all. One hundred (41%) of the victims had been on the job for less than 1 year.

Fifty-one (23%) of the incidents occurred at establishments that employed 500 or more workers. Eighty-five (38%) of the incidents occurred at establishments that employed less than 50 workers.

Two hundred twenty-one (99%) of the incidents involved alternating current (AC). One incident involved direct current (DC). Two incidents involved AC arcs. Of the 221 AC electrocutions, 74 (33%) involved less than 600 volts and 147 (66%) involved 600 volts or more. The number of electrocutions by voltage level is listed in Figures 9 and 10. Forty (54%) of the lower-voltage electrocutions involved household current of 120 to 240 volts. Manufacturing companies accounted for 40 (54%) of the lower-voltage incidents. This is particularly disturbing due to safety features such as electrical safety interlocks, emergency stop devices, and electrical guarding inherently designed into manufacturing equipment.

Of the 147 higher-voltage incidents, 111 (76%) involved distribution voltages (7,200-13,800 volts) and 21 incidents involved transmission voltages (above 13,800 volts). Of the incidents involving at least 7,200 volts, 41 (28%) resulted from contacting an energized powerline with a boomed vehicle. Thirty-five incidents occurred when conductive equipment such as an aluminum ladder or scaffold contacted an energized powerline. The weight of this equipment sometimes required more than one worker to move or position it, resulting in multiple fatalities. Thirteen deaths occurred in six separate incidents when workers erected or moved scaffolds that came in contact with energized, overhead powerlines. Electric powerline line mechanics were victims in 47 (36%) of the incidents involving transmission and distribution voltages.

Almost all American workers are exposed to electrical energy at sometime during their work day, and the same electrical hazards can affect workers in different industries. Based on the analysis of these cases, NIOSH identified five case scenarios that describe the incidents resulting in the 244 fatalities: (1) direct worker contact with an energized powerline (28%); (2) direct worker contact with energized equipment (21%); (3) boomed vehicle contact with an energized powerline (18%); (4) improperly installed or damaged equipment (17%); (5) conductive equipment contact with an energized powerline (16%).

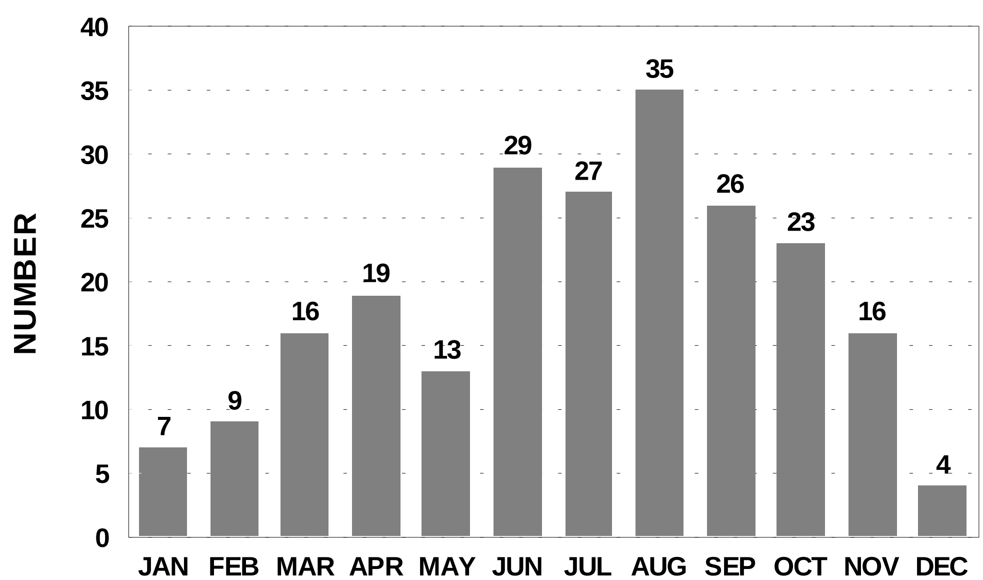

Figure 8. *Frequencies of Electrocution Incidents Identified by FACE by Month, 1982-1994*

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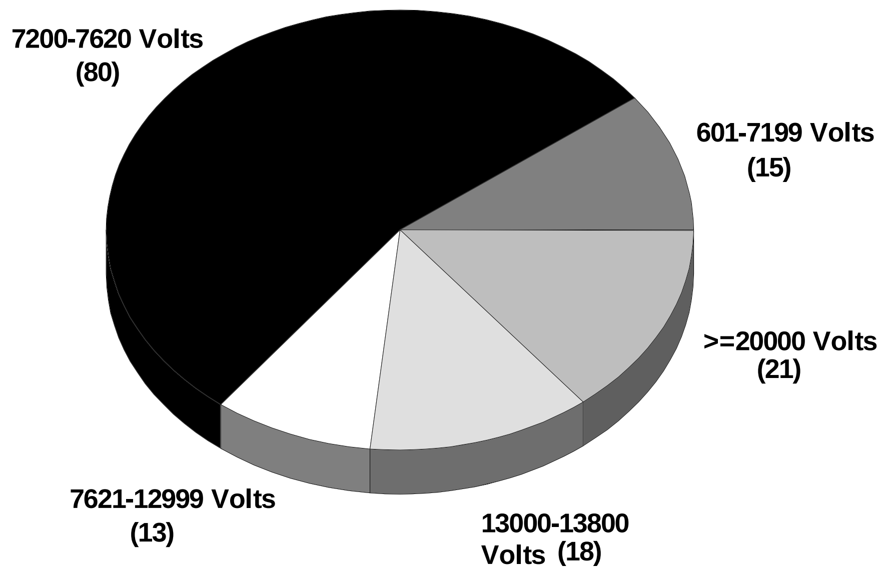

Figure 9. *Frequencies of Electrocution Incidents Identified by FACE by High Voltage Level (>600 Volts), 1982-1994*

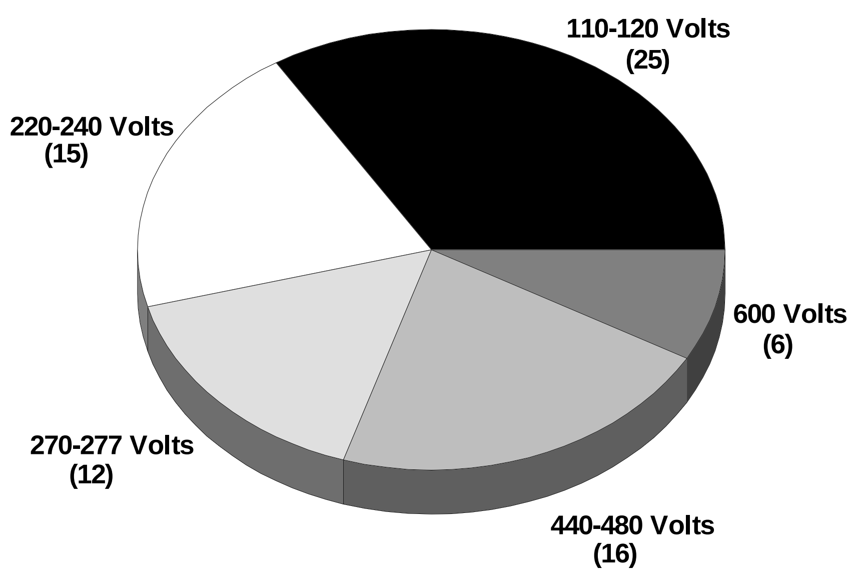

Figure 10. *Frequencies of Electrocution Incidents Identified by FACE by Low Voltage Level (<600 Volts), 1982-1994*

Scenario 1

Workers in various occupations such as sign technicians, tree trimmers, utility line workers, and telecommunication workers are often exposed to overhead powerlines. These exposures can be greatly reduced by isolating or insulating the energy source from the worker. This can be accomplished by erecting a physical barrier, by insulating the powerline, or by following required clearance distances. More than once during FACE investigations, co-workers interviewed did not know the powerlines posed a hazard, i.e., they thought the powerlines were insulated.

Scenario 2

Direct worker contact with energized equipment can occur in a variety of ways. Maintenance technicians might inadvertently contact overhead crane runway conductors. Electricians or technicians troubleshooting or testing electric circuitry might contact an energized circuit. Maintenance workers may fail to replace an isolating plate covering electrical conductors, exposing passing workers. Compliance with the applicable articles of the National Electrical Code and lockout/tagout procedures established by OSHA could eliminate the potential for such contact, thereby reducing the risk of electrocution.

Scenario 3

Workers guiding suspended loads, or standing against or near a crane or other boomed vehicle—such as a concrete pumping truck, or derrick truck—whose boom contacts a powerline are in danger of electrocution. The risk of electrocution could be reduced if OSHA regulations regarding clearance distances [(29 CFR 1926.550 (a)(15)] are observed, or if the required lookout person [29 CFR 1926.550 (a)(15)(iv)] is utilized.

Scenario 4

Improperly installed or damaged equipment can be responsible for occupational electrocutions in a variety of ways. The most frequently cited OSHA electrical regulation is improper grounding of equipment or electrical circuitry. If the frame of a piece of electrical equipment or machinery does not have a grounding conductor attaching the frame to ground, as required to divert dangerous fault current to ground, and an electrical fault occurs, anyone touching that frame and any other object at ground potential would receive an electrical shock. Should a fault occur with a grounding conductor present, the circuit would open or trip as an alert that a problem existed, except in high-resistance grounding applications. Damaged guards can expose workers to energized conductors in proximity to their work areas. Additionally, damaged extension cords or extension cords with their ground prong removed can expose workers to the danger of electrocution.

Failure to maintain a continuous path to ground can expose entire electrical systems to damage and can expose the structures within which they are housed and workers within these structures to electrical and fire hazards.

For example, many electrical systems are installed in a manner that allows a structure's water pipes or other conductive conduit to serve as a continuous path to ground in compliance with the NEC. However, FACE investigations have identified cases of electrocution or fire as a result of an interruption in a continuous path to ground. During renovation or repair activities, conductive components may be replaced by nonconductive components such as PVC pipe, which will interrupt the path to ground. This may result in fire due to the intense overheating of components of the electrical system. Additionally, workers contacting improperly grounded components while being at ground potential would be exposed to electric shock.

Scenario 5

The task of positioning or repositioning conductive equipment may place more than one worker at risk. The weight of mobile scaffolding, grain augers, or aluminum extension ladders equipped with pendant-operated lifts often requires more than one worker for positioning or repositioning, resulting in multiple electrocutions if contact with an overhead powerline occurs. Using a lookout person, observing required clearance distances, or lowering this equipment before transport would greatly reduce worker exposure to any potential electrical hazards present.

DISCUSSION

The fatality data from NTOF help to illustrate the magnitude of the electrocution problem nationally and allow a comparison of the potential risks in various industries. The information from FACE investigations allows for the identification of more detailed information on electrocution hazards, such as contact with overhead powerlines, contact with exposed conductors, inadequate personal protective equipment, and nonexistent lockout/tagout procedures, or other measures necessary for working around energized conductors and equipment.

FACE reports and NTOF death certificates identified many of the same hazards for fatal electrocutions. The largest number of deaths were in Construction, Transportation/Communication/Public Utilities, and Manufacturing, while the highest fatality rates were in the Construction and Mining industries. Linemen were involved in the largest number of electrocutions.

Direct worker contact with an energized powerline caused the largest number of electrocution deaths. Almost all of the incidents investigated by FACE involved alternating current. Over half of these incidents involved voltages over 600 volts. Of the 147 higher-voltage electrocutions, over two-thirds involved distribution voltages (7,200-13,800 volts).

While progress has been made in reducing the number of work-related electrocutions, (50% decrease from 1980-1992), additional efforts are needed if we are to continue progress towards preventing deaths due to electrocution.

PREVENTION: ELEMENTS OF AN ELECTRICAL SAFETY PROGRAM

Virgil Casini, B.S.

At least one of the following five factors was present in all 224 incidents evaluated by the FACE program: (1) established safe work procedures were either not implemented or not followed; (2) adequate or required personal protective equipment was not provided or worn; (3) lockout/tagout procedures were either not implemented or not followed; (4) compliance with existing OSHA, NEC, and NESC regulations were not implemented; and (5) worker and supervisor training in electrical safety was not adequate. These subjects are addressed in various NIOSH Alerts[26-36] and related publications.[37]

Most of the 224 occupational electrocution incidents investigated as part of the FACE program could have been prevented through compliance with existing OSHA, NEC, and NESC regulations; and/or the use of adequate personal protective equipment (PPE). All workers should receive hazard awareness training so that they will be able to identify existing and potential hazards present in their workplaces and relate the potential seriousness of the injuries associated with each hazard. Once these hazards are identified, employers should develop measures that would allow for their immediate control.

Based on an analysis of these data, to reduce occupational electrocutions, employers should:

- Develop and implement a comprehensive safety program and, when necessary, revise existing programs to thoroughly address the area of electrical safety in the workplace.

- Ensure compliance with existing OSHA regulations Subpart S of 29 CFR 1910.302 through 1910.399 of the General Industry Safety and Health Standards[3] and Subpart K of 29 CFR 1926.402 through 1926.408 of the OSHA Construction Safety and Health Standards.[4]

- Provide all workers with adequate training in the identification and control of the hazards associated with electrical energy in their workplace.

- Provide additional specialized electrical safety training to those workers working with or around exposed components of electric circuits. This training should include, but not be limited to, training in basic electrical theory, proper safe work procedures, hazard awareness and identification, proper use of PPE, proper lockout/tagout procedures, first aid including CPR, and proper rescue procedures. Provisions should be made for periodic retraining as necessary.

- Develop and implement procedures to control hazardous electrical energy which include lockout and tagout procedures and ensure that workers follow these procedures.

- Provide those workers who work directly with electrical energy with testing or detection equipment that will ensure their safety during performance of their assigned tasks.

- Ensure Compliance with the National Electrical Code[5] and the National Electrical Safety Code.[6]

- Conduct safety meetings at regular intervals.

- Conduct scheduled and unscheduled safety inspections at worksites.

- Actively encourage all workers to participate in workplace safety.

- In a construction setting, conduct a jobsite survey before starting any work to identify any electrical hazards, implement appropriate control measures, and provide training to employees specific to all identified hazards.

- Ensure that proper personal protective equipment is available and worn by workers where required (including fall protection equipment).

- Conduct job hazard analyses of all tasks that might expose workers to the hazards associated with electrical energy and implement control measures that will adequately insulate and isolate workers from electrical energy.

- Identify potential electrical hazards and appropriate safety interventions during the planning phase of construction or maintenance projects. This planning should address the project from start to finish to ensure workers have the safest possible work environment.

The FACE data indicate that although many companies had comprehensive safety programs, in many cases they were not completely implemented. This underscores the need for increased management and worker understanding, awareness, and ability to identify the hazards associated with working on or in proximity to electrical energy. It is the responsibility of management to provide a safe workplace for their workers and to develop and implement a comprehensive safety program. In some cases, this may entail the development of additional worker training, and/or the evaluation and restructuring of existing safety programs. Management should also provide adequate training in electrical safety to all workers and strictly enforce adherence to established safe work procedures and policies. Additionally, adequate personal protective equipment should be available where appropriate. Information or assistance in accomplishing these measures can be provided by OSHA, electrical safety consultants, or other agencies or associations that deal with electrical safety. A strong commitment to safety by both management and workers is essential in the prevention of severe occupational injuries and death due to contact with electrical energy.

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PART II

FATALITY ASSESSMENT AND CONTROL EVALUATION (FACE) INDEX AND SUMMARY REPORT ABSTRACTS, 1982-1994 ELECTROCUTIONS

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FACE ELECTROCUTION CASES FOR MONOGRAPH

The following pages contain a list of the FACE investigative reports included on this CD by case report number, along with the report title and a short description of each case. The first two numbers of the case report number denote the year in which the case was investigated; the following two numbers identify a sequential file number for a particular year.

Clicking on the FACE report number or the Bookmark margin will link directly to the FACE report.

82-03: Electrocution Resulting from Crane Cable Contact with Power Line
Truck driver standing on the ground directing crane operator electrocuted when crane cable contacted 7200V powerline. Victim on the ground helping to guide a ladder being positioned by the crane.

83-08: Fatal Incident Summary Report: Electrocution of an Electrician
Electrician electrocuted at coal-fired power plant while replacing limit switch on coal sampler. Lockout procedures not followed. Contact with 220V line.

83-09: Fatal Incident Summary Report: Electrocution of a Painter
Painter working on electrical transmission tower electrocuted after direct contact with a grounding line that held a static charge.

84-17: Fatal Accident Summary Report: Electrocution in a Fast Food Restaurant
Fast food restaurant employee electrocuted while plugging a portable electric toaster into a 110V/20 amp receptacle.

85-01: Worker Electrocuted at Power Substation in Howesville, West Virginia
Worker electrocuted through direct contact with overhead 69000V powerline while dismantling electric substation tower. Co-worker had advised victim that lines not yet deenergized by power company.

85-03: Transportation Employee Dies from Electrical Injuries Resulting from Contact with Overhead Powerline
Transportation worker electrocuted when iron rod used to measure asphalt level in storage tank contacted overhead 7200V powerline.

85-04: Crew Foreman Dies Due to Electric Arc from Power Line
Electrical line construction foreman electrocuted by electric arc while attempting to cut 7200V powerline and attach it to new pole.

85-06: 19-Year-Old Warehouseman Electrocuted by a 440 Volt Trolley Wire in Kentucky
Warehouse worker electrocuted after coming in contact with bare 440V runway conductor (trolley wire) and grounded metal pallet storage rack. Victim at top of storage rack helping to remove mining auger by attaching a chain to it so it could be lowered by a crane.

85-07: Two Workers Electrocuted by 23,000 Volt Power Line While Erecting a Steel Support Structure

Two steel erection workers electrocuted while using a crane with a telescoping boom to move an assembly of steel framing members. Contact with 23000V overhead powerline.

85-08: Workman Electrocuted When Crane Load Line Contacts 7200 Volt Power Line

Construction worker electrocuted when crane load line contacted 7200V overhead powerline. Victim in process of hooking a load to the crane.

85-11: Worker Electrocuted in Mushroom Cannery in Ohio

Mushroom cannery worker electrocuted while attempting to unclog a drain beneath a processing table. Victim contacted motor connection box while kneeling in water.

85-14: Construction Worker Electrocuted When Crane Boom Contacts 13,800 Volt Power Line in Arizona

Construction worker electrocuted when crane cable contacted 13800V overhead powerline. Victim in contact with crane's outrigger.

85-15: Electrocution of Carpenter, Setting Forms, When Crane Contacted 34,000 volt Power Line in Pennsylvania

Carpenter electrocuted and another worker severely burned when crane with telescoping boom contacted 34000V overhead powerline while he was setting metal forms for a highway retaining wall. Electricity passed from cable through form through victim to ground.

85-16: General Foreman Electrocuted While Testing Circuits in North Carolina

Foreman electrocuted after contacting one phase of a 23000V conductor within a switch cabinet. Replacing high-voltage distribution switch at the time of the incident.

85-17: City Foreman Electrocuted and Three Crew Workers Critically Injured While Erecting a Traffic Control Pole

Foreman electrocuted, three crewmen critically injured during erection of 36-foot traffic control device pole which contacted 26000V overhead powerline as derrick truck operator attempted to place it.

85-18: Worker Electrocuted By 7200 Volt Power Line in North Carolina

Construction worker electrocuted when 7200V overhead powerline fell on trailer attached to utility truck.

85-19: Truck Driver Electrocuted while Unloading Concrete Blocks in North Carolina

Driver unloading concrete blocks at building supply mart electrocuted when boom of truck-mounted crane apparently contacted 9000V overhead powerline. Outriggers on truck not set. Truck tipped while boom only 12 to 18 inches from powerline.

85-21: Billboard Worker Dies When Metal Ladder Contacts 7200 Volt Power Line in Kentucky

Worker on billboard electrocuted when 24-foot metal hook ladder contacted an overhead powerline.

85-22: Fireman Electrocuted While Rappelling Down Building in West Virginia
Volunteer firefighter electrocuted after contacting 7200V overhead powerline while rappelling down the front of a fire station.

85-24: Video Store Owner Electrocuted
Video store owner electrocuted when he contacted an energized circuit while repairing an air conditioning thermostat. Victim grounded through aluminum ladder.

85-25: Contract Worker Electrocuted While Repairing 13.2 kV Power Line in North Carolina
Lineman electrocuted after contacting a distribution system he believed to be deenergized.

85-28: 29-Year-Old Welder Electrocuted in Ohio
Maintenance worker electrocuted as he attempted to turn off a welder. Exposed cable, broken insulation, water on floor.

85-29: Two Construction Workers Electrocuted When Crane Contacts One Phase of a 13.4 kV System in Tennessee
Two construction laborers electrocuted when a crane contacted a 13400V overhead powerline under installation by another firm.

85-30: Sign Serviceman Working Off of a Truck Mounted Platform Ladder Electrocuted in Ohio
Sign service worker working from aerial ladder truck electrocuted by direct contact with 7200V overhead powerline.

85-32: 20-Year-Old Construction Worker Electrocuted when Backhoe Contacts 7200 Volt Power Line at Construction Site in Kentucky
Construction worker electrocuted when backhoe broke utility pole, causing 7200V overhead powerline to fall a few feet from where he was standing.

85-34: Billboard Worker Dies when Scaffold Makes Contact with Power Line in Tennessee
Billboard worker electrocuted as scaffold contacted 13800V overhead powerline. Working from “stage”-type scaffold positioned between catwalk and billboard.

85-35: 24-Year-Old Textile Worker Electrocuted in North Carolina
Textile worker electrocuted while adding a new supply roll of warp to a weaving loom after contacting a loom and a feeder. Faulty receptacle to feeder.

85-36: Employee of an Electrical Contracting Firm is Electrocuted in North Carolina
Electrical worker electrocuted when he slipped and fell into a 7200V, 240/120V single-phase, step-down transformer he was wiring.

85-37: Brick Worker Electrocuted in Georgia
Brick company worker electrocuted when boom on a truck-mounted crane he was operating with a pendant controller contacted a 7200V overhead powerline.

85-38: Production Welder Electrocuted in Ohio
Production welder plugged cord of a portable welder into a defective extension cord and was electrocuted.

85-39: Worker in Rubber Products Plant Electrocuted in Ohio
Maintenance worker electrocuted when 20-foot piece of angle iron he was carrying struck an uninsulated supply wire on an electrical transformer.

85-41: Mobile Home Assembly Line Worker is Electrocuted in Ohio
Mobile home assembly-line worker electrocuted when he contacted the exterior of a mobile home energized by a short circuit in the wiring of an adjacent home.

85-42: Utility Company Employee Electrocuted in California While Drilling Under a Road
While drilling horizontally under a road to install new gas lines, a gas utility worker was electrocuted after a drill contacted a 4160V powerline. Co-worker injured.

85-43: County Worker Dies In Tennessee
County highway worker electrocuted when the 20-foot steel handle of a modified post-hole digger he was holding contacted a 7200V overhead powerline.

85-46: Soldier Electrocuted While Installing Communication Wire in Georgia
Soldier electrocuted while installing WD-1 communication wire across road on military firing range. Threw wire across 440V powerlines that crossed the road.

85-47: Iron Worker Electrocuted in Indiana
Iron worker electrocuted after touching ceiling fixture as he was transported from work station in a truck-mounted aerial bucket.

85-48: Service Technician Electrocuted in North Carolina
Service technician electrocuted in crawlspace at private home while performing maintenance on an oil furnace.

86-01: Electronics Plant Employee Electrocuted in North Carolina
Electronic technician electrocuted as he demonstrated how feeders were to be connected to bus bars. Contact with 380 volts.

86-02: A Journeyman Electrician Electrocuted in North Carolina
Electrician electrocuted after contacting 277 volts while making a connection in a 4-inch junction box at a construction site.

86-03: Electric Company Lineman Electrocuted in Indiana
Lineman electrocuted while attaching a guy wire to a utility pole during installation of a 7200V powerline between adjoining poles.

86-04: Electric Company Employee Electrocuted in Ohio
Utility worker electrocuted while trying to open a pole-mounted, ground-level air switch on a three-phase, 69000V powerline.

86-05: School Maintenance Worker Electrocuted in Ohio
School maintenance worker electrocuted after contacting transformer wire.

86-06: Three Electrocuted on Farm in Georgia

Three farm workers electrocuted when grain auger they were moving contacted a 7200V overhead powerline.

86-07: Two Electrocuted on Farm in Georgia

Two farm workers electrocuted when grain auger they were moving contacted a 7200V overhead powerline.

86-08: 18-Year-Old Electrician's Apprentice Electrocuted in North Carolina

Apprentice electrician electrocuted after contacting 277V uninsulated wire during installation of overhead junction box.

86-09: Lineman Electrocuted in North Carolina

Lineman electrocuted while working from an aerial bucket truck to install a transformer. Direct contact with 13200V overhead powerline. Truck not grounded.

86-11: Two Electrical Contractor Employees Electrocuted in Kentucky

Two electrical workers in aerial bucket electrocuted while attaching transformer to utility pole. Operator on ground inadvertently moved boom upward, causing victims to directly contact high-voltage overhead powerline.

86-14: 21-Year-Old Technician Electrocuted in Indiana

Operator of plastic extrusion machine electrocuted after contacting metal machine part energized at 10000V (used for treating plastic sheeting). Incident occurred while another worker performing maintenance on machine.

86-16: Printing Machine Operator Electrocuted in Indiana

Bindery machine operator electrocuted when he contacted a 480V circuit inside a panel box while trying to check an electrical relay.

86-17: 28-Year-Old Truck Driver Electrocuted in Georgia

Truck driver electrocuted when crane boom on his truck contacted a 7200V overhead powerline. Unloading precast concrete manhole assemblies.

86-18: Telephone Construction Worker Electrocuted in North Carolina

Telephone construction worker electrocuted and two other workers injured when the boom of a truck crane contacted a 7200V overhead powerline. Victim was groundman repairing a guy wire section laying across the truck crane’s outrigger.

86-20: 23-Year-Old Lineman Electrocuted in North Carolina

Lineman electrocuted after contacting a lightning arrester conductor while working from an aerial bucket. Contact with 7200V overhead powerline.

86-21: Lineman Electrocuted in North Carolina

Lineman electrocuted when he contacted a 7200V powerline at an electrical substation. Line erroneously assumed to be dead.

86-22: 21-Year-Old Electrocuted While Moving Grain Auger in Indiana
Warehouse worker guiding grain auger by hand electrocuted as auger contacted 12470V distribution system.

86-24: 37-Year-Old Scale Technician Electrocuted in Indiana
Scale technician electrocuted while helping a crane operator prepare to lift a platform scale frame. Wire winch cable extending from boom tip contacted a 7200V overhead powerline.

86-25: 34-Year-Old Superintendent of Manufacturing Electrocuted in North Carolina
Superintendent electrocuted while inspecting electrical relays in an electrical control panel box.

86-26: 50-Year-Old Utility Worker Electrocuted in Ohio
Utility worker electrocuted when aerial bucket in which he was working contacted a 7200V overhead powerline.

86-27: Part-time Laborer Electrocuted in Ohio
Laborer electrocuted when metal pole he was carrying (used to scrape soot from plant smokestacks) contacted a 7200V overhead powerline. Co-worker apparently attempting rescue seriously burned.

86-28: 24-Year-Old Manufactured Home Installer Electrocuted in Indiana
Worker electrocuted while using a 110V auger to install tie-down rods for a manufactured home. Auger had no continuous grounding system. Co-worker received shock, after which auger fell across victim, electrocuting him.

86-29: 29-Year-Old Mechanic Electrocuted in Indiana
Mechanic electrocuted when he contacted a grounded horizontal conductor with one hand and an energized three-way connector with the other. Performing maintenance on electrical distribution system.

86-30: Township Maintenance Worker Electrocuted in Ohio
Maintenance worker electrocuted when aluminum pruning pole with a saw attached to it contacted a 7200V overhead powerline while he was trimming a tree.

86-31: 23-Year-Old Groundman Electrocuted in North Carolina
Groundman electrocuted while transferring electric distribution lines and a transformer to a new utility pole. Co-worker seriously injured.

86-32: General Laborer Electrocuted in North Carolina
Laborer at pickle plant electrocuted when he contacted a faulty splice on a 440V power cord for a portable pump while filling a tank with brine.

86-33: 26-Year-Old Electrician's Helper Electrocuted in South Carolina
Electrician’s helper electrocuted while wiring a fluorescent light fixture in a suspended ceiling. Procedures for deenergizing and testing of circuits not followed.

86-35: 34-Year-Old Maintenance Worker Electrocuted in Ohio
Maintenance worker electrocuted while replacing a ballast in a fluorescent light fixture. Conductor not deenergized, polarity reversed because of installation error.

86-36: 22-Year-Old Construction Worker Electrocuted in Kentucky
Carpenter electrocuted when portable electric saw apparently developed a ground fault. Engaged in construction of laundry building for apartment complex.

86-39: Two Workers Electrocuted in Tennessee
Painter and carpenter electrocuted when a tubular metal scaffold they were rolling to another work area contacted a 12000V overhead powerline.

86-40: 37-Year-Old Lineman Electrocuted in Georgia
Lineman on utility pole electrocuted while reaching overhead with a hot-stick to place a jumper line on one phase of a three-phase 7200V primary line.

86-41: 52-Year-Old Electrical Technician Electrocuted in Indiana
Electrical technician electrocuted while testing circuits in a metal cabinet housing power transmission and distribution equipment. Contact with 10000V energized resistor.

86-42: 31-Year-Old Groundman Electrocuted in North Carolina
Groundman electrocuted while cleaning connectors that linked overhead powerlines to service lines to a private home. Victim working without rubber gloves from aerial bucket truck.

86-43: 25-Year-Old Restaurant Manager Electrocuted in North Carolina
Restaurant manager electrocuted after contacting handle of refrigerator that had a ground fault. Slipped on wet, soapy floor he was cleaning.

86-45: 29-Year-Old Electrocuted at Ice Cream Plant in Tennessee
Maintenance worker electrocuted when he contacted an energized circuit in the control box of a popsicle-wrapping machine that was not working. Victim performing diagnostic tests while standing on a metal platform one foot above a wet floor.

86-46: 21-Year-Old Groundman Electrocuted in Tennessee
Groundman electrocuted when truck's aerial boom contacted a 7200V overhead powerline while he was in contact with the truck.

86-47: 54-Year-Old Certified Electrician Dies in North Carolina
Electrician electrocuted while repairing airport runway lights. Co-worker misinterpreted signal, reenergizing circuit before electrician finished.

86-49: National Guardsman Electrocuted in West Virginia
National Guard commander electrocuted when he climbed a tower supporting 46000V transmission lines and contacted a jumper line. Engaged in demolition of tower as training exercise.

86-50: 40-Year-Old Lineman Technician Electrocuted in North Carolina
Meter technician, working as a lineman, electrocuted while attempting to repair a fallen 120V powerline. Powerline splice caught victim's glove, exposing his arm to direct 120-volt current.

86-51: 41-Year-Old Truck Driver Electrocuted in Kentucky

Truck driver electrocuted while operating remote control of a truck-mounted crane boom that contacted overhead 7200V powerline. Electric current traveled through controller to victim to ground.

86-53: 52-Year-Old First Class Electrician Electrocuted in Indiana

Electrician electrocuted while performing preventive maintenance on a high-voltage circuit breaker at electrical substation.

86-55: Lead Line Mechanic Electrocuted in Maryland

Line mechanic electrocuted after contacting energized tap while replacing a fuse holder.

87-02: 36-Year-Old Laborer Electrocuted In North Carolina

Laborer electrocuted when he contacted a 7200V overhead powerline. Standing on roof of house as it was being moved to another location, lifting overhead wires so they would clear the house.

87-03: Mechanic Electrocuted in Tennessee

Mechanic electrocuted when 25-foot two-way radio antenna he was helping to load contacted a 7200V overhead powerline.

87-04: Apprentice Sheetmetal Worker Electrocuted in Tennessee

Sheet metal apprentice electrocuted while guiding a powered scaffold that was being unloaded from the flatbed of a truck with a truck-mounted crane. Hoist cable contacted 6500V overhead powerline, and was engulfed in flames. Victim standing on wet ground nearby.

87-07: 34-Year-Old Machine Operator Electrocuted in Ohio

Machine operator electrocuted when he contacted an energized conductor in a motor control box that had had the cover plate removed. Using gang slitter machine to cut bulk rolls of fiberglass at time of incident.

87-08: Laborer Electrocuted in North Carolina

Laborer electrocuted when 21-foot aluminum flagpole he was installing contacted a 7200V overhead powerline. Victim carrying flagpole upright.

87-09: Laborer Electrocuted in Maryland

Laborer electrocuted when he contacted a 13000V underground powerline while digging with a pneumatic clay spade.

87-10: Pump Operator/Truck Driver Electrocuted in Maryland

Pump operator electrocuted when the boom on the truck-mounted concrete pump he was operating contacted a 7600V overhead powerline. Incident unwitnessed, but victim probably standing beside truck using a pendant controller.

87-11: Laborer Electrocuted in Ohio

Laborer in oil recycling plant electrocuted when he contacted a pump housing that had become energized due to faulty wiring. Engaged in pumping oil from a filtering tank to an analysis kettle.

87-12: Four Members of a Maintenance Crew Electrocuted in California at a Major Naval Installation

Four maintenance workers at a naval installation electrocuted, and a crew chief critically injured, when the tubular welded-frame scaffold they were wheeling into position contacted a 12000V overhead powerline.

87-13: Laborer Electrocuted in Tennessee

Laborer helping to unload sewer pipe electrocuted when the boom cable of a truck-mounted crane contacted an overhead powerline, causing an electrical arc. Victim grasping pipe and wire choker at time of incident.

87-14: Stagehand Electrocuted in Tennessee

Stagehand electrocuted when he contacted an exposed electrical wire protruding from a junction box. Victim lying on a metal catwalk reaching out to replace a ceiling tile when incident occurred.

87-15: 19-Year-Old Laborer Electrocuted in Kentucky

Laborer painting a concrete silo electrocuted when his telescoping paint roller contacted a 7200V overhead powerline.

87-16: 31-Year-Old Fire Chief Electrocuted in North Carolina

Fire chief electrocuted while trying to remove an injured person from a car which had hit a pole carrying a 7200V powerline.

87-18: Worker Electrocuted in South Carolina

Laborer electrocuted while steam-cleaning a rubber mill (converts bulk rubber to strips). Contacted machine, which had energized switch, while standing in water with a metal cleaning wand.

87-19: 20-Year-Old Bricklayer Electrocuted in Maryland

Bricklayer engaged in construction of brick wall electrocuted when tubular welded-frame scaffold contacted 7620V overhead powerline. Electric current flowed from the powerline to a section of wire reinforcement carried by a co-worker to the scaffold to victim to ground.

87-21: Injection Mold "Set-Up" Man Electrocuted in Tennessee

Worker setting up injection molding machine in plastics manufacturing plant electrocuted when he contacted an adjacent grinding machine that had a ground fault.

87-22: Laborer Electrocuted in Ohio

Mold-maker apprentice electrocuted while trying to repair and install a fluorescent light fixture that had a short circuit.

87-24: Lineman Apprentice Electrocuted in Indiana

Apprentice lineman electrocuted while attaching a wooden cross arm to a new utility pole. Direct contact with 12000V powerline on an existing pole.

87-28: Two Painters Electrocuted in Ohio

Two painters electrocuted while painting a 20-foot metal light pole from an aluminum ladder. One victim on ladder, the other on ground steadying ladder. Ladder apparently slipped, then slid along crossbar of light pole, placing victim on ladder in contact with 12460V overhead powerline and electrocuting the victim on the ground.

87-29: Lathe Operator Electrocuted in North Carolina

Lathe operator electrocuted when he contacted the frame of a lathe energized by a ground fault, presumably while walking between two lathes.

87-31: 28-Year-Old Electronic Technician Dies from Electrical Burns in Georgia

Electronic technician died of burns sustained in explosion in a 20000V switch compartment at a rail car maintenance shop. Victim sprayed cleaning fluid on energized circuits causing ignition.

87-32: 27-Year-Old Painter Electrocuted in Georgia

Painter electrocuted when 24-foot aluminum ladder he was positioning contacted 7200V overhead powerline. Victim working alone to paint gutters on apartment building .

87-34: 19-Year-Old Electrician's Apprentice Electrocuted In Georgia

Electrician's apprentice electrocuted when he contacted live conductors while disassembling an energized switch box in an office building. Victim apparently believed box to be deenergized.

87-35: Lineman Electrocuted in Maryland

Lineman electrocuted while changing jumper wire at electrical substation, contacting energized switch (34500V lines).

87-36: 41-Year-Old Truck Driver Electrocuted After Unloading Bricks in Maryland

Truck driver electrocuted when his truck-mounted crane contacted a 7600V overhead powerline. Standing at rear of truck operating crane with conductive pendant controller.

87-37: Truck Driver Electrocuted in North Carolina

Truck driver electrocuted when the bed of his dump truck contacted a 7200V overhead powerline. Presumably stepped out of truck to inspect exploded tires. He grasped the truck door handle, which provided a path to ground.

87-38: Lineman Electrocuted in North Carolina

Lineman electrocuted when the boom of a derrick truck contacted a 7200V overhead powerline while he was leaning against the truck. Co-worker raised boom before grounding rods were in place.

87-40: Painter Electrocuted in Virginia

Painter electrocuted when he began wrapping plastic around an insulator in preparation for painting a steel structure at a substation. Contacted 11000V conductor while standing on steel beam.

87-41: 56-Year-Old Pipe Layer Electrocuted in North Carolina

Pipe layer electrocuted when the boom of a backhoe contacted a 13200V overhead powerline. Victim was guiding load attached to backhoe bucket.

87-42: Apprentice Lineman Electrocuted in Virginia

Lineman trainee electrocuted when he attempted to remove a ground wire from a 230000V transmission circuit. Grasped tower end of ground still attached to powerline.

87-43: 32-Year-Old Electrician Electrocuted in Georgia

Electrician electrocuted while replacing a socket on an energized fluorescent light fixture. Victim was stripping insulation from an improperly grounded wire on a ballast.

87-44: Construction Worker Electrocuted in Maryland

Construction foreman electrocuted while guiding a boring machine attached to a crane into a ditch. Crane boom contacted 13000V overhead powerline.

87-48: Two Workers (a carpenter and a laborer) Electrocuted in South Carolina

Carpenter and laborer electrocuted when section of tubular welded-frame scaffolding they were helping to move came loose and contacted 13750V overhead powerline.

87-52: Driller Electrocuted in Virginia

Driller electrocuted when boom of hydraulic well drilling machine he was operating contacted a 34500V overhead powerline.

87-53: An 18-Year-Old Groundman Electrocuted in North Carolina

Groundman electrocuted when energized 13200V powerline broke and fell onto pole trailer onto which he was loading a pole. Trailer was not grounded.

87-54: Truck Driver Electrocuted in North Carolina

Truck driver electrocuted when he raised the bed of his dump truck into a 12000V overhead powerline. Victim standing to the side of the truck operating lever that controlled bed.

87-55: Electrician Electrocuted in North Carolina

Electrician electrocuted when he contacted an energized wire in a fluorescent light fixture at a private residence.

87-56: Utility Person Electrocuted in Virginia

Utility worker electrocuted while disconnecting power source to a knitting machine motor, inadvertently touching an energized prong on the damaged plug.

87-58: 19-Year-Old Electrician's Apprentice Electrocuted in Maryland

Apprentice electrician electrocuted when he contacted an energized circuit while installing lights on an ocean pier. Victim ignored instructions not to proceed until circuits verified to be deenergized.

87-60: Maintenance Manager Dies in North Carolina

Maintenance manager electrocuted as he attempted to make a connection in an energized air conditioner at an apartment complex.

87-61: Laborer Electrocuted in Virginia

Laborer/truck driver electrocuted while holding onto a hook suspended from the hoist cable of a truck-mounted crane. Cable contacted 19900V overhead powerline.

87-62: Laborer Electrocuted in Indiana

Handyman electrocuted when he apparently contacted an energized cap on a well while searching for a water leak.

87-63: 30-Year-Old Electrician Electrocuted in Maryland

Electrician electrocuted when he contacted an energized conductor while installing wiring for a refrigeration system.

87-65: Tree Trimmer Electrocuted in Indiana

Tree trimmer electrocuted when he directly contacted a 7200V overhead powerline while working in a tree.

87-66: Laborer Electrocuted in Virginia

Laborer electrocuted when the mast of a well-drilling rig he was operating contacted a 7200V overhead powerline. Victim saw smoke coming from rig's tires, then tried to enter truck cab to shut off truck.

87-68: Electrician Electrocuted in Indiana

Electrician electrocuted after contacting a 110V conductor while working in a crawlspace to install a furnace in a cottage.

87-69: Electrician Electrocuted in Tennessee

Electrician electrocuted when he contacted 480V power supply to a generator that supplied power to a glue machine.

87-70: Electrician Electrocuted in South Carolina

Electrician electrocuted when he contacted the energized metal frame of a foundry stoker he was trying to repair.

88-02: Painter is Electrocuted in South Carolina

Painter electrocuted when he contacted the housing of an energized fluorescent light fixture at a textile plant. Ground wire apparently disconnected in the past.

88-03: Apprentice Lineman Electrocuted

Apprentice lineman electrocuted while stringing a new length of overhead powerline that contacted an existing 12000V powerline above him. Electricity passed from new line to a trailer through the victim to ground.

88-04: Painter Electrocuted in North Carolina

Painter electrocuted when aluminum extension ladder he and a co-worker were raising contacted 7200V overhead powerline.

88-05: Construction Worker Electrocuted in North Carolina

Construction worker electrocuted when aluminum extension ladder he was standing on contacted 7200V overhead powerline as it tipped backwards.

88-11: Maintenance Supervisor Electrocuted

Maintenance supervisor electrocuted when he contacted a 22000V energized conductor in a control box. Victim evaluating malfunction of laser-guided cutting machine. Advised operator to stop the equipment, but not to deenergize it.

88-13: Cement Finisher Electrocuted

Cement finisher electrocuted when the metal handle of a cement-finishing tool he was using contacted an overhead powerline.

88-19: Deputy Sheriff Electrocuted

Deputy sheriff electrocuted while moving a 7200V powerline that fell when a car struck a utility pole.

88-21: Maintenance Worker Electrocuted

Maintenance worker trainee electrocuted when he contacted an energized conductor in a junction box left uncovered the day before when a motor on a textile machine was replaced. Victim engaged in replacement of a plastic vacuum hose on the same machine.

88-22: Two Pipefitters Electrocuted

Two pipefitters electrocuted when the boom of the crane moving a metal welding shed contacted a 12400V overhead powerline. Victims standing on the ground grasping the shed to guide it into place.

88-23: Lineman Electrocuted

Lineman electrocuted when his hands contacted both sides of a switch on a pole-mounted capacitor bank. Victim inexplicably raised aerial bucket into overhead powerlines after removing gloves.

88-24: Laborer Electrocuted

Laborer electrocuted when he contacted 115 volts while adjusting the limit switches on an overhead door opener.

88-25: Apprentice Lineman Electrocuted

Apprentice lineman engaged in relocation of powerlines electrocuted when he contacted a 13200V overhead powerline. Climbed pole before lines fully deenergized.

88-26: Yard Maintenance Worker Electrocuted

Maintenance worker for structural steel firm electrocuted when the boom of a crane moving a steel I-beam he was guiding contacted a 13000V overhead powerline. Crew engaged in cleanup of storage yard chose to stack I-beams directly below powerlines.

88-28: Asbestos Worker Electrocuted

Asbestos removal worker electrocuted after contacting an exposed overhead conductor in a utility tunnel.

88-31: Welder/Pipefitter Electrocuted

Welder/pipefitter killed when he contacted an energized 110V conductor while removing a fluorescent light fixture, and fell 29 feet to the floor. Cut into energized wire with uninsulated metal wire cutters.

88-32: Welder Electrocuted by Contact with an Energized Overhead Crane Conductor

Welder electrocuted when he contacted a conductor on an overhead crane. Engaged in adding reinforcing steel to the bridge of an overhead crane at a steel fabrication firm. Victim believed crane to be deenergized.

88-34: Laborer Electrocuted when Metal Work Platform Became Energized

Laborer electrocuted when metal basket he was working from apparently damaged insulation on power supply to overhead crane. Steel I-beam with which victim had contact became energized. Victim engaged in repairing security system.

88-35: Assistant Pool Manager Electrocuted

Assistant manager at municipal swimming pool electrocuted when she contacted a mixing motor that had a ground fault. Engaged in mixing chemical solution to be added to pool.

88-37: Electrician Electrocuted when He Contacted an Energized Wire

Electrician electrocuted when he touched the uninsulated part of a wire stripper that was in contact with a 110-volt circuit that had not been deenergized at the panel box. Installing residential floodlighting.

88-40: Laborer Electrocuted After Contacting Crane Touching Power Line

Construction laborer electrocuted when he touched the hoist cable of a crane whose boom was in contact with a 2400V overhead powerline. Engaged in removing forms from newly poured concrete wall and placing them on the crane’s choker cable.

88-41: Journeyman Electrician Electrocuted by Touching Energized Light Socket

Electrician working in crawlspace electrocuted when his shoulder contacted a broken light bulb in an unguarded ceiling-mounted socket, and his head contacted a steel water pipe. Engaged in tracing wiring at a tobacco manufacturing plant.

88-45: Electrical Contractor Crew Leader Electrocuted

Crew leader for electrical contractor electrocuted while installing transformers on concrete pads for an underground transmission system for a housing development. Failure to place grounds.

88-47: Equipment Operator/Lineman Electrocuted

Equipment operator/lineman electrocuted when the wooden crossarm on a utility pole gave way, dropping energized wires on him. Engaged in replacing an electrical distribution system.

89-01: Steelworker Electrocuted when He Contacts Fan with Damaged Power Cord

Steelworker electrocuted when he contacted a ventilation fan with damaged insulation on the power cord that had allowed the entire frame of the fan to become energized.

89-04: Equipment Operator Electrocuted by Contact with Power Line

Equipment operator electrocuted when he directly contacted a 7600V overhead powerline while installing a traffic light. Raised aerial bucket from which he was working, apparently misjudging height of powerline.

89-06: Lineman Electrocuted by Contacting Energized 12,000-Volt Power Line

Lineman electrocuted when he contacted a 12000V overhead powerline while installing "squirrel guards" on a transformer. Apparently slipped and contacted the energized side of a cut-out switch while working with bare hands.

89-08: Sign Technician Electrocuted Stepping from Energized Ladder Truck

Sign technician electrocuted when steel hoist cable attached to the extended ladder on his truck contacted a 12000V overhead powerline as he was driving. Victim apparently realized there was contact, stopped the truck, and stepped outside, still holding the door of the cab.

89-09: Supervisor Dies Following Electrical Fire

Hydroelectric supervisor died as a result of burns he suffered in an electrical fire. While calibrating analog meter, co-worker dropped overheated voltameter onto exposed high-voltage bus bars, creating a short circuit and a fire which ignited clothing. Co-worker seriously burned.

89-10: Machine Operator Electrocuted when Crane Contacts Overhead Power Line

Machine operator electrocuted when crane boom contacted a 12000V overhead powerline as he was guiding a steel pipe by hand. Victim's firm working at a pit directly under powerline positioning a boring machine that was to drill under a road.

89-11: Lineman Supervisor Dies Following Contact with Energized Conductor

Lineman supervisor electrocuted when he contacted an energized fuse holder while on a utility pole. Engaged in rebuilding powerlines for rural electric cooperative. No personal protective equipment used.

89-15: Laborer Electrocuted as Boom of Bucket Truck Contacts a 7200-volt Power Line

Laborer standing on ground electrocuted when the boom of an aerial bucket truck with which he was in contact touched a 7200V overhead powerline. Two workers engaged in clearing tree branches away from powerline, co-worker working in bucket.

89-16: Roofer Electrocuted When Ladder Contacts 7200-Volt Power Line

Roofer electrocuted when a 40-foot aluminum ladder he was positioning contacted a 7200V overhead powerline. Engaged in replacing shingles on church roof.

89-17: Electrical Foreman and Groundman Electrocuted When Guy Wire Contacts 13,200-Volt Power Line.

Electrical foreman and groundman electrocuted when the groundman removed a guy wire from its anchor and began to place it on the ground. Wire apparently contacted a 13200V powerline while both victims were touching it.

89-18: Journeyman Electrician Electrocuted when Lockout Attempt Falls

Electrician electrocuted after he contacted an energized 50000V transformer. After deenergizing identical system, mistakenly entered energized area. Performing scheduled maintenance at pulp and paper mill.

89-19: Maintenance Mechanic Electrocuted While Touching Damaged Power Cord

Maintenance mechanic at meat packing plant electrocuted when he contacted a strapping machine power cord with damaged insulation. Current passed through victim to wet floor.

89-26: Apprentice Lineman Electrocuted while Upgrading a Power Distribution System
Apprentice lineman working from aerial bucket electrocuted when he contacted a 13700V overhead powerline while upgrading an electrical distribution system. Holding a clamp in one hand, victim may have pushed a cable off the bucket with the other hand and contacted the powerline.

89-27: Distribution Line Technician Dies after Contacting Energized Conductor
Electrical distribution line technician died as a result of injuries suffered when he directly contacted an overhead powerline while repositioning his aerial bucket. Failure to place insulating hose on lines.

89-36: Distribution Line Technician Electrocuted by Conductor in Contact with 7200-volt Power Line
Distribution line technician electrocuted and a co-worker seriously burned when a powerline they were installing contacted an energized 7200V powerline overhead. Both victims on the ground helping to pull slack out of the new line when line snagged in tree, contacting energized line.

89-37: Laborer Electrocuted When He Contacts 4160-volt Power Line on Rooftop
Laborer electrocuted when he contacted a 4160V powerline after inexplicably entering a restricted power service enclosure. Victim engaged in sandblasting air conditioning unit on roof of plant prior to incident.

89-39: Apprentice Lineman Dies after Contacting 7200-volt Primary Wire
Apprentice lineman electrocuted when he touched a 7200V overhead powerline while attempting to transfer lines to a new utility pole. No personal protective equipment or guards used.

89-40: Service Operations Technician Dies after Contacting 7680-volt Switch.
Service operations technician electrocuted after he contacted an energized 7680V switch while working to restore power to a shopping mall. No personal protective equipment used.

89-42: Television Cable Installer Electrocuted
Cable TV installer electrocuted when his head contacted a 7280V overhead powerline that ran 5 feet above the roof of a house. Installing TV cable on existing utility poles at time of incident.

89-43: Foundry Laborer Electrocuted While Loading Electric Induction Furnace
Foundry laborer electrocuted when a piece of scrap metal he was helping to load into a damaged electric induction furnace became energized. Current passed from scrap metal through victim through furnace frame to ground.

89-48: Truck Driver Dies When Crane Boom Contacts Powerline
Truck driver electrocuted when the boom of a truck-mounted crane he was raising by remote control contacted a 14400V overhead powerline. Current passed through power cord of controller through victim to ground.

89-50: Apprentice Electrician Electrocuted
Apprentice electrician electrocuted when he apparently contacted an energized conductor in a junction box while in contact with metal gridwork. While installing light fixture at office complex under construction, victim may have inadvertently cross-wired two neutral conductors.

90-01: One Laborer and Two Steel Workers Electrocuted when an Elevated Work Platform Contacts 69,000-volt Powerline in Ohio

Three construction workers electrocuted and three others seriously burned when the mobile elevating work platform they were moving contacted a 69000V overhead powerline. Victims moved platform from location where adequate clearance existed but made contact with powerline where ground sloped upward.

90-02: Tree Trimmer Crew Leader Dies When He Contacts Energized Powerline in Puerto Rico

Leader of tree-trimming crew electrocuted during hurricane cleanup when he contacted a downed powerline he believed to be deenergized. Electric current from portable generator operating at gas station nearby reenergized powerline.

90-03: Lineman Dies When He Contacts Energized PowerLine in Puerto Rico

Lineman, working at night, electrocuted during hurricane cleanup when he directly contacted a powerline dangling from a pole. Victim either did not see the line, or believed it to be deenergized.

90-04: Meter Reader Dies When He Contacts Energized Clothesline Wire in Puerto Rico

Meter reader electrocuted when he grasped a metal clothesline energized by a downed powerline in an effort to regain his balance after tripping over a chain-link fence.

90-05: Lineman Dies When He Contacts Energized Power Line in Puerto Rico

Lineman electrocuted while attaching a 2400V powerline to a pole-mounted insulator. Victim assured by supervisor that line was deenergized, but it was in fact energized by portable generator.

90-06: Electrical Lineman Electrocuted by Contact with Energized Powerline in Puerto Rico

Lineman electrocuted when the boom of bucket of the bucket truck from which he was working rotated into an energized 4800V powerline and secondary fuse box. Victim reattaching tool basket to bucket. Basket hook caught on lever controlling boom, swinging boom into powerline.

90-08: Line Technician Electrocuted During Power Restoration Following Hurricane Hugo in South Carolina

Line technician electrocuted after his head directly contacted an energized jumper wire while restoring power after a hurricane. Victim positioned between powerlines trying to locate transmission problem.

90-09: Painter Electrocuted while Repositioning an Aluminum Extension Ladder in Virginia

Painter electrocuted when the aluminum extension ladder he was positioning tipped backwards and contacted a 7200V overhead powerline. Engaged in house painting.

90-10: Carpenter Electrocuted in Pennsylvania when Aluminum Edging Contacts Powerline

Carpenter working from aluminum ladder jack scaffold electrocuted when a piece of aluminum drip edging he was installing on a roof contacted a 7200V overhead powerline.

90-22: Electrician Electrocuted after Contacting an Energized 480-volt Bus Bar in South Carolina

Electrician electrocuted when he inexplicably switched a circuit breaker to the “on” position and contacted an energized bus bar while performing repairs at a hotel following a hurricane. Victim and co-worker assigned to clear ground fault.

90-26: Lineman Electrocuted After Contacting 7,200-Volt Cutout Switch on Utility Pole in Tennessee.
Lineman electrocuted when he contacted a reenergized cutout switch on a utility pole. Had climbed back up pole to remove piece of electrical tape without putting gloves and safety belt back on. Reached for tape, boots slipped, and hand contacted switch.

90-27: Lineman Electrocuted When He Contacts a 7200-volt Powerline While Installing a Guy Wire in North Carolina
Lineman electrocuted when he contacted a 7200V overhead powerline while installing a guy wire. Arm contacted an existing powerline three inches beyond an insulating line hose.

90-29: Laborer Touching Suspended Cement Bucket Electrocuted When Crane Cable Contacts 7200-Volt Powerline in North Carolina
Driver of cement truck stopped truck below powerline, crane operator (not aware of truck position) swung cement bucket under line, and laborer (victim) pushed down on handle of bucket door, bringing crane cable in contact with 7200V powerline. Crew about to wash out cement bucket with water.

90-31: Laborer Dies from Electrical Injuries Sustained in an Electrical Distribution System Substation in Virginia
Laborer died from injuries suffered when the galvanized pipe he was carrying contacted an energized 12500V jumper wire at a electrical substation.

90-32: Electrician Electrocuted When He Contacts Energized Conductor in a Manhole in Virginia
Electrician electrocuted after contacting an energized conductor in a manhole.

90-34: Tree Trimming Groundsman Electrocuted after Grasping a Guy Wire that Contacted an Energized Guy Wire in Virginia
Tree trimming groundsman electrocuted when the guy wire he was grasping swayed (due to slack in the wire) and contacted an energized pole-mounted jumper wire. Victim had just finished cutting trees and brush from around guy wire, one end of which was secured to utility pole, other end to steel rod in the ground.

90-36: Concrete Worker Electrocuted after Grabbing an Energized 440-Volt Conductor in Virginia
Concrete worker at manufacturing plant electrocuted when he climbed a steel column, stepped onto a steam pipe, and grasped a conductor that powered a wall crane. Attempting to untangle the hoist chain of an overhead crane that was caught on an I-beam.

90-37: Maryland Steelworker Electrocuted When He Contacted Energized Toaster Oven Casing in Employee Lunchroom
Steelworker electrocuted when he contacted the energized casing of a toaster oven in an employee lunchroom while resting his arm on an air conditioner.

90-38: Well Driller Electrocuted When Pipe on Crane Cable Contacts 12,000-Volt Overhead Powerline in Virginia
Well driller electrocuted when a metal pipe being hoisted by a truck-mounted crane made direct contact with a 12000V overhead powerline. Victim standing at side of truck using pendant remote controller. Crew engaged in repair of submersible pump for water well at private home.

90-39: Foreman Electrocuted and Lineman Injured After Truck-mounted Crane Boom Contacts 7,200-volt Overhead Powerline in Virginia

Telecommunications company foreman electrocuted when he grasped the door handle of a burning truck mounted with a crane, the boom of which was in contact with a 7200V overhead powerline. Powerline contact occurred when poles supporting billboard were being pulled out of the ground.

90-40: Utility Lineman Electrocuted in Ohio

Lineman electrocuted when he simultaneously contacted both sides of a fused powerline jumper. Working from aerial bucket repositioning powerlines after tree trimming operation.

91-01: Distribution Line Technician Electrocuted in South Carolina

Distribution line technician electrocuted while clearing branches from a 7200V overhead powerline he believed to be deenergized. Victim positioned in tree, co-worker heard arcing sound, and victim fell to the ground.

91-03: Tree Trimming Groundsman Electrocuted after Contacting an Energized Aerial Bucket Truck in South Carolina

Tree trimming groundsman electrocuted when the boom of an aerial bucket truck with which he was in contact touched a 23000V overhead powerline.

91-05: Construction Laborer Electrocuted After Handling Damaged Energized Extension Cord in Virginia

Construction laborer electrocuted when he apparently contacted a damaged extension cord that became energized. Constructing waterfront bulkhead for residence at edge of lake.

91-08: Truck Driver Electrocuted after Contacting an Energized Dump Truck in South Carolina

Truck driver electrocuted when he raised the bed of his dump truck into a 7200V overhead powerline. Standing on the ground operating the lever that raised and lowered the bed.

91-10: Lineman Electrocuted After Contacting 7600-volt Powerline During Attempt To Restore Electrical Power in Tennessee

Lineman working from aerial bucket electrocuted while restoring power after a storm. Victim grasped supply end of conductor with one hand, chain hoist in other hand contacted neutral jumper. Failure to ground energized line.

91-20: Lineman Trainee Electrocuted after Contacting an Energized Pickup Truck in South Carolina

Lineman trainee electrocuted when he grasped the door handle of a pickup truck energized through a powerline on the ground that had contact with a jumper wire. Victim was apparently planning to try to move the truck.

91-21: Construction Laborer is Electrocuted When Crane Boom Contacts Overhead 7200-volt Powerline in Kentucky

Construction laborer electrocuted while grasping a wire rope load choker attached to a crane cable with one hand and a vertical steel rod with the other hand. Crane contacted 7200V overhead powerline. Crew engaged in placement of steel roof joist on roof of school under construction.

91-22: Laborer Electrocuted Upon Contacting an Energized Conveyor in Kentucky
Laborer electrocuted while painting a section of support steel for a conveyor system at a plant under construction. Victim and co-worker failed to report receiving minor shocks from conveyor prior to incident.

91-25: Electrical Lineman Electrocuted After Contacting Energized Trailer-Mounted Line Tensioner in South Carolina
Lineman working on ground operating trailer-mounted line tensioner electrocuted when the tensioner became energized. Jerking, then swaying, of new powerline caused it to contact existing 14200V powerline. Possible improper tension on new powerline, or failure of tensioner braking system.

91-28: Textile Worker (Fixer) Electrocuted When He Contacts an Energized Conductor in South Carolina
Textile worker electrocuted when he contacted an energized conductor inside the control box of a carding machine. While inspecting malfunctioning machine, victim directed air from hose with metal nozzle into control box. Nozzle contacted conductor.

91-29: Crew Foreman Electrocuted When He Contacts Energized Conductor in South Carolina
Crew foreman electrocuted when he contacted an energized conductor on a utility pole while attempting to retrieve TV cable wire tangled in overhead powerline.

91-32: Technician Electrocuted While Performing Maintenance on a Walk-in Cooler in Virginia
Refrigeration technician performing maintenance tasks electrocuted when he contacted the improperly grounded refrigeration unit of a walk-in cooler at a restaurant.

92-01: Electrical Contracting Company Line Mechanic Electrocuted After Contacting Energized Conductor While Working From an Aerial Bucket—Virginia
Line mechanic electrocuted while working from an aerial bucket in hot, humid conditions to attach an energized conductor to a cross-arm-mounted insulator. Co-worker observed current arcing across a cross-arm bolt in contact with victim's chest.

92-02: Lineman Electrocuted After Contacting Energized Conductor While Working From the Bucket of an Aerial Lift Truck in Virginia
Lineman electrocuted when he contacted an energized powerline while working from the bucket of an aerial bucket truck. Rubber glove caught in wire and partially pulled off, causing wrist to directly contact powerline.

92-06: Roofing Mechanic Trainee Electrocuted in South Carolina
Roofing mechanic trainee electrocuted when he inadvertently contacted an energized service entrance conductor on the roof of a warehouse. Incident occurred as victim stood up after kneeling on corner of roof to take measurements.

92-07: Electrical Technician Electrocuted after Contacting a 800-volt Conductor in South Carolina
Electrical technician electrocuted when he inadvertently contacted an energized conductor inside a voltage regulating control cabinet at a new rolling mill. Victim attempting to identify voltage regulation problem, tracing wiring that was not color-coded.

92-12: Powerline Worker Electrocuted While Performing Maintenance on Overhead Powerline—Alaska
Powerline worker electrocuted when he grasped an energized jumper wire he apparently believed to be deenergized. Victim impaired by marijuana, using no personal protective equipment. Assigned to repair section of lines plagued by intermittent outages.

92-16: Textile Worker (Machine Operator) Electrocuted After Contacting an Energized Conductor--South Carolina
Textile machine operator electrocuted while directing compressed air from hose with metal nozzle in an attempt to cool the electrical components inside the control panel of a sueder machine at a textile plant. Control panel left uncovered.

92-20: Electrical Project Supervisor Dies After Contacting An Energized Conductor--South Carolina
Electrical supervisor electrocuted at a plastic-bottle packaging plant when he contacted an energized conductor inside a control panel. Tracing wiring in control panel for a compressor motor starter without deenergizing unit.

92-24: Roofer's Helper Electrocuted When Ladder Platform Hoist Contacts a Powerline--South Carolina
Roofer's helper electrocuted and a co-worker injured when the metal ladder platform hoist they were positioning contacted a powerline. Moving hoist in preparation for placement of new shingles on roof of residence.

92-25: Electrician Electrocuted After Contacting Energized Conductor While Working From the Bucket of an Aerial Lift Truck—Virginia
Electrician electrocuted when he contacted an energized powerline while working from an aerial bucket truck to replace cutout switches on a utility pole. No personal protective equipment used, nor were lines covered with insulating blankets or line sleeves.

92-27: Painter Electrocuted When Metal Ladder Contacts a Powerline—Virginia
Painter electrocuted when the metal ladder he was moving contacted an overhead powerline. Engaged in job site cleanup after painting exterior of private home.

92-30: Apprentice Lineman Electrocuted While Setting Utility Pole—Virginia
Apprentice lineman electrocuted when he slipped on wet ground, allowing his unprotected upper body to fall against the utility pole he was helping to set, as the top of the pole was in contact with an overhead powerline.

93-14: Truck Driver and Company President Electrocuted After Crane Boom Contacts Powerline--West Virginia
Truck driver and company president electrocuted when the boom of a truck-mounted crane contacted a 7200V overhead powerline. Driver using remote control for unloading of concrete blocks at residential construction site. President attempted to assist him upon observing contact, inadvertently contacting energized truck himself.

93-18: Electrician Apprentice Electrocuted after Contacting a 480-volt Conductor in South Carolina

Apprentice electrician electrocuted when he apparently lost his balance while standing on a metal ladder attached to operator's cab of an overhead crane and contacted a conductor on another overhead crane. Climbing ladder to reach second crane to perform maintenance on hoisting motor.

94-08: Department of Transportation Maintenance Foreman is Electrocuted and a Highway Maintenance Worker Severely Burned When Truck Bed Contacts Overhead 7,200-volt Powerline--South Carolina

Department of Transportation foreman is electrocuted and a highway maintenance worker severely burned when truck bed contacts overhead 7,200-volt powerline. The dump truck containing asphalt was backed against a paving machine the men were leaning on.

94-10: Journeyman Wireman Electrocuted After Contacting Energized Switchgear Components at Power Plant--West Virginia

Journeyman wireman electrocuted after contacting energized switch gear components at a power plant. The journeyman simultaneously contacted two 6.9 kV buss terminals.

94-17: HVAC Contractor and Employee Electrocuted in Crawlspace--North Carolina

A HVAC contractor and his employee were electrocuted while installing aluminum straps to anchor ductwork to floor joists in a crawlspace. The victim contacted an energized strap, then was grabbed by the contractor. Electrical energy flowed through both men to ground.

PART II

Fatality Assessment and Control Evaluation (FACE)
Full Text of FACE Reports, 1982-1994
Electrocutions

FACE 82-03: **Electrocution Resulting from Crane Cable Contact with Power Line**

INTRODUCTION

This report is based upon an investigation of a single occupational electrocution resulting from a crane's cable coming in contact with a 7200 volt power line. At approximately 11:25 A.M. on October 15, 1982, the accident occurred at the construction site of a 200,000 gallon water tank being erected on the Donley farm in Greene County, Pennsylvania. This tank was being built for the East Dunkard Township Water Association by Welding Inc. of Charleston, West Virginia.

This investigation is part of the National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research's (DSR) Accident Investigation Program and was made pursuant to a formal request from Dr. James L. Frost, Deputy Chief Medical examiner for the State of West Virginia. The objective of this report is to provide additional information on the background and circumstances of this fatal accident so that the Deputy Chief Medical Examiner may better comprehend its etiology. The content of this report does not address immediate causes nor standard violations which was the focus of the investigation conducted by the Occupational Safety and Health Administration (OSHA).

The information included in this report results from both interviews with pertinent individuals and direct observation at the accident site. A pre-investigation conference was held via telephone with a co-owner of the company on October 27, 1982. Representatives of DSR visited the accident site on October 28, 1982 and conversed with the owner of the farm, the job foreman, and co-workers who were there at the time of the accident. DSR representatives also visited the company headquarters in Charleston on November 3-4, 1982. The co-owners of the company, the crane operator involved in the accident, the assistant to the shop superintendent who was in charge of safety presentations, office workers, and the next-of-kin of the victim were all interviewed and found to be extremely accommodating.

BACKGROUND

Welding Inc., the employer of the victim, began as a small job shop in June of 1947 and has since expanded into doing general construction and fabricated steel activities. These construction activities (for example, erection of boilers, water tanks, metal buildings, overnight facilities, pools, ice rinks, pipelines, and commercial buildings) have taken place within a 200-250 mile radius of Charleston, WV. The annual number of workers employed by the company has ranged from 83 to 90 full-time equivalents for 1979-81. The company employs approximately four truck drivers (occupation of the victim) and three crane operators. The company owns heavy equipment (tractors, trailers, backhoes, dozers, cranes, etc.) and occasionally rents equipment it needs, but doesn't have. The company has four cranes. Employees who operate heavy equipment receive on-the-job training and no formal instruction.

With specific reference to water tank construction, the company has twenty years' experience. For the past ten years, the company has erected approximately twenty to thirty tanks per year. These water tanks have ranged in size from 200,000 to 750,000 gallons. Average erection time for a four or five men crew is ten to fourteen days. The parts for the tanks are fabricated at the company shop in Charleston and then shipped by truck to the erection site. Construction of these tanks is somewhat seasonal; the company can erect some tanks in the winter when the snow is off the ground and they can get to the job site.

According to the employer, the company has a safety program although it does not exist in written form. The assistant to the shop superintendent teaches safety and organizes weekly safety presentations. These presentations, which are thirty minutes in length, are given at the company headquarters in Charleston. Employee attendance at these presentations is not mandatory and only those employees who are not in the field are potentially able to attend. The company provides hardhats and safety glasses (both prescription and nonprescription) while employees are responsible for providing their own safety shoes.

With reference to the overall injury experience of the company, data were abstracted from the OSHA logs and are shown in Table 1. During 1979-81, the total (first-aid and OSHA recordable) injury rate ranged from 45.0 to 57.7 injuries per 200,000 person-hours (equivalent to 100 person-work years where 2000 hours constitute one work year). The magnitude of the total injury rates reflected the large incidence of first-aid injuries. The company's first-aid injury incidence rates ranged from 20.8 to 31.4 injuries per 200,000 person-hours and consisted mainly of foreign bodies in the eye(s). The OSHA recordable injury rates (injuries which result in lost workday(s) and/or medical attention other than first aid) range from 12.1 to 27.2 injuries per 200,000 person-hours). In comparison, the 1980 OSHA recordable injury experience for the non-residential building construction industry (SIC 154) was 19.4 injuries per 200,000 person-hours.

With reference to the company's accident history pertinent to this fatal accident, the company had a history of two other fatal accidents and one near-miss. Approximately 10 years ago, a water tank was being painted when a worker on a scaffold fell approximately 10 feet to his death. The other fatal accident occurred approximately 10 to 12 years ago, was a crane-related electrocution, and involved the same crane operator. During an electrical storm, the crane had broken down along the side of the road. The operator was moving the boom in order to allow sufficient space to jump the dead battery. After positioning the boom, the operator was leaving the cab when he and his helper were shocked. According to several company sources, the subsequent OSHA investigation could not determine whether the electricity resulted from current jumping from the powerlines overhead (the boom may have been within the absolute limit of approach to the powerlines) or from lightning striking the crane. No citations were issued. The near-miss occurred in May 1982 and involved a crane's boom/cable coming in contact with overhead power lines. This near-miss occurred at a coal field where a crew was using a crane to load the sections of another crane's boom into a trunk. An employee was holding on to the line when the crane operator, the father of the employee, swung the boom into the 40,000 volt powerlines. The employee received serious but nonfatal injuries.

CIRCUMSTANCES OF THE ACCIDENT

The company was contracted to build two water tanks for the East Dunkard Township Water Association. All pieces for both tanks were fabricated at the company's shop in Charleston. These pieces were then transported by truck and unloaded at the first job site. The first tank had been completed and the crew was transporting the pieces for the second tank to its erection site on the Donley farm, a distance of approximately 1 1/2 miles. The fatal accident occurred on the second day of erecting this second tank.

The erection site for the tank had been selected by a consulting engineer and a subcontractor had laid the concrete foundation. The victim had driven a truck from Charleston the day before the accident in order to transport the fabricated pieces and equipment from the site of the completed first tank. On the day of the accident, the crew at the job site included the victim, foreman, crane operator, and three welders. The victim, who had been with the employer for 4-1/2 years and had 2 years' experience as a truck driver, had worked 13 hours the day before while the crane operator, who worked for the employer for approximately 14 years and had 10 years' experience as a crane operator, had worked 12 hours.

On the day of the accident, the crew began work at 7:00 a.m. At the time of the accident (approximately 11:25 a.m.), the first load for that day had been brought over from the site of the first water tank. At this time, the first 10 feet of the tank had been erected. The crane was situated on the east side of the tank. The loaded truck was parked next to the crane in an excavated space. The first load of the day was being removed from the truck at the time of the accident. At this time, the job foreman had left the site in order to make a telephone call. The victim and one welder were assisting the crane operator in unloading the truck while the other two welders were working inside the tank. An enclosed ladder was the first item unloaded from the truck. The crane operator lifted the ladder off the truck and swung it to his right (northward) over the top of the tank. He was planning to place the ladder on the dirt bank on the north side of the tank, apparently believing that this was the side of the tank to which the ladder would be attached. However, the employer stated that this ladder was to go on the south rather than the north side. After clearing the tank, the crane operator was swinging and lowering the ladder simultaneously. The boom was extended approximately 45' and the jib was not attached. The crane operator had difficulty making the load clear the welding equipment on the northern side. The victim thus decided to assist with moving the ladder around the welders and placing it on the ground. The welder who was helping unload stayed on the truck. The victim held onto the ladder and the welding equipment was between him and the crane. This factor along with the slope of the land and the position of the crane apparently precluded the operator and the welder from completely observing the victim. The victim gave the crane operator a hand signal to continue moving the ladder, and once the crane operator began to swing and lower the ladder, the victim was apparently completely out-of-sight. The next thing the crane operator knew was that a portion of the crane cable near the end of the boom was on fire and he swung the boom in the opposite direction, away from the powerlines. The crane operator then left the crane, turned off the welding equipment, and found the victim laying on the ground. Subsequent to the accident, the employer contacted the electric company who came out and moved the line to the far side of the crosstie and insulated it. The co-owner of the company stated that in the future requests would always be made prior to starting construction.

ACKNOWLEDGMENTS

NIOSH's Division of Safety Research wishes to express its gratitude for the assistance and cooperation of the Deputy Chief Medical Examiner, the employer, and the individuals (employees and next-of-kin) who were interviewed. The employer was extremely accommodating and took every conceivable action to fully assist NIOSH with the investigation. The interviewees were extremely congenial and facilitative when providing information and answering questions. It was the assistance and cooperation of these parties that made this report possible.

Table 1. *Employment and Injury Characteristics of the Company 1979-1981*

			Occupational Injury Incidence				Occupational Injury Rates (per 200,000 person hours)			
Year	Full-Time Equivalent	Person Hours of Exposure	First Aid Injuries	Nonlost Workday Injuries	Lost Workday Injuries	Total Injuries	First Aid Injuries	Nonlost Workday Injuries	Lost Workday Injuries	Total Injuries
81	85	165889	26*	2	8	36	31.4	2.4	9.7	43.5
80	83	173281	18**	10	11	39	20.8	11.5	12.7	45.0
79	90	183885	28***	15	10	53	30.5	16.3	10.9	57.7

**includes 17 foreign body in the eye(s) injuries*
***includes 12 foreign body in the eye(s) injuries*
****includes 14 foreign body in the eye(s) injuries*

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FACE 83-08: **Fatal Incident Summary Report: Electrocution of an Electrician**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Study. By scientifically collecting data from a sample of similar fatal incidents, this study will identify and rank factors which increase the risk of fatal injury for selected employees.

On July 12, 1983, a Class A electrician with approximately ten years' experience was working at a nonunion coal-fired power plant. At approximately noon, he was electrocuted while replacing a limit switch on a coal sampler. The attending medical examiner notified DSR about this fatality on July 13, 1983.

CONTACTS/ACTIVITIES

Subsequent to receiving notification, DSR sent a research team, consisting of an epidemiologist and industrial hygienist, to visit the company and survey the incident site on July 25-26, 1983. Interviews were held with the plant manager, assistant plant manager, personnel supervisor, personnel assistant, coal yard foreman, electrician foreman and electricians. Information obtained from these interviews pertained to the company history and processes, policies and procedures, incident scenario, safety and training programs, employee evaluations, injury record, and relevant work practices. The incident site was surveyed in the presence of a plant representative who was able to describe the appearance of the site when the victim was found. The condition of the site when surveyed was similar to that when the incident occurred except the tools and equipment used by the victim had been removed and installation of the coal sampler limit switch had been completed. During the survey, the locations of the victim, his possessions and tools, and the limit switch were identified and 35 mm pictures were taken.

SYNOPSIS OF EVENTS

The coal-fired power plant, which was built in 1950, has a generating capability of 1.1 million kilowatts and employs approximately 350 workers (6 of whom are Class A electricians). Specific technical and safety training programs exist in addition to written safety rules (general, hazardous energy, first aid, transport, etc.) Specific procedures exist for job briefings, job clearances, and lockout/tagout practices.

On Monday, July 12, the victim had his scheduled day off (he had also been on vacation the entire previous week). On the afternoon of July 12, another electrician examined the malfunctioning coal sampler and concluded that its limit switch needed to be replaced. However, insufficient time precluded its being replaced that afternoon and a job order was written for its replacement the next day.

On Tuesday, July 13, the victim reported to work on time and received a job briefing at 7:30 a.m. which concerned the repair of an elevator and the replacement of the coal sampler limit switch. By 11:30 a.m. the victim had received a second job briefing for the limit switch together with a written job order. The victim walked to the building containing the coal sampler and supposedly took a normal lunch break from 11:45 to 12:15. At about 12:25 three workers were riding a manlift up to the fourth floor of the building. As they reached the third floor, they saw the victim lying face-up underneath a conveyor belt. On the ground next to the victim were a pack of cigarettes and two folded one dollar bills. The victim's body had no traumatic medical signs associated with a fall to the concrete, nor was his body in a position that would result from a fall.

Based upon information collected and observations made, the probable sequence of events are as follows: The victim was standing on the conveyor belt guard in the process of installing the new limit switch. Two of the three wires were connected and he was in the process of connecting the last wire, the hot one with approximately 220 volts. However, this wire coming out of the conduit was too short to reach the switch. Probably, the victim grabbed this wire with his right hand and attempted to pull it down further out of the conduit. As he did, the bottom part of his hand contacted the limit switch. When the wire hit the upper part of his palm, a completed circuit was made. Due to the amount of voltage, the victim was not killed instantly; his heart probably went into arrhythmia. He probably felt uncomfortable, decided to get down and perhaps take a smoke, and, according to the medical examiner, died seconds later.

MEDICAL FINDINGS

Examination of the body showed electrical burns on the right hand, aspiration of foodstuff into secondary and tertiary bronchi, contusion of left mastoid scalp and abrasion of right mid-tibial area. Toxicologic tests of blood for alcohol and urine for basic, neutral and narcotic drugs were all negative. The attending medical examiner concluded that the cause of death was electrocution.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The major etiologic factor for this fatal incident was the failure of the victim to follow a standard permit/ clearance procedure for lockout of electrical power. It appeared that this failure resulted from the inattention of the victim rather than the difficulty of the procedure or the lack of sufficient time to complete the job. If the switch had been de-energized by the appropriate lockout procedure at one of two possible locations, this fatal incident would have been prevented. The lockout procedure had been successfully used in the past by the victim and other electricians in similar as well as much more hazardous and complicated situations.

One explanation for the failure to follow the lockout and permit procedures may have been a somewhat cavalier attitude of the victim towards relatively small voltages of electricity. The research team was able to observe and was concerned about such an attitude in other electricians at the plant.

It is recommended that future efforts be made to stress the importance of and strictly enforce the company permit and lockout procedures regardless of the voltage involved. Safety training should stress that <u>all</u> voltages of electricity are potentially lethal.

The courtesy and cooperation of the company officials and employees interviewed by the research team were exemplary and are gratefully acknowledged.

FACE 83-09: **Fatal Incident Summary Report: Electrocution of a Painter**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Study. By scientifically collecting data from a sample of similar fatal incidents, this study will identify and rank factors which increase the risk of fatal injury for selected employees.

On July 14, 1983, a 22-year-old white male painter working on an electrical transmission tower accidently contacted a grounding line which had a static charge. After entering a state of ventricular fibrillation for several seconds, he lost consciousness and fell to a lower beam on the tower. By the time co-workers lowered him to the ground, rescue attempts were unsuccessful in reviving him.

CONTACTS/ACTIVITIES

DSR received notice of the case from the attending medical examiner on July 20, 1983, and contacted the power company whose transmission tower was involved. Contact was also made with the painting firm contracted by the power company to paint its towers. On July 28, a safety researcher and epidemiologist traveled to the town near the incident site where meetings were held with representatives from the painting company, and the co-workers and supervisor of the fatally injured painter. During these meetings, information was obtained about the case, the painting company and worker perceptions of what had happened. The attending medical examiner also participated in the latter part of this discussion.

In mid-afternoon, the researchers, medical examiner, and OSHA personnel investigating the case participated in a discussion and site visit with the power company officials. During the meeting at the power company's local office, information was obtained about the essential aspects of the company's safety program and on the design considerations of transmission towers that seemed relevant to the fatal electrocution. A visit was then made to the incident site where both painting and power company representatives reviewed the circumstances and events of the accident. Photographs and a videotape showing details of the tower were taken.

SYNOPSIS OF EVENTS

The power company has in excess of 500 electrical power transmission towers in the region. The painting company had contracted to paint several hundred of these during the summer of 1983. The tower painting task was carried out by a team of six to eight skilled painters who testified that a single tower could be completely painted in two hours if the entire crew was present.

The tower involved in the incident was approximately 100' high, and situated roughly 100 yards from the nearest roadway. At about 9:00 a.m. the crew was working on the tower. The victim was painting the framework of a tower member at a height of about 94' above ground, and was wearing a safety belt around his waist. Other crew members were working on another section of the tower some distance from him. Co-workers reported that they heard a "crackling noise" and "staccato shouts," and the victim saying "the wire bit me." They saw him fall about 20', hitting several cross-members before he stopped. His co-workers lowered him to the ground and began mouth-to-mouth resuscitation. Emergency medical personnel were called and they instituted full cardiopulmonary resuscitation without success. He was pronounced dead at 9:20 a.m.

Based on evidence of paint on the victim's sleeve, it is believed he brushed the static line with his sleeve or arm as he painted the supporting element. The charge on this line, which functions as a grounding wire, can climb to 1000 volts or 100 amps before flushover to the tower occurs. While the charge is a static one which discharges quickly, workers are aware that it can jolt and are trained to keep a distance. It is believed in this case that the charge was large enough to induce heart fibrillations which resulted in loss of consciousness.

MEDICAL FINDINGS

The deceased was examined by the Deputy Chief Medical Examiner, who reported no entrance or exit wounds on the body, which are often formed in electrocution cases. The body was that of a healthy, athletic young male with no other pathological anomalies. The medical examiner reported that he had seen other electrocutions with no exit-entry wounds, especially in cases where electricity is transferred to the body diffusely over an area.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Electrocution is not an uncommon cause of death, particularly in this and other occupations. Had the following factors been better controlled, this untimely death may have been prevented.

First, the static or ground line on transmission towers is capable of carrying lethal charges, which can vary with atmospheric, climatic, and power usage factors. A practice of discharging the ground line through a special grounding tool to the tower itself was apparently not followed just prior to this exposure.

Second, in spite of training in the hazards of electrical work, the lack of warning associated with such hazards as this one requires special precautions. A test instrument to help the worker judge the charge on the ground line may in some cases be feasible.

Third, a fatal heart attack, of the kind induced here, need not be inevitable if emergency steps are taken immediately. While in this case emergency actions appear to have been as prompt as possible, a general warning seems appropriate that CPR may be necessary and should be available.

FACE 84-17: **Fatal Accident Summary Report: Electrocution in a Fast Food Restaurant**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Study. By scientifically collecting data from a sample of similar fatal accidents, this study will identify and rank factors which increase the risk of fatal injury for selected employees.

On June 30, 1984 at approximately 1:05 a.m., an 18-year-old employee with 15 months' experience at a fast food restaurant was electrocuted while plugging a portable electric toaster into a 110 volt/20 amp receptacle.

CONTACTS/ACTIVITIES

On July 9, 1984, NIOSH received a request for technical assistance from the Deputy Chief Medical Examiner.

On July 26, 1984, a research team, consisting of an epidemiologist, occupational health nurse, industrial hygienist and consulting engineer, conducted a site survey and interviewed employees (including the restaurant manager). A visit was also made to the city police department where copies of witness statements and electrician reports were obtained.

SYNOPSIS OF EVENTS

After closing the restaurant on June 30, 1984, four employees and an assistant manager were cleaning and preparing the facility for opening by the morning shift. The routine for clean-up included moving portable equipment, sweeping and damp mopping. By approximately 1 a.m., this had nearly been completed and the employees were preparing to leave. Three of the employees were finished and were waiting up front. The assistant manager was in his office and the victim was replacing the portable equipment. Although not an official policy, workers often plugged the equipment back in so that it was ready for the morning shift. After damp mopping the floor approximately five to ten minutes earlier, the victim was in the process of plugging the toaster into a floor outlet (containing three 110v receptacles and one 220v receptacle) when he received what resulted in a fatal shock.

The assistant manager heard a noise and went up front to tell the employees to "cut the horseplay." When they denied this and he noticed that the victim wasn't present, he went to look for him. The victim was found with one hand on the plug, the other hand wrapped around the receptacle box and with his face on top of the outlet. He was still in contact with the current and convulsing when found. An employee attempted to take his pulse but was shocked. The assistant manger then went to the breaker box and attempted to open the breaker for that circuit. Unable to locate the specific breaker, the assistant manager then called the emergency squad. He then returned to the breaker box and found the appropriate breaker. The electric current was turned off after the victim had been in contact with it for approximately three to eight minutes. The employee checked for a pulse again and found a very rapid radial pulse. The employee and assistant manager then went to the front of the store to unlock the doors for the rescue squad. Another call to the rescue squad was placed. The employee then checked his carotid pulse and found none.

A store employee who lived nearby then arrived and started CPR. Upon arrival, the emergency squad continued CPR. Altogether, CPR was administered for approximately one and one-half hours. The victim was pronounced DOA at the emergency room of the local hospital.

Later that morning, the restaurant had two different electricians check and evaluate the circuits in the outlet. Both electricians concluded that the voltages of the circuits were correct, no grounds or shorts were found, and no broken insulation was observed. They did conclude that two of the 120v receptacles were worn and loose, and the 120v plug of the portable toaster had a crack. These receptacles and plug were replaced.

After the accident, the preventive strategy adopted by the restaurant is to have employees go to the breaker box and open the appropriate circuits before plugging or unplugging equipment.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Based upon available information, it is surmised that, while holding the plug, the victim's right hand slipped forward to make contact through the index finger to the energized prong. With his left hand holding the spring-loaded receptacle cover open, a current path through the arms, chest and heart would be established from energized prong to ground. Numerous factors contributed to the occurrence of this fatal accident. Some of these factors include:

1. The location of the receptacle outlet: By being on the floor, it restricted vision of and access to receptacle(s) and increased exposure to water from mopping.

2. The design of the receptacle outlet: With spring-loaded cover caps mounted above rather than below the receptacles, a two-handed operation is required for insertion or removal of the plug.

3. The design of the 110 receptacle: Direct observation showed that the plug's prongs became energized before the plug had been completely inserted and twisted (a gap of 3/8" existed).

4. The design of the plug: No barrier (sleeve or flange) enclosed the prongs in order to prevent unintentional human contact.

5. The absence of Ground Fault Circuit Interrupter Breaker(s) (GFCI): During the site survey, no GFCIs for the electrical system could be found. If a GFCI had been on the circuit used for the portable toaster, it would have sensed the flow of current through the victim's body and interrupted the circuit before sufficient current passed to cause physical damage to the body.

6. Recent mopping of the floor: Water present on the floor and possibly the receptacle outlet may have increased the possibility of the electric current grounding through the victim's body.

7. Action of the victim: Being that the incident occurred early in the morning and at the end of the shift, possible fatigue and/or hurriedness of victim may have contributed to his right hand slipping and making contact with the energized prong.

8. Emergency response: If CPR had been initiated when an unstable pulse was first detected rather than later when no pulse could be found, the chances of reviving the victim might have increased.

The elimination of one or more of these factors may have prevented this electrocution. Of all the possible prevention strategies, the installation of GFCI's probably represents an easy and most comprehensive approach.

The employer's preventive strategy of employee access to the breaker box is not recommended. The use of circuit breakers for primary switching is not advisable for three reasons: (1) it represents an active rather than passive preventive strategy which is completely dependent upon totally correct human behavior; (2) the expected life cycle of a breaker may be reduced when continually operated as a primary switch; and (3) circuit breaker panels should not be accessible to everyone, because it permits one not familiar with the panel board electrical system to energize and de-energize critical circuits.

FACE 85-01: **Worker Electrocuted at Power Substation in Howesville, West Virginia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting a Fatal Accident Circumstances and Epidemiology (FACE) Program which is focusing on electrocutions. By scientifically collecting data from a sample of electrocutions, this study will identify and rank factors which increase the risk of electrocution for selected employees.

On September 18, 1984 at approximately 11:45 a.m., a 31-year-old employee was electrocuted while dismantling an abandoned electric substation tower.

CONTACTS/ACTIVITIES

On September 18, 1984, NIOSH was requested for technical assistance from the State Deputy Chief Medical Examiner.

On October 5, 1984, a research team, consisting of an epidemiologist and a safety engineer, conducted a site survey and interviewed the only other worker (brother of deceased) who was on-site the day of the fatality. Interviews were later held with the deceased's wife and the local sheriff's deputy who investigated the accident.

SYNOPSIS OF EVENTS

An electrical utility company had abandoned the substation and sold the unit to a private citizen. This individual sold the salvage rights to a third person who in turn contracted the demolition of the substation towers, which were of steel beam construction, to the deceased's brother. At mid-morning of September 18, 1984, the deceased and his brother arrived at the substation to begin demolition of the towers. The substation was secured by a perimeter security fence and locked entrance gate. Since the brothers were contracted to demolish the towers, they were provided with a key to allow access into the secured area. The brother stated that he had requested the utility company to de-energize the overhead powerlines when the tower was ready to be dropped to the ground (after the removal of all pertinent bolts) and they had agreed to do so. The brother also stated that he warned the victim that the powerlines were still energized.

The towers were composed of columns, beams and joists which were bolted together at the connecting joints and also bolted at each column foundation base. (Refer to Figure for approximate configuration of the towers.) The towers were approximately 40' in height and were located directly beneath three distribution lines. These distribution lines were charged with a potential of 69 KVA, each. The lines were approximately 6 feet above the tower.

In order to put the tower on the ground, the brothers planned to remove all but one of the bolts from each stabilizing joint. This would allow the frame to move downward as though it were hinged at each joint when a force was applied to it. Once the frame was on the ground it could easily be cut into manageable pieces.

On the day of the incident, the brothers were in the process of removing the connection bolts from the joints in two of the columns. Each brother was working on a separate column. They were working their way up the column from the ground using the column lattice work as an access system. The deceased, who was nearly 20 years younger than his brother, completed his column first. He asked his brother if he needed help. His brother gave a negative reply, telling him to go down and get a cup of coffee while he finished his column. Within a few moments the surviving brother heard a noise and saw his younger brother falling from the tower with his clothes ablaze. He descended the column and went to his brother's aid. A railroad engineer, who was passing by in a train at the time of the accident, stated that he "was attracted by a noise sounding like that made by an electronic bug whacker and a bright flash of light." This engineer then looked in the direction of the substation, saw the victim falling from the tower, and immediately called for emergency help.

The victim was transported to a nearby hospital where he was pronounced dead. Death was due to electrocution.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Based upon available information, it is surmised that the victim climbed from the column onto the top tower beam. He did this so he could walk over to help his brother remove the remaining bolts from that column. As the victim raised up into a standing position he either came in contact with or in near proximity to (approximately 1 inch)[1] the live 69 KVA line which was directly above the beam. This permitted sufficient electrical current to flow through his body to electrocute him.

Various factors contributed to the occurrence of this fatal accident. Some of these factors are:

1. The location of the steel tower in relation to overhead electrical power lines:

   The tower was immediately under three high voltage power lines which had not been moved when the substation was de-activiated. The close proximity of the energized power lines to the tower (51-61) presented a reasonably foreseeable risk of contact when dismantling the tower.

2. The distribution lines were not disconnected or isolated from the entered production source nor insulated or guarded:

   With the lines carrying a potential of 69 KVA, the risk of electrocution while working in the immediate vicinity of the lines is increased.

3. The insufficient level of hazard perception demonstrated by the victim:

   Such a level may have resulted from lack of recognition of the danger, misjudgment of his ability to transverse the beam without approaching the line, inexperience around or lack of respect for electrical energy, incomprehension of the prior warning or insufficient warning, greater concern for the safety of his brother rather than himself, etc.

REFERENCE

1. Bernstein T [1983]. Electrocution and Fires Involving 120/240 V Appliances. IEEE Transactions on Industry Applications, Vol. IA-19(2):155-159. (March-April 1983)

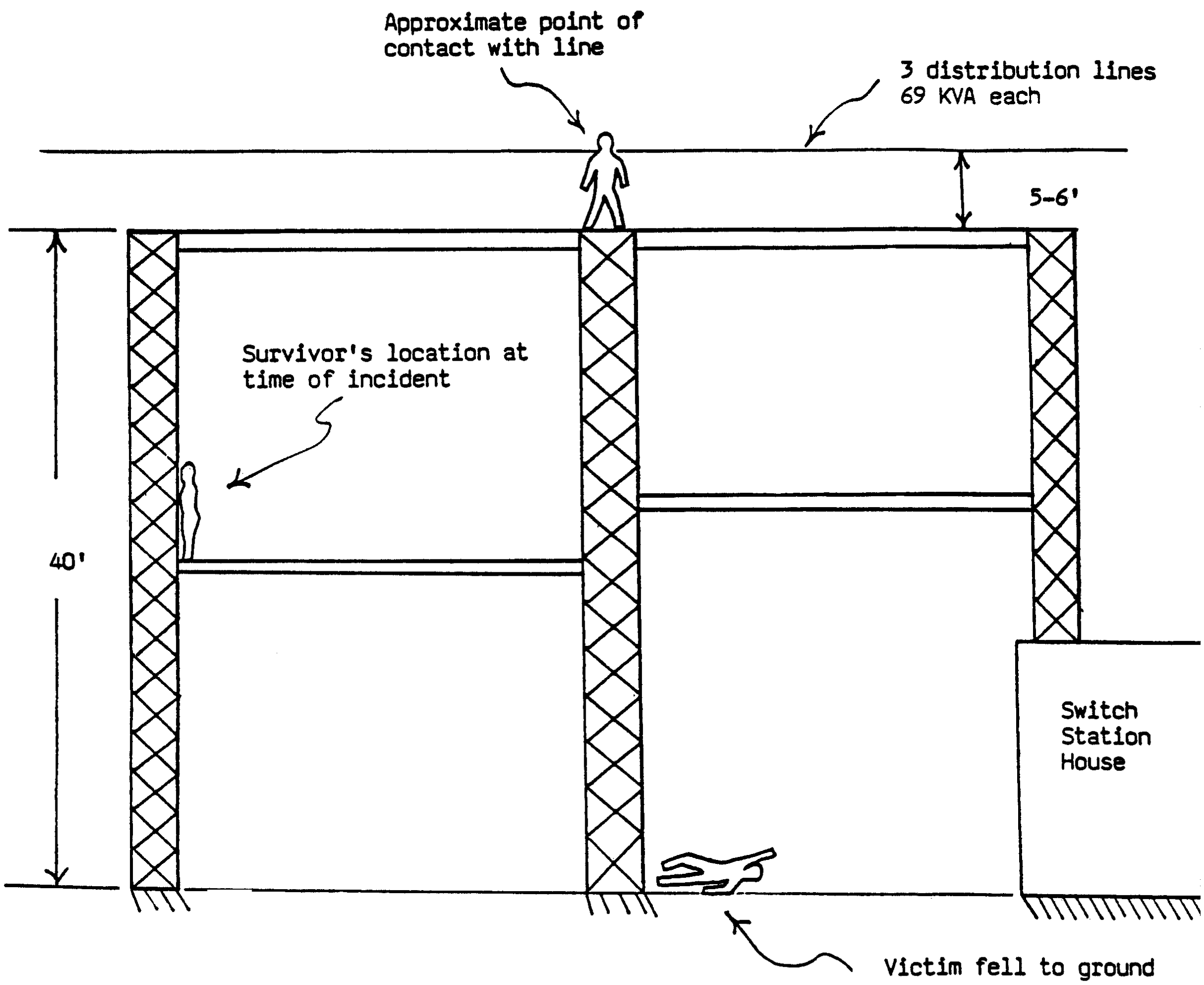
Approximate point of contact with line
3 distribution lines 69 KVA each
5-6'
40'
Survivor's location at time of incident
Switch Station House
Victim fell to ground

Figure.

FACE 85-03: **Transportation Employee Dies from Electrical Injuries Resulting from Contact with Overhead Powerline**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors which influence the risk of fatal injury for selected employees.

On November 5, 1984, a 49-year-old crew leader for a state department of transportation was measuring the amount of asphalt in a 10,000 gallon storage tank. As he removed the 12' 8" iron measuring rod from this tank, the rod came in contact with a nearby overhead powerline (7200 volts). The crew leader sustained severe electrical burns to the hands, arms, axilla, back and thighs. He was taken by the local emergency medical service to the nearest hospital and transferred later that day to a hospital burn unit. On November 25, 1984, while still a patient in the burn unit, the worker died due to pulmonary emboli resulting from the electrical burn injuries.

CONTACTS/ACTIVITIES

On November 27, 1984, DSR was notified by the Occupational Safety and Health Division of the State Department of Labor and invited to send a team to accompany their safety officer during his accident investigation. The DSR research team, consisting of an epidemiologist and industrial hygienist, provided assistance to the safety officer and collected research information for the FACE project.

On November 29-30, 1984, the safety officer and research team conducted their joint field activities. An opening conference was held with the highway safety engineer and the supervisor for the department of transportation county office where the victim worked.

Interviews were also held with the chairman of the facility's safety committee, other supervisors and foremen, co-workers, nurses and doctors from the burn unit, a prison inmate who was the only witness to the accident, the city electrical engineer, and the next-of-kin. A survey of the accident site was conducted and video and 35 mm pictures were taken.

SYNOPSIS OF EVENTS

The department of transportation county office has approximately 35 employees, including the victim and one other worker who were occupationally classified as crew leaders II, and 20 road maintenance workers. The responsibilities of this office include the maintenance of public roads in the county. The existing safety program seemed primarily orientated towards potential hazards associated with working out on roads rather than in the supply yard.

The victim had ten years' experience with this office and had been promoted four months earlier to crew leader II. He was the crew leader responsible for patching roads. Approximately two weeks before the accident, he aggravated a back problem by lifting objects on the job and missed a week of work. He had returned to work for a week when the accident occurred.

On Monday morning, November 5, the victim and inmate worker left the yard by truck and worked along various roads, hauling dirt and picking up concrete block along the sides of the road(s). After lunch they returned to the supply yard where their first task was to fill a portable "tar kettle" from the 10,000 gallon storage tank of asphalt.

Apparently, this storage tank had originally been the tank for a railroad storage car. The supply yard had been established in 1966 or 1967 and the tank had been there, at the same location as at the site of accident, since then. The three overhead powerlines (each single phase, 7200 volts) running along the perimeter of that side of the yard, had been there since 1968. The approximate special relationships of the tank and powerline are shown in the accompanying figure. The method used by the county office to ascertain the fullness of this asphalt tank entailed climbing to the top of the tank, removing a long iron measuring rod (analogous to the oil dipstick of an automobile engine), and measuring or approximating the length of asphalt adhering to the rod. Conversations with other workers at the office revealed that a two man team would often perform this task and that a near-miss (circumstances almost identical to the fatal accident) occurred approximately five years earlier.

The victim connected the "tar kettle" to the asphalt tank through a portable pump. Although the tank is designed (elevated height) to gravity feed the asphalt, in cold weather it is difficult for the asphalt to flow and a pump is needed.

After starting to fill the "tar kettle," the victim went to the yard offices, where he was instructed to check how much asphalt remained in the storage tank.

According to the highway maintenance engineer-supervisor, co-workers, and next-of-kin, the victim had no experience at this task. Furthermore, the worker who usually checked the tank was off that day.

The victim climbed to the top of the tank while the inmate worker stayed on the ground and watched. With his back against the platform railing such that he faced away from the powerline, he pulled the rod (measuring 12' 8" long) out of the tank. As the bottom end exited the tank, the top end apparently swung in a downward motion and the rod contacted the closest of the three overhead powerlines, which was approximately seven feet away.

Immediately following the victim's contact with the energized lines, several employees responded to his aid. One employee was a trained volunteer paramedic who tried to stabilize the victim while awaiting the rescue squad. The emergency medical team arrived within a few minutes of the occurrence and transported the victim to a local hospital.

After the accident, the highway maintenance engineer-supervisor had the tank moved approximately 33 feet from the powerlines. He stated that there were intentions to move the tank before the accident so that a berm could be placed around the tank, in order to contain any spillage. According to the supervisor, the fatal accident expedited the tank being moved but it was not the primary reason.

CONCLUSIONS/RECOMMENDATIONS

The most probable path of the electrical current was from the rod to the victim's hands, through his body, out his knees and back, to the platform's ladder and then to ground. Various factors contributed to the occurrence of this fatal accident. Some of these factors are:

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1. The location of the tank in close proximity to the proximal overhead powerline. The horizontal distance between the closest part of the work platform and the proximal powerline may have been as little as seven feet.

2. The elevation of tank. The tank was elevated in order to allow gravity to cause asphalt to flow out of the bottom of the tank. However, in cold weather, the viscosity of the asphalt increased such that use of an external pump was necessary to remove asphalt. The continuous availability of a pump circumvents the need for the tank being elevated so high. The work platform on top of the tank was approximately 18 feet off the ground. Given an approximate shoulder height of 51 for most workers, this elevation places a diagonal distance of approximately 7-9 feet between the powerline and worker. The length of the measuring rod was 12' 8."

3. The type of measuring rod used. The rod consisted of metal rather than a non-conductive material.

4. The weight of the measuring rod. When a worker(s) holds the 1/2 inch rod at one end (as when it is just pulled out of the tank), its heaviness, approximately 20 lbs which includes adhering asphalt, causes a loss of control and gravity forces the other end to go in a downward direction.

5. The existing method used by the company to check the fullness of the tank. This tank required workers to climb to the top of the tank, which increased the hazards of not only contacts with the nearby electrical line but also falls from elevations. Suitable alternative methods existed, such as sounding the tank from the ground or keeping inventory records pertaining to when and how much asphalt is removed.

6. Given the existing method of checking the tank, the company did not establish a written standard operating procedure (SOP) which ensured safety. Since no SOP existed, employees were not trained in the safe procedures.

7. The inexperience of the victim and possibly his physical condition. No experience with the task and no SOP minimized the worker's ability to recognize the electrical hazard. Since no SOP existed, the worker possibly did not realize that the task was often done with two workers rather than just one. The only witness stated that the victim's back had been bothering him that day. Consequently, the victim might have chosen the body position (posterior of body against rail and towards powerlines) he did in order to reduce strain on his back. However, regardless of the condition of his back, it most likely did not directly cause the rod to contact the powerline.

The cooperation of and assistance from the OSHA safety officer, the state OSHA agency, and the employer were greatly appreciated.

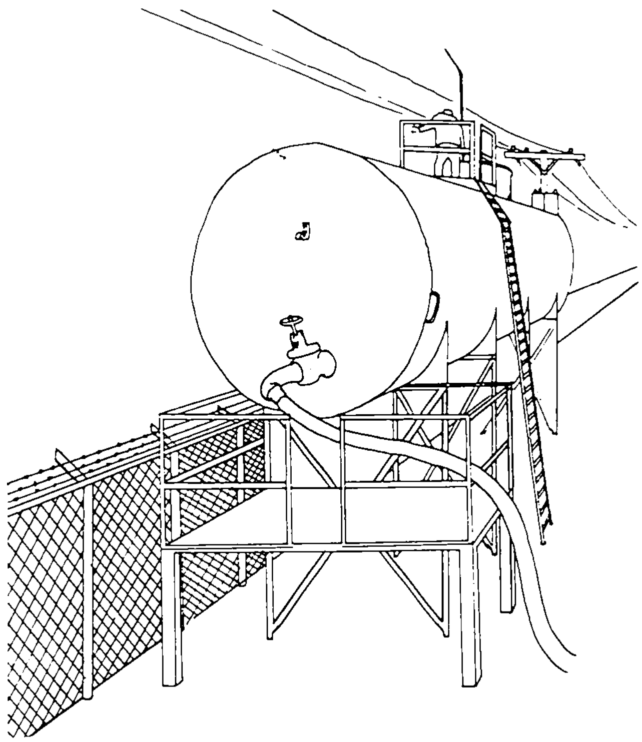

***Figure**. Configuration of Accident Site*

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FACE 85-04: Crew Foreman Dies Due to Electric Arc from Power Line

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, the FACE will identify and rank factors which increase the risk of fatal injuries for selected employees.

On November 28, 1984, an electrical line construction company foreman died from electrical and thermal burns which were caused by an electric arc.

CONTACTS/ACTIVITIES

Subsequent to a request for technical assistance from the State Occupational Safety and Health Administration, a DSR research team, consisting of an occupational health nurse and a safety engineer, assisted in evaluating the incident. The State OSHA compliance officer provided the team with a briefing of the circumstances of the incident and introduced the team to the employer. The employer provided more facts concerning the incident and also provided information regarding the following: employer's organization, safety program, number of employees, responsibilities for safety, courtesy copy of the employer’s safety manual, review of past injuries within the company, names of witnesses to the incident, names of cohort occupations and employees, and examples of the pieces of equipment which the crew was using on the day of the incident.

Work at the incident site had been completed. Therefore, the team did not survey that particular site. The employer informed the team that a similar activity was being performed at another location and invited the team to survey the new site since it would exemplify the work activities and hazardous exposures.

SYNOPSIS OF EVENTS

The employer had contracted with a local utility company to relay some existing lines and add new wire to the system. On the day of the incident, the crew was in the process of performing this work. Refer to figure for layout of the incident work site. The existing span, which had to be moved, was between poles numbered 1 and 3. It consisted of three individual 7200 volt AC lines. These three lines had to be cut and moved to form spans 1 to 2 and 2 to 3. The crew had already moved two of the three lines to pole number 2. The victim was working from an aerial lift device while dead-ending the third span conductor between poles number 1 to 2 (conductor C in Figure). The conductor was attached to the cross arm by a wire grip and come-along. The dead-end of the conductor was to be attached to a dead-end insulator device. However, the conductor was too long for the span and could not be properly attached to the dead-end insulator device, because the wire grip was too close. In the process of correcting this condition, an electric arc occurred which caused the victim's clothing to catch fire. The crew lowered the aerial lift device to its lowest point and had to rig a hoist line to remove the victim to the ground. The victim was transported to a nearby hospital by rescue squad for emergency treatment and was later transferred to a specialized burn center where he expired the following day. The medical examiner's probable cause of death was identified as electrocution and severe burns.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the electric arc occurred while the victim was preparing to move the wire grip on the conductor so the span end could be attached to the dead-end device. The arc occurred as a result of either the victim moving the conductor causing the wire grip clevis to contact the unguarded guy wire or the victim was working between the conductor and guy wire and inadvertently came in contact with both at the same time.

The following factors contributed to this fatal incident:

1. The work had to be performed on conductors energized at 7200 volts AC. The contract required that customer service could not be interrupted.

2. All conductors within six feet of the work area were not covered with insulators as required by written company safety practices.

3. The victim was not wearing rubber sleeves as required by written company safety practices.

4. The placement of wire grips on the original span conductor was in error causing one wire grip to interfere with proper dead-ending of the span.

5. Foremen had responsibility for enforcement of company safety practices in the field. The company relied upon the foremen to implement the safety practices and rarely observed field activities for compliance.

6. The foreman was performing tasks not required by his position.

7. The crew worked ten-hour shifts and the incident occurred approximately 8 1/2 hours into the shift.

Recommendation: Upper management should observe the field crew safety practices more frequently. Foremen should be held accountable for implementation of written company safety practices.

Recommendation: All energized or grounding conductors within the work area should be protected by insulating materials as required by written company safety practices.

Recommendation: All crew members should wear the protective clothing and equipment as specified by written company safety practices.

Recommendation: When cutting a span into critical lengths, tape measurements should be made by the ground crew and marked for the aerial workers, or use of other measuring methods should be tried. Optical measuring devices are available and should be practical for use by workers in aerial lift devices.

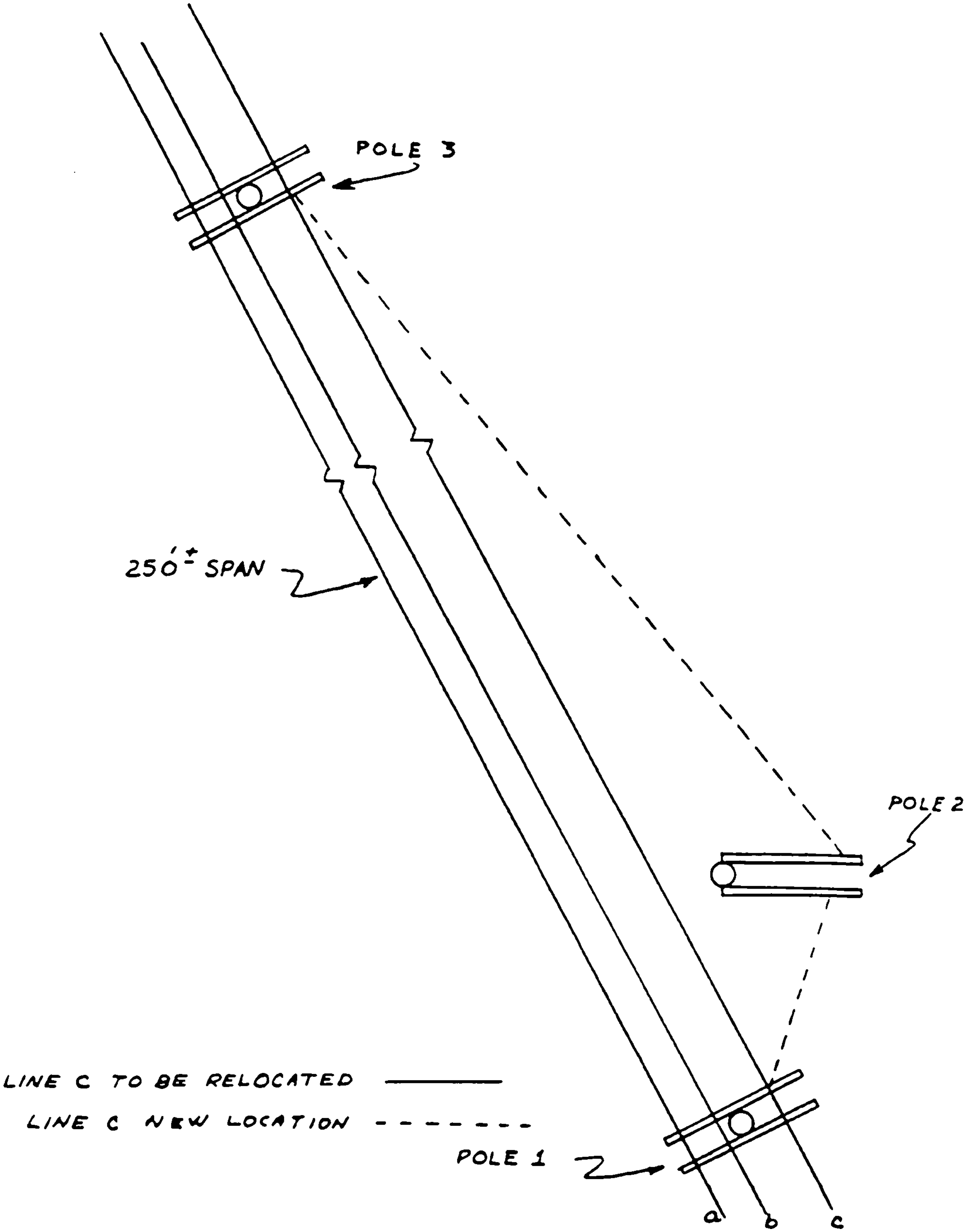
POLE 3
250'± SPAN
POLE 2
LINE C TO BE RELOCATED
LINE C NEW LOCATION
POLE 1
a
b
c

***Figure*.**

FACE 85-06: **19-Year-Old Warehouseman Electrocuted by a 440 Volt Trolley Wire in Kentucky**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, the FACE will identify and rank factors which influence the risk of fatal injuries for selected employees.

On December 8, 1984, at approximately 3 p.m., a 19-year-old warehouseman employed by a mine service equipment company was assisting with the removal of a mine machine part from a metal pallet storage rack. The employee climbed approximately nine feet to the top level of the rack. While awaiting the positioning of an overhead bridge crane, he came in contact with both the bare 440 volt runway conductor providing power to the crane and the "grounded" metal rack. After the victim maintained this contact for several seconds, the supervisor de-energized the line. The fatally injured worker fell to the concrete below. The attending coroner concluded that death was due to electrocution.

CONTACTS/ACTIVITIES

On December 10, 1984, DSR received a request from the State OSHA for technical assistance in evaluating the circumstances surrounding this fatality. On December 11, 1984, a research team consisting of an epidemiologist, a safety specialist, and a consulting engineer conducted a site survey and interviews. The general manager of the facility and co-workers who were present at the time of the accident were interviewed. The county coroner and the parents of the deceased worker were also interviewed. The site survey included video and 35 mm documentation.

SYNOPSIS OF EVENTS

The company employing the victim started 42 years ago as a family-owned repair shop for coal mine equipment and was recently purchased by a large conglomerate mine service company. Presently, this facility employs a total of 54 people (4 office workers, 42 shop workers, 4 truck drivers, and 4 salesmen). The company is primarily engaged in repairing coal mine machinery, which involves disassembly/ assembly of equipment, welding, fabrication, and machining. In addition, support activities include marketing, advertising, transporting, and shipping and receiving.

The victim was hired as a warehouseman two months prior to the accident and had little previous work experience. He worked primarily with two other people (supervisor and inventory control clerk) in shipping and receiving.

The three shipping and receiving personnel were assigned the task of retrieving a mining auger off the top pallet of a storage rack so that it could be shipped to a customer. Other workers were nearby unloading a truckload of furniture at a loading platform. Saturday is not a normal workday. However, there were approximately ten workers in the plant on the day of the accident.

The storage rack was located along the interior wall of the building beneath the overhead bridge crane track and runway conductors (see figure). As shown in the figure, the 3-phase, 440 V conductors were within a few inches of the top of the rack. The pallet and rack arrangement was set up so that a forklift could be used to lift and lower a pallet down to ground level, then the overhead crane could be used to lift and carry the part to its destination. On the day of the accident, the forklift was out of propane fuel, thus necessitating the use of the crane to remove the part from the rack. This usage required a worker (the victim) to climb to the top of the rack, attach a chain to the mining auger (after the crane was moved into position) and attach the chain to the crane hook. At the time of the accident, the crane was being operated by the inventory control clerk.

Shortly after the crane operator warned the victim to be careful and before the supervisor had time to de-energize the lines, the victim contacted the energized line. After de-energization occurred, the victim fell from the top of the metal rack to the concrete floor, a distance of approximately nine feet. Several people unsuccessfully attempted to resuscitate the victim before the Emergency Medical Service (EMS) arrived. The victim was pronounced dead in a hospital emergency room within an hour after the accident.

Inspection of the area around the top pallet provided insight about how the accident might have occurred. The victim was in a squatting position facing towards the back of the plant. The victim was looking in the direction of the moving crane, while trying to maintain his balance on the uneven surfaces of the parts on which his feet rested. His right hand was holding a metal brace of the pallet rack. Finger impressions in the dust on the lower runway conductor showed that his left hand made contact with the lowest bare runway conductor. The path of current flow passed through the victim probably through the unpainted metal lip of the brace he held with his right hand.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The contributing factors leading to this electrocution include: a) proximity of the metal pallet rack to bare 440 V conductors; b) lack of visual danger signs in the vicinity of the bare conductors; c) deviation from the usual procedure of using a forklift to move items from the storage rack; and d) insufficient hazard recognition by the victim.

Specific recommendations for prevention include:

1. The pallet storage rack should be removed from the area of the runway conductors.

2. "Danger Voltage" signs should be placed in vicinity of exposed conductors.

3. Guarding should be installed in areas where close worker access to bare runway conductors is necessary.

4. The company should improve their safety training on hazard recognition and safe work practices.

The cooperation and assistance of the State OSHA investigator, plant manager and his employees are greatly appreciated.

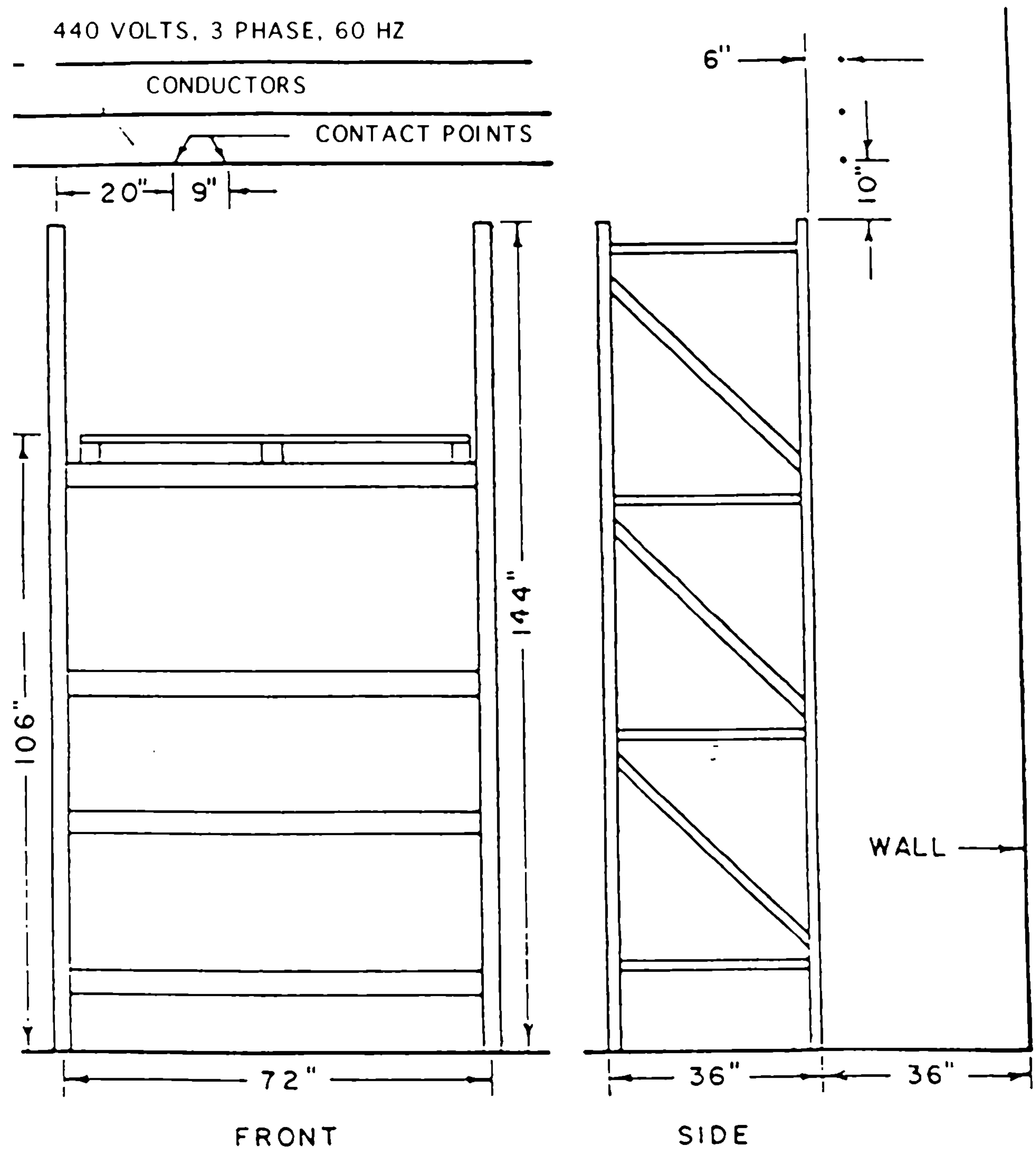
440 VOLTS, 3 PHASE, 60 HZ
CONDUCTORS
CONTACT POINTS
20"
9"
6"
10"
144"
106"
72"
36"
36"
WALL
FRONT
SIDE

Figure 1.

FACE 85-07: **Two Workers Electrocuted by 23,000 Volt Power Line While Erecting a Steel Support Structure**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors which influence the risk of fatal injury for selected employees.

On December 11, 1984, at approximately 8:00 a.m., a co-owner and three employees of a steel erection company were using a telescoping boom crane to move a section of steel framing member at the construction site of a commercial storage shed. As this section was moved, it contacted one phase of a 23.000 KVA overhead power line. Two of the three employees who were in direct contact with the steel section were electrocuted while the third received serious electrical burn injuries.

CONTACTS/ACTIVITIES

The Tennessee Department of Labor, Occupational Safety Division invited a DSR team, consisting of an epidemiologist and consulting engineer, to collect research information. On January 7, 1985, this team visited the office of the area director who had conducted the State's investigation. At this time, the area director informed the team that the co-owners who employed the victims, had dissolved their company, sold their equipment, and could not be contacted by telephone. Consequently, the team's field activities were limited to ascertaining what was learned and concluded by the area director during his investigation and conducting a site survey of the accident location. The majority of this report's content resulted from the latter activity.

SYNOPSIS OF EVENTS

The company employing the victims was established in July, 1984 and owned by two men who had numerous years' experience as ironworkers. This construction project represented the first major job for the company who was serving as the subcontractor for steel erection. This project consisted of the erection of a 40' X 180' materials storage shed (consisting of a structural steel framework enclosed with a sheet metal roof and sides) at a warehouse facility. The 180' side was in a north-south direction and the 40' side was in an east-west direction.

At the time of the accident, the major steel framework had been erected except for the end sections. After the south end was erected, the workers discovered that an incorrect roof beam had been installed (Figure 1). To replace this beam, a decision was made to use a crane to lower the south section to the slab (Figure 2). The incorrect beam was unbolted from the two corner columns, but was left connected to the two intermediate columns. These intermediate columns were disconnected from the anchor bolts on the slab. A lifting sling was placed around the incorrect beam with the intention of raising the whole assembly (beam and support columns) off the anchor bolts, tipping it in a northward direction, and laying the whole assembly on the slab. Then the columns would be unbolted and the correct beam installed.

A plan view of the building layout and the proximity of the two sets of 23 KVA overhead power lines to the work area are shown in Figure 3. One set of power lines ran in an east-west direction. This set came from a corner pole (outside the fence) on the west side of the slab and steel uprights. These powerlines fed a transformer bank consisting of 3, single phase, 23 KVA transformers which supplied power to the facility. One of these lines was approximately a five foot diagonal distance from the structural section which was to be lowered. The second set of power lines ran on the west side of the structure along its entire 180' length. The inside phase of this set appeared to be approximately 10 feet diagonally from the upright columns of the structure's west side.

As the co-owner (standing on the running board and operating the hydraulic crane controls) raised the steel section, two workers attempted to pull the base of the west column towards the north while the third worker tried to pull the east column likewise. Due to unbalanced forces, the east end of the incorrect beam rotated and/or tipped into the inside phase of the east-west powerlines. The phase to ground voltage was approximately 13.200 KVA. Two workers (one on each of the support columns) were electrocuted. The remaining worker, pulling the west column, sustained extensive electrical burn injuries on his left hand, left arm, and both feet and was in the burn unit of a local hospital when the field activities were conducted. It is surmised that he was still alive because he had only one hand in contact with the column. The electrocuted workers had both hands on the columns and this probably facilitated the path of current through vital organs. The co-owner who was operating the crane was not injured.

Subsequent to the accident, the city building inspector issued a "cease work" order which will not be removed until the utility company adjusts the location of the power lines.

CONCLUSION/RECOMMENDATIONS

Various factors contributed to the occurrence of this fatal accident. Some of these factors are:

1. Initial approval for construction was granted by the city building inspector. It is recommended that in the future, the issuing body of construction permits should incorporate rules and regulations requiring all known electrical lines (both overhead and underground) be referenced on building application drawings.

2. Apparent insufficient safety awareness by the general contractor prior to issuing a subcontract and during steel erection.

3. The electrical lines were neither de-energized, insulated, nor moved away from the construction activity.

4. The apparent insufficient recognition, knowledge, and appreciation of the dangers of electrical energy, as demonstrated by the employees of the steel erection company.

5. The incorrect beam was installed.

6. Failure to use nonconductive taglines in performing the task of lowering the steel structure. One existing guideline suggests using nonconductive tagline to control all loads being moving in the proximity of powerlines. (Dickie DE [1975]. Crane Handbook, Ontario: Construction Safety Association of Ontario.)

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7. The subcontractor had no written safety program nor standardized procedures for working around power lines.

The cooperation and assistance of the State OSHA and their area director are greatly appreciated.

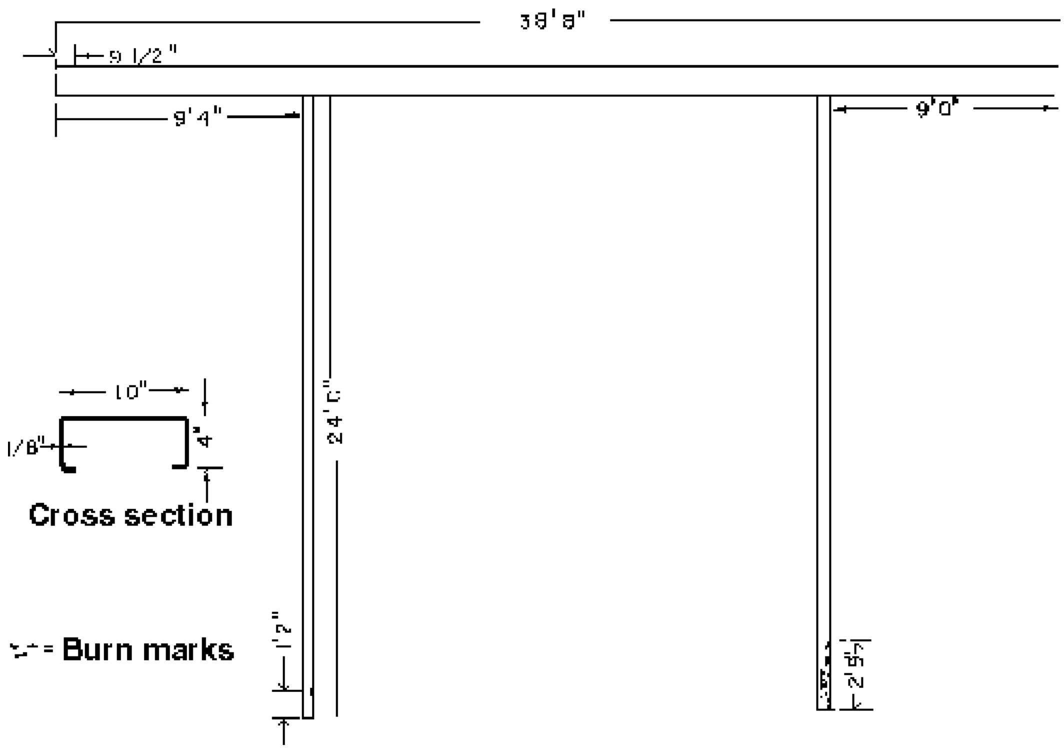

***Figure 1**. Steel Framing Configuration*

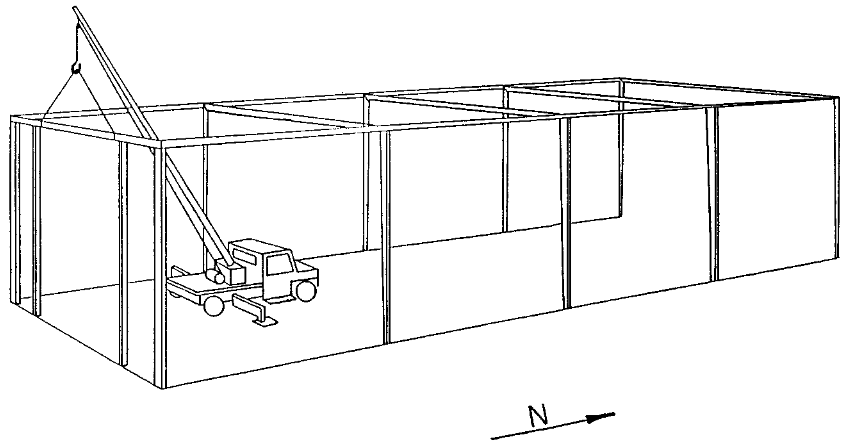

Figure 2.

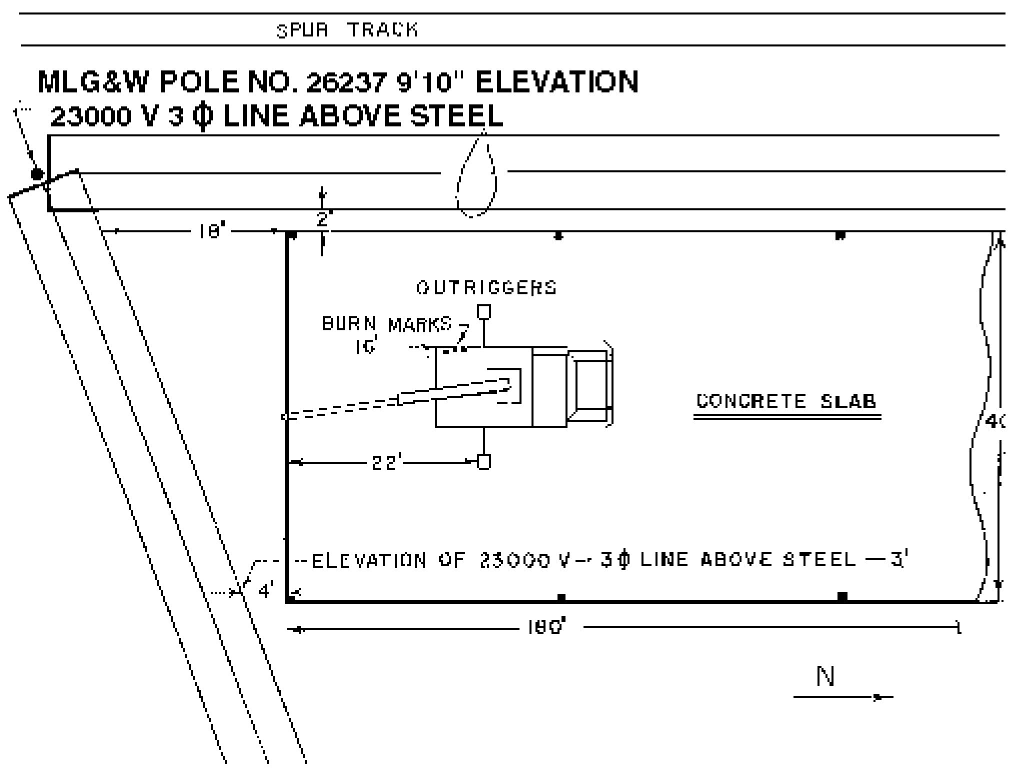

Figure 3.

FACE 85-08: **Workman Electrocuted When Crane Load Line Contacts 7200 Volt Power Line**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, the FACE will identify and rank factors which increase the risk of fatal injuries for selected employees.

On January 3, 1985, at approximately 9:45 a.m., a construction worker was electrocuted when a crane came into contact with an overhead 7200 VAC power line while the worker was attempting to hook a load to the crane.

CONTACTS/ACTIVITIES

Subsequent to a request for assistance in evaluation of the electrocution, DSR provided a research team to assist the state Occupational Safety and Health Administration. The research team, consisting of a safety engineer and a mechanical engineer, met with the state OSHA investigator who provided details about the accident. The team accompanied the investigator to the incident site where they photographed the general layout of the site and interviewed the victim's co-workers and other individuals who were working nearby.

SYNOPSIS OF EVENTS

The work site was within an established shopping center. A chain grocery store had contracted to have an addition built onto an existing building. The prime contractor had sub-contracted with the victim's employer to install the roof on the addition. The roof was to consist of fabricated metal roofing joists and metal decking with an overlaid built-up asphalt roof. The joists, decking and 1" by 1" joist angle bracing materials, had been delivered to the worksite while the masonry work was being completed. The materials were off-loaded from the delivery truck by a forklift and stored at the edge of the property as directed by the prime contractor. Part of the material was placed directly beneath a 7200 volt AC distribution line which was 37' above the stored material.

The victim's employer had contracted with a crane rental company to provide a truck-mounted crane and operator at the work site to assist in erecting the roof. The operator arrived with the crane at the worksite at approximately 8:00 a.m. on the morning of the accident. The victim's supervisor told the crane operator and the victim which materials needed to be moved and where to place them. He also warned them about some of the materials being under the power lines and suggested they drag them out with the crane instead of lifting them straight off the ground. The operator then positioned the crane to begin moving the roof structure materials. With the victim's assistance in rigging and hooking the loads, the operator moved four bundles of roofing joists from their temporary storage area to an area closer to the building. They then proceeded to move a bundle of joist angle bracing which was directly beneath the power line. Apparently, as the victim was in the process of hooking the load to the crane, the load line contacted the power line when the boom moved and the electricity flowed through the victim's body to ground.

The operator saw the victim fall to the ground and yelled for help. Two of the victim's co-workers responded, one began CPR and the other called for emergency help. A paramedic rescue squad arrived within 5 minutes and continued CPR. A pulse was detected about 10 minutes after contact with the electricity. The victim was then transported by a paramedic helicopter to a local hospital and was pronounced dead soon after arrival.

CONCLUSIONS/RECOMMENDATIONS

The following factors contributed to this electrocution:

1) Storage of construction materials beneath overhead power lines.

2) Use of crane load lines within a 10 foot distance of overhead power lines.

3) Both the crane operator and the victim took the risk in order to get the job done.

4) The working surface was wet from thawed sleet.

5) The crane operator knew he was close to the overhead power lines but did not adequately observe the crane's movement toward the lines while setting the hook over the load.

6) The crane's controls were on a pivot arm which allowed operation from either side of the truck. When pivoted to the opposing side the controls are reversed and operate in a reverse direction. Therefore, the crane operator may have thought he was activating the load line when in reality he was causing the boom to swing in a lateral direction inadvertently making contact with the lines.

RECOMMENDATIONS

1) Stored materials should be kept in areas where they do not create additional job hazards. Company safe work practices should address proper temporary storage of work materials.

2) Cranes should not be used within a distance of 10 feet from overhead power lines without first having the lines deenergized, insulated with protective coverings, or having an approved insulated lifting device on the load line.

3) Company safe work practices or safety policies should emphasize that employees not take undue risks to accomplish the job.

4) Since the crane was working within the ten foot absolute limit of approach to the overhead lines, employees hooking loads should have worn protective rubber, lineman's gloves and boots to insulate them from ground (damp working surface in this case).

5) When cranes are being used near overhead lines and could possibly enter the absolute limit of approach zone to the lines when the crane boom is swung, a signalman or warning device should be used to notify the crane operator of the crane's proximity to the power lines.

6) Equipment manufacturers should not place controls on pivot arms which cause reversal of function and direction when pivoted from one side of the equipment to the other. This potentially creates operator confusion and could result in severe consequences.

FACE 85-11: **Worker Electrocuted in Mushroom Cannery in Ohio**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) project, which is focusing primarily upon selected electrical-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, the FACE will identify and rank factors which increase the risk of fatal injuries for selected employees.

On March 5, 1985 a 21-year-old male was electrocuted while attempting to unclog a drain trough located beneath a piece of mushroom processing equipment. Two additional workers received an electrical shock while attempting to rescue the electrocuted worker.

CONTACTS/ACTIVITIES

The Division of Safety Research was contacted by the Industrial Commission of Ohio for purposes of providing technical assistance in this fatality. It was determined that this fatality would be included as part of DSR's FACE project. A research team consisting of a safety specialist, an electrical engineer, and a medical doctor visited the site of the fatality. Discussions were held with a representative from the Industrial Commission of Ohio. An extensive interview was conducted with the owner of the plant. At the time of the site visit the plant was not in operation. Thus, no employees were available to interview. The plant and the location of the electrocution were photographed by the NIOSH team using 35 mm and video cameras.

SYNOPSIS OF EVENTS

The site of the fatality was a wholesale mushroom canning operation. The company has been in operation for many years and employs approximately 14 people. The work force includes a secretary, salesman, vice-president, foreman, and 8 to 10 production workers. The production workers man various stations throughout the mushroom canning process. A normal workday is from 6 a.m. to 2 p.m. Workers begin the day by affixing labels to cans of mushrooms which had been processed the previous day. At mid-morning the workers begin the mushroom canning process. The mushrooms are washed, processed through a shaker table, baked in a large oven, placed in a 68 ounce metal can, sealed with a lid, and processed through a retort operation.

Several days prior to the accident, the cannery owner was ordered by the City to reduce the solid waste material leaving his plant. Because this waste was a significant contributor to the plugged drains and resultant flooding on public property, the owner was given 30 days to eliminate the conditions. To comply with the order, the owner made several attempts to filter the larger waste prior to entry into the drain system. Employee acceptance, however, was not widespread because each, at some time, had to place the filter over the drain, later remove the filter for cleaning, and finally replace the filter again. Consequently, none of the filters were being replaced. On the night before the accident, the owner made a filter from a steel grate and bolted it to the floor over the drain. The grate was intended to provide the necessary filtering while eliminating the practice of removing the filter. The employees would then remove the larger solids from the top of the grate and discard them elsewhere.

At 9:30 a.m. the 21-year-old male victim was working in the retort room when his supervisor requested that he report to the mushroom processing room where he was asked to unclog a drain trough located directly beneath the shaker table. A 7 inch wide trough runs beneath the entire mushroom processing area. Attached midway and beneath the shaker table is a motor connection box. The motor connection box is located 42 inches above the clogged trough. The water backed up around the drain and formed a pool about 3 feet in diameter and 4 inches deep. To clean the filter, the victim had to crawl on his hands and knees under the table and remove the debris by hand while kneeling in the pooled water. While there were no witnesses to the electrocution, co-workers of the victim felt he was unclogging the drain with one hand and holding on to a 3 phase, 220 volt power cable which supplied electrical energy to the table's drive mechanism. The cable, not being properly fastened, was partially pulled from the mechanism's connection box. The victim was in contact with electric current for approximately 15 seconds. During that time one co-worker reached for the victim and received a shock. A second co-worker contacted the shaker table and received a minor shock. Another co-worker immediately de-energized the equipment and the victim fell face down into the water. The medics arrived 8 minutes after the incident and attempted to revive the victim. The worker was pronounced dead on arrival at a local hospital.

CONCLUSIONS/RECOMMENDATIONS

Examination of the motor connection box attached beneath the shaker table showed it to be rusted and had many sharp edges. The box was not waterproofed. When the cover was removed for inspection, approximately 8 ounces of water fell from the connection box. The electrical connections were good, but there was no strain relief to hold the power cable in place. The insulation on the power cable conductors was badly deteriorated. This may have been caused by the constant immersion in water. Inspection showed that while some of the insulation was still in sound condition, much of it was easily chipped away with only the abrasive force of a finger nail.

One large section of the white conductor's insulation had been torn almost off. By examination of the torn segment of insulation and the improper strain relief, it was very likely that the cable was abruptly pulled (but not detached) from the box and across the sharp rusted edges. This force would have been sufficient to tear back the deteriorated insulation and directly connect the three phase power to the ungrounded frame of the motor and table. This was the most likely source of electrical energy which caused the electrocution.

In general, parts of the electrical distribution system for the plant were very old, constructed in a piecemeal fashion, and did not meet the National Electric Code. Specifically, visual examination of the shaker table's electrical service revealed several unsafe electrical conditions:

1. The shaker table was not grounded. The ground wire was brought to the local disconnecting means but not continued to the table.

2. The power cable was not properly fastened and sealed in a water-tight conduit. The motor rating was not suitable for wet applications.

Additional factors associated with this electrocution include: the victim was not wearing appropriate personal protective equipment specific to the task he was performing, the task and body position of the victim immediately prior to the electrocution, the accumulation of 4 inches of water under the shaker table, the worker used electrical cable to support himself (either intentional or unintentional), and no system was in place to catch the mushrooms before they entered the drain trough, thus contributing to the water accumulation problem.

While not an exhaustive list, specific recommendations include:

1. The electrical system of the plant should be inspected and modified to satisfy requirements of the latest edition of the National Electric Code.

2. Where appropriate, ground-fault circuit-interrupters should be installed.

3. Persons working with the equipment should be required to wear the appropriate personal protective equipment.

4. The use, where practical, of insulating barriers mechanically attached to the processing machinery will prevent direct contact with the conductive parts by the line workers.

5. The processing procedure should be modified so that it reduces the number of mushrooms falling onto the floor and prevents mushrooms from flowing into the trough. This would not only prevent the city sewers from becoming clogged with mushrooms but will also prevent the drain inside the plant from becoming clogged.

6. Management should implement a hazard identification program and make the employees aware of their role in the program.

7. The employer should request technical assistance from the Industrial Commission of Ohio for the development and implementation of a more comprehensive occupational safety and health program.

FACE 85-14: Construction Worker Electrocuted When Crane Boom Contacts 13,800 Volt Power Line in Arizona

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors which influence the risk of fatal injury for selected employees.

On March 14, 1985, a construction company was in the process of laying sections of concrete water pipe in the Arizona desert when the fatal accident occurred. The company had been laying pipe all morning. The crane was moved as needed to lift the heavy concrete pipe into place. At approximately 11:20 a.m. two workman guided the operator as he moved the crane into a new location. As the workmen were in the process of placing support timbers beneath the outrigger pads, the operator began extending the crane boom to prepare for the next lift. The crane's cable contacted a 3 phase 13,800 volt overhead power line, thereby electrocuting one worker who was in contact with the crane's outrigger.

CONTACTS/ACTIVITIES

The Division of Occupational Safety and Health (DOSH) of the Industrial Commission of Arizona invited a DSR research team, consisting of a safety engineer, a research industrial hygienist and a medical doctor (DSDTT) to collect research information. On April 8, 1985, the team visited the office of the Director of DOSH to discuss the fatality. The owner of the company was contacted by telephone to make arrangements for the investigation and schedule times and events. The owner of the company made voluntary right-of-entry conditional upon all data collected being treated as privileged information until this case was settled in court before any meeting or investigation could take place. The owner was informed about technically collected information being subject to the Freedom of Information Act requests and that this could not be agreed to. Therefore, no investigation of this fatality was conducted.

RECOMMENDATIONS

1. The OSHA Safety and Health Standards, 29 CFR 1926.550(a)(15), have specific requirements for the safe use of cranes around overhead power lines. Electrical distribution and transmission lines should be de-energized and visibly grounded or separated from cranes with independent insulating barriers. If this standard is not used, then cranes may operate proximate to power lines when:

    a) a minimum clearance (absolute limit of approach) is maintained between the crane and the lines (10 feet for < 50 kV and 10 feet plus .4 inch for each 1 kV over 50 kV, or twice the length of the line insulator but never less than 10 feet) or,

    b) in transit with no load and boom lowered if the absolute limit of approach is 4 feet for < 50 kV, 10 feet for 50 kV to 345 kV, or 16 feet for up to and including 750 kV.

    Additionally, 1926.550(a)(15) requires a signalman be used when it is difficult for the crane operator to use direct observation to maintain the proper clearance; and if cage-type boom guards, insulating lines, or proximity warning devices are used the work practices still must satisfy the aforementioned standards.

2. The Construction Safety Association of Ontario also recommends safe work practices to include: the use of nonconductive taglines to guide loads, the use of insulating personal protective equipment by exposed workers, and the storage of material away from power lines.

FACE 85-15: **Electrocution of Carpenter, Setting Forms, When Crane Contacted 34,000 volt Power Line in Pennsylvania**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injury for selected employees.

On April 11, 1985, a joint venture construction company was setting forms for a retaining wall on an outbound highway from Philadelphia. At this construction location approximately 15 carpenters and laborers, 2 supervisors, and an operating engineer had started work at 7:00 a.m. At 2:10 p.m. a carpenter was guiding a 4' X 8' metal form with a 3/4" plywood face into place with the assistance of an 18-ton, telescoping boom crane. The crane touched a 34,000 volt power line; the carpenter was electrocuted and another laborer, who was over 50 feet away, was severely burned.

CONTACTS/ACTIVITIES

On April 12, 1985, the NIOSH Region III consultant contacted DSR about the case. DSR contacted the OSHA Area Director on April 12, 1985 and set up a meeting for April 16th with the investigating compliance officer. On April 17th the OSHA compliance officer, a NIOSH statistician, and a technical information specialist conducted a site visit to interview workers and take photographs of the accident site.

SYNOPSIS OF EVENTS

The construction work crew had been working 10 hour days, from 7:00 a.m. to 5:30 p.m. with a 15 minute break in midmorning, 30 minutes for lunch, and no break in the afternoon. The carpenters and laborers would typically make forms, set forms in place, and knock down forms after the concrete was cured. On this site the crane was picking forms from a 15 foot hill behind the future location of the retaining wall, placing them on the ground alongside the highway, and moving them into place so that the carpenters and laborers could set and bolt the forms, prior to pouring the retaining wall. Immediately above the site on the hill was a 34,000 volt power line, which crossed the highway at a height of about 50 to 55 feet. The 18 ton (rough terrain) crane had a boom that could extend from 28 feet to 70 feet. The operator had 34 years of experience operating a crane. There was a supervisor on the site, but a signal man had not been assigned to spot the location of the boom in relation to the power lines for the operator. No insulators or barriers were placed between the power line and crane. The weather that day was overcast, with 54 degrees F temperature and 55% humidity. The ground was dirt or gravel and there was no standing water.

At approximately 2:10 p.m. on April 11, 1985, the crane contacted the 34,000 volt power line. Electricity traveled through the crane cable, to the form, and to ground through the carpenter. The carpenter had both hands on the form and both feet on the ground. Another path to ground was through the crane outrigger, to an overhead sign, to a temporary electrical box on the sign post, to an electrical drill and to ground through the arm and leg of another worker over 50 feet from the crane. The carpenter was killed, and the other worker received burns to the left hand and lower left leg. Over 15 eyewitnesses stated that the electricity arced over 10 feet from the power line to the crane boom. However, examination of the crane cable indicated that the cable contacted the power line directly. The supervisor was 15 feet from the site of the electrocution.

The victim was immediately given CPR by a nurse, who had seen the accident from the highway and stopped to give aid. The victim was rushed by EMS to a local hospital where he was pronounced dead by a staff physician. The other worker was rushed by EMS to a different hospital, where he was treated and released on April 14, 1985.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA standard 1926.550(a)(15) requires that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers. Additionally, 29 CFR 1926.550(a)(15)(IV) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means. The crew in this case did not satisfy these requirements.

Recommendation #2: Employers should develop and enforce specific safety policies and procedures concerning specialized tasks, such as operation of a crane or other heavy equipment.

Discussion: The employer did not have specific safety policies concerning crane operation. The employer should identify hazardous conditions present when performing a task and should develop specific policies that reduce the hazard potential. These policies should be enforced to assure compliance.

Recommendation #3: Employers should hold management and first-line supervisory personnel accountable for job site safety.

Discussion: The supervisor permitted an unsafe operation to continue and did not take proper precautions. Safety responsibilities that include accountability for all levels of supervision should be developed and supervisory personnel should be held accountable for all safety responsibilities. Performance evaluations and other incentives should address safety.

Recommendation #4: Employers should assure that work related tasks are planned to minimize the hazards to which the employees are exposed.

Discussion: The materials to be used for construction of the retaining wall were stored directly under the power line. The employer should have considered all aspects of job planning, including safety, when originally laying out the job site.

Recommendation #5: Employer attitudes should demonstrate a concern for employee safety.

Discussion: The employer continued to unload and store forms under the high voltage lines after the fatality occurred. Supervisory personnel, if unaware of the hazard before the accident, should have recognized the hazard associated with this practice after the accident. Employers should understand that the attitudes towards safety that they convey to their employees are potentially the attitudes that the employees develop.

FACE 85-16: **General Foreman Electrocuted While Testing Circuits in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that increase the risk of fatal injuries for selected employees.

On April 13, 1985, employees of an electrical contracting firm under contract to the local electric company were replacing an existing high voltage distribution switch located in a commercial/residential development. At 9: 00 a.m. the foreman contacted one phase of a 23,000 volt conductor within the switch cabinet. The foreman was electrocuted and a second employee received superficial flash burns of the eyes and face.

CONTACT/ACTIVITIES

The Division of Safety Research was contacted by the North Carolina Occupational Safety and Health Administration (NCOSHA) to provide technical assistance in the evaluation of this incident. This fatality was included as part of the FACE project. A research team consisting of a safety specialist and a consulting engineer visited the site of the fatality. Discussions were held with the NCOSHA Compliance officer, the corporate Personnel Director, the corporate Safety Director, the injured worker, and other employees of the electrical contracting firm. The location of the electrocution was photographed by the research team.

The electrical contracting firm started business forty years ago and presently employs 1,250 in six states. Approximately 100 employees are administrative, with the balance being field personnel. The contractor installs and maintains overhead and underground electrical distribution systems and telephone lines, performs substation work, and maintains right-of-ways. The non-union firm hires local laborers through personal contacts. All training is on the job. A preplacement safety orientation session is given to each new employee along with two books; "Safety Regulations" and "Safety Procedures." Work hours have increased from forty to sixty hours per week the past several months, due to an excessive workload. The electrical contractor maintains a safety van that provides on-site training to all employees. Video cassettes, slides, etc., are used to demonstrate proper procedures for on the job safety and first aid.

SYNOPSIS OF EVENTS

The local electric company requested that the contractor replace a high voltage distribution switch for an underground system with another switch that included a disconnect on the load side. The new switch could isolate circuits on the load side independently of each other. Although the existing switch had been in service only one year, it became necessary to install a new switch due to the rapid growth of the area.

To install the new switch, it was necessary to schedule a power outage for the morning of April 13, 1985. A written request dated April 4, 1985, scheduled a power outage for the morning of April 13, 1985. The installation of the new switch was assigned to the assistant general foreman, a crew foreman, and a two-man service crew. Shortly before 9:00 a.m. on April 13, a workman for the local electric company arrived at the site to coordinate the power outage. Because none of the contracting firm's employees were present, the workman proceeded to another small job in the area, intending to return later. Prior to the return of the electric company's employee, the assistant general foreman and the crew foreman of the electrical contractor arrived at the site and discussed whether or not the distribution switch had been de-energized. The crew foreman was authorized to have possession of the cabinet lock keys, since his work required access to such cabinets. The crew foreman removed the locks and opened the door of the cabinet. The assistant general foreman removed the insulation barrier and, using a tic tracer, attempted to determine if the distribution system was de-energized. The assistant general foreman guided the tic tracer with his right hand so that it contacted one phase of the 23,000 volt source. The contact allowed 13,200 volts to pass to ground through the assistant general foreman's body. He fell forward and was still breathing. The crew foreman received minor flash burns of the eyes and face and stated that he was "electrified," shaken, and proceeded to run.

By this time the two-man service crew arrived at the site. At 9:03 a.m. the service crew radioed their office to call an ambulance. One of the crew members arriving at the scene had EMT training and applied CPR until the rescue squad arrived. The rescue squad arrived at 9:09 a.m. and continued treatment during transportation to a local hospital, where the victim was pronounced dead at 10:20 a.m.

Upon investigation of the incident, it was learned that the assistant general foreman was not wearing the required personal protective equipment, rubber gloves and rubber sleeves, when he proceeded to work. Written company work procedures require a system to be de-energized and proper grounds installed before and during work on this equipment. The system had not been de-energized and properly grounded. Two days before the incident both workers were present at a safety demonstration that discussed the very job being performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer must enforce proper work procedures.

Discussion: Supervisory employees did not follow proper work procedures when changing a high voltage distribution switch and did not wear personal protective equipment (i.e., rubber gloves and rubber sleeves). Two days before the incident both workers attended a safety demonstration that specifically addressed the correct procedure to follow when performing this task and appropriate protective equipment was on the service truck (30 feet from the accident site). The company had established proper work procedures; however, the employees chose not to follow them. Enforcement of proper work procedures is required to assure compliance.

Recommendation #2: Communication and coordination policies between the power company and the electrical contractor must be followed.

Discussion: It was the policy of the power company and the electrical contractor that representatives of both concerns would meet at the job site before any work was initiated. The employees of the electrical contractor did not follow this policy.

Recommendation #3: Employees should be assigned tasks commensurate with their level of experience, training, and skills.

Discussion: The employees involved in this incident had limited experience replacing an existing high voltage distribution switch. The victim had only worked for the company for six months and the other three employees had no experience replacing an existing high voltage distribution switch. During interviews with several other randomly selected employees, it was noted that they had little or no experience working with electrical energy. The employer did not have a preplacement program to assess the skills of potential employees and to assure their placement into positions for which they were qualified.

FACE 85-17: **City Foreman Electrocuted and Three Crew Workers Critically Injured While Erecting a Traffic Control Pole**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related fatal injuries and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, the FACE will identify and rank factors which increase the risk of fatal injuries for selected employees.

On April 23, 1985 a foreman was killed and three members of his crew were critically injured while erecting a 36' concrete traffic control device pole which came into contact with a 26 KVA power line. A fifth man, the derrick truck operator, was uninjured.

CONTACTS/ACTIVITIES

The Division of Safety Research received an invitation from a Florida county health officer to evaluate this accidental electrocution as part of the FACE project. A research team consisting of a safety engineer, a safety specialist, and an engineering consultant worked with the city's Insurance and Risk Management Officer to collect data concerning this accident.

The city employs approximately 8400 full time personnel; however, the total workforce can be as many as 12,000, due to the hiring of temporary workers. Management responsibilities of the city's safety and health program are performed by the insurance and risk management staff, which is located within the Financial Department. The city has developed a written safety program, issues an Employee Safety Handbook to each new city employee, and has a comprehensive Safety Policy Manual specifically for the Traffic Engineering Department whose members were involved in this accident.

Although the Traffic Engineering Department has a specific safety program concerning these work activities, the employees do not receive training relative to working near or with high voltage power lines. However, the city has an electric authority that operates and maintains electrical distribution within the city. The electric authority employees are thoroughly trained in the recognition, evaluation, and control of hazards associated with electrical distribution.

Local visits were made to the city Electric Authority, to the city motor pool, and to the accident site. Site photographs, taken the day of the accident, were available in the Office of Insurance and Risk Management. Additionally, the accident site, showing the completed work, was photographed by the NIOSH team (video and 35mm cameras). The crane operator was interviewed, although the three injured crewman were not because they were still in critical/guarded condition. Comparison workers from the city's Electric Authority were selected and interviewed, because these employees are exposed to similar workplace hazards.

SYNOPSIS OF EVENTS

On April 22, 1985, the crew from the city Traffic Engineering Department prepared a foundation excavation approximately 3' x 3' x 6' deep for the pole at a four-way intersection. While excavating the foundation, the crew encountered a water main, at a depth of about 3 1/2 feet. A wooden box form was erected inside the excavation to keep the water main from being embedded in concrete upon setting the pole. The foundation excavation was approximately 3 feet horizontal from the edge of the street pavement and was located under a three phase 26 KVA overhead power line. The bottom phase of the power line was approximately 28 feet above ground level.

On the morning of the accident the crew arrived to erect the pole. The pole was 36 feet in length, approximately 10 inches square at the top, 16 inches square at the bottom, and weighed 5,240 pounds. The pole was rated 100% conductive. The pole was attached to a "pole digger derrick truck" by a one inch steel hoist rope rigged slightly below the pole's midpoint with the upper portion of the pole contained in a stabilizing clamp located at the end of the derrick truck boom. This method provides for the lifting of poles in an almost vertical position for ease of placement in foundation excavations. A field supervisor who arrived on the scene, felt that the derrick truck was obstructing traffic and he began directing traffic at the intersection. The pole was then hoisted, placed into position over the hole, and the butt end of the pole was lowered approximately 3 1/2 feet into the hole just above the wood form protecting the water main. The pole could not be placed directly into the hole because the energized overhead power lines were in the way. Therefore, the foreman and the crew members had to push against the butt of the pole to guide it into proper position for lowering it to the bottom. It is possible they were trying to position it so as to not damage the enclosed water line. The derrick truck operator then received a hand signal from one of the workers to lower the pole. The derrick truck operator was not sure which crew member gave the hand signal because of the crew's position while pushing on the pole and the operator's obscured vision. However, as the operator lowered the pole, it came into contact with the bottom phase of the overhead three phase 26 KVA power line. Upon contact, a flash occurred and the derrick truck operator immediately pulled the pole away from the power lines. The contact of the pole to the 26 KVA power line resulted in the fatal electrocution of the foreman, and critical injuries to the other three crew members on the ground. One of the injured workers stated that all four men were wearing insulated lineman's gloves; however, only one pair of insulated gloves could be found at the scene of the accident.

The field supervisor, who was directing traffic, heard the loud noise and immediately proceeded to the accident scene. He radioed central dispatch for help, and a rescue vehicle, which was in the vicinity of the accident site, arrived on the scene within one minute and first aid was begun. E.M.T.'s arrived on the scene a short time later. The fatally injured worker was flown by life flight helicopter to a local hospital where he was pronounced dead-on-arrival.

CONCLUSIONS/RECOMMENDATIONS

Recommendation #1: Employers should enforce existing regulations concerning crane operations.

Discussion: OSHA standards 1926.550 (a)(15) and 1910.180 (J) require that the minimum clearance between electrical lines rated 501CV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "deenergized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers which cannot be part of the crane. Additionally, 29 CFR 1926.550 (a)(15MV) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means. The crew in this case did not satisfy these requirements.

Recommendation #2: Employers should enforce policies and procedures concerning specialized tasks, such as pole setting.

Discussion: The Employee Safety Handbook included a detailed procedure to be followed when installing a traffic pole. This procedure requires that (a) insulated "sleeves" be placed over the primary conductors and the end of the pole being set; (b) lines be deenergized and tagged and automatic re-set devices on the lines be deactivated when setting a pole near energized lines with voltage of l3 KVA or above; (c) employees wear rubber lineman's gloves with appropriate voltage rating when setting a pole in energized areas. Compliance with those procedures would have reduced the threat of serious injury.

Recommendation #3: Employers should hold management and first-line supervisory personnel responsible for job site safety.

Discussion: Two supervisory employees permitted this task to be performed without taking proper precaution, as specified in the Employee Safety Handbook. This deviation from handbook requirements suggests that safety responsibilities at the job site are not adequately defined or enforced by higher levels of supervision. City management should develop safety responsibilities for all levels for supervision and supervisory personnel must be held accountable for all safety responsibilities.

Recommendation #4 Employers should assure that personnel assigned to perform a specific task are thoroughly trained in the performance of this task and any associated hazards.

Discussion: The personnel assigned to set the traffic signal pole were trained in the proper procedures of pole setting; however, precautions noted in the employee handbook were not implemented. They did not receive extensive training in working near or with high voltage power lines or the electrical hazards generally associated with this work. Personnel working near or around high voltage power lines should receive training, so that they would be able to recognize and control the hazards present and prevent future accidents. Other city departments, such as the electric authority, should be considered for performing these activities, if they are properly trained.

Recommendation #5: Employers should assure that engineering and design personnel should be made aware of problems concerning field work activities and associated hazardous field conditions.

Discussion: The location of the pole displayed poor hazard awareness considering the proximity of the overhead power lines and the underground interference caused by the water main. Personnel performing design engineering activities should assist in identifying existing hazardous conditions which could interfere with the safe performance of field work.

FACE 85-18: **Worker Electrocuted By 7200 Volt Power Line in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors which influence the risk of fatal injury for selected employees.

The accident occurred on April 30, 1985, at 3:30 p.m., as workers of an electrical construction company were removing a temporary pole structure which was used to secure a 7200 volt power line while new 150,000 volt lines were being installed. When the 7200 volt line was released from the temporary structure, an arc created by a loose tie line caused the power line to burn through and fall to the ground, electrocuting a workman on the ground.

CONTACTS/ACTIVITIES

The North Carolina Department of Labor, Division of Occupational Health and Safety, requested technical assistance from NIOSH/DSR and this case has been included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On May 8 and 9, 1985, the DSR research team, which consisted of a research industrial hygienist and a safety specialist, visited the accident site, met with the safety director of the electrical construction company, interviewed workmen who were on site at the time of the accident, and interviewed the next-of-kin.

SYNOPSIS OF EVENTS

An electrical construction company was to install a new high voltage system (150,000 volt transmission lines) for service upgrading. The new high voltage lines (running north and south) were approximately 30 feet above the existing 7200 volt lines (running east and west). In the event of an accident, i.e., one of the 150,000 volt lines falling across the 7200 volt lines, a temporary structure was constructed. This temporary structure consisted of two wood utility poles installed vertically (approximately 20 feet apart), and one pole across the top horizontally, forming an inverted "U." The 7200 volt power line was secured to the left vertical pole. This was accomplished by pulling the line down a few inches (for tension) and using a tie line to secure it to the top of an insulator.

The accident occurred when the temporary structure was to be removed. A workman was near the top of the temporary structure in a hydraulic lift bucket and was unwinding the tie line that secured the 7200 volt power line to the insulator when the 7200 volt line (under tension) jerked upward. This upward movement caused the tie line to whip around the left vertical support pole, contacting a ground line that was stapled to the pole (from a previous job and not required on this job). Contact with the ground line created an arc and burned through the 7200 volt line. The power line fell to the ground landing on a pole trailer that was hitched to a utility truck. A workman between the trailer and the truck was in contact with a steel anchor rod that protruded from the rear of the truck. This workman was electrocuted.

CONCLUSIONS/RECOMMENDATIONS

1. Employers should provide adequate training to supervisors and employees in the recognition, appreciation, and avoidance of safety hazards and should assure that employees are proficient in assigned tasks.

Discussion: Adequately trained employees should have recognized the hazards associated with this task and could have taken several preventative actions. Removal of the ground wire from the support pole, tying the 7200 volt power line to the bottom of the insulator instead of to the top, de-energizing the 7200 volt line, the use of insulating materials on the 7200 volt power line (sleeves or rubber blankets), or the maintenance of a clear zone under the work area could have prevented this accident. The employees performing this task did not appear to be adequately trained and failed to recognize the hazards associated with this task.

2. Management and first-line supervisory personnel must be responsible for job site safety.

Discussion: Supervisory personnel permitted a ground wire to be installed within a few inches of a 7200 volt power line and did not take adequate steps to assure the safety of the employees at the job site (i.e., use of insulating materials, maintenance of a clear zone, etc.).

FACE 85-19: **Truck Driver Electrocuted while Unloading Concrete Blocks in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) project, which is focusing primarily upon selected electrically-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors which influence the risk of fatal injury for selected employees.

The accident occurred on April 30, 1985, at 2:45 p.m. as concrete blocks were being unloaded at a building supply mart. The manager of the building supply mart walked outside the store and found the delivery driver on the ground. The Emergency Rescue Squad was called and transported the driver to a local hospital where he was pronounced dead. It was first believed that the driver had suffered a heart attack. However, an autopsy determined the cause of death as electrocution. Preliminary survey of the accident site revealed that the truck crane, which was used to unload the blocks, was approximately 12-18" from a 9000 volt power line.

CONTACTS/ACTIVITIES

The North Carolina Department of Labor, Division of Occupational Health and Safety, requested technical assistance from NIOSH/DSR and this case has been included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On May 6 and 7, 1985, the DSR research team which consisted of a research industrial hygienist and a safety specialist visited the site of the accident, met with the employer and representatives of the North Carolina OSHA Office, and conducted comparison worker interviews. Interviews were also conducted with the sheriff's department officials that responded to the accident.

SYNOPSIS OF EVENTS

The victim was employed by a family owned block manufacturing company that has 12 full time employees. The company manufactures concrete and cinder building blocks. The blocks (dependent upon size) are secured in lots of 72 or 96 per bundle by metal straps.

On the afternoon of the accident, the victim had two deliveries to make, one to a building supply mart (four bundles) and one bundle to a construction site. The victim arrived at the building supply mart at 2:45 p.m. and proceeded to unload the bundles of blocks. At 3:20 p.m. the store manager noticed the delivery truck was still there and the engine was running. The manager went out to check on the delivery and found the driver lying on the ground and unresponsive. The manager called for the emergency squad and, while awaiting their arrival, administered CPR with the assistance of a nurse who was in the store at the time of the accident. The victim was transported to a local hospital where he was pronounced dead-on-arrival.

Since there were no eye witnesses to the fatal accident, the accident scenario that follows was developed from interviews conducted with the law enforcement officials that investigated the accident, owner and employees of the block manufacturing company, investigation of the accident site, and inspection of the truck used to deliver the blocks.

The victim arrived at the building supply mart at 2:45 p.m. and proceeded to unload the bundles of blocks (approximately 2000 pounds each) with a crane that is mounted on the truck bed. The victim did not use the right outrigger that would have prevented the truck from tipping while being unloaded. The left outrigger was missing. The last bundle of blocks was being unloaded and the tip of the crane was approximately 12 inches from a 9000 volt power line (which was approximately 16' vertically from the ground). While attempting to swing and guide the forks with his left hand and holding the control pendant with his right hand, the truck tipped to the right, allowing the boom to contact the 9000 volt line, electrocuting him.

CONCLUSIONS/RECOMMENDATIONS

Recommendation #1: Employers should enforce existing regulations concerning crane operations.

Discussion: Current OSHA standards 1926.550 (a)(15) and 1910.180 (j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "deenergized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers which cannot be part of the crane. The crane operator/delivery driver did not comply with these requirements.

Recommendation #2: Employers should provide adequate training to employees (delivery drivers) in the recognition appreciation, and avoidance of safety hazards and should assure that employees are proficient in assigned tasks.

Discussion: Adequately trained employees (delivery drivers) should have recognized the hazards associated with this task and could have taken measures to prevent the accident. The driver was aware of the location of the power line (because of reported problems in the past) and could have unloaded the blocks in a location that did not present an electrical hazard. The driver was also remiss in not using the outrigger on the truck to prevent it from tipping when the loaded crane caused an imbalance.

Recommendation #3: Employers should develop written safety policies and procedures and these policies and procedures should be enforced.

Discussion: The employer should develop written safety policies and procedures that clearly state what is expected within the company. These policies and procedures should, in this instance, cover the following: required tasks of each employee and the proper method for compliance, loading and unloading techniques required for delivery drivers or yard operators, proper use of equipment and the reason for proper use, and procedures to be followed when equipment is not in proper repair and could present a safety hazard.

FACE 85-21: **Billboard Worker Dies When Metal Ladder Contacts 7200 Volt Power Line in Kentucky**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors which influence the risk of fatal injuries for selected employees.

On May 4, 1985, a 28-year-old male billboard worker was electrocuted when a 24 foot hook ladder he was using came into contact with a 7200 volt overhead power line. The billboard worker was in the process of scraping a billboard at the time of the accident.

CONTACTS/ACTIVITIES

The Division of Safety Research received an invitation from officials of Kentucky's Occupational Safety and Health Program to evaluate this electrocution incident as part of the FACE project. A research team consisting of a safety engineer and two safety specialists visited the site of the accident and the outdoor advertising agency that employed the victim. The accident site was photographed by the DSR research team. Additionally, video tape was taken of the actual posting of a billboard, demonstrating the standard operating procedure followed by the billboard workers. FACE survey instruments were completed for the comparison workers and the victim. Comparison workers were chosen randomly from the company's roster of billboard workers. Interviews were conducted with a company representative, comparison workers, and the wife of the victim.

SYNOPSIS OF EVENTS

On Saturday, May 4, 1985, the victim received his work assignment from the outdoor advertising company's branch office in a nearby town instead of his regular work station. The victim usually worked a regular 5 day, 40 hour work week; however, overtime work at this branch office was required because of an exceptionally heavy work load. Since his residence was located midway between the two offices, the victim had taken a company vehicle home the previous night. He arrived at the branch office at approximately 7:00 a.m. and applied paste to the posters that he would hang that day. He left the branch office at approximately 7:30 a.m. and proceeded to his first work site where he posted three billboards, one of which had to be scraped. Upon completion of the work at this site, he proceeded to the next location, the accident site. The victim had eight years of experience posting billboards and had posted the billboards at the site of the accident on several previous occasions. The 12 foot by 24 foot billboard was mounted on telephone poles four feet above ground level and was set back from the road approximately 12 feet. A company representative who was interviewed stated that evidence at the accident site (i.e., paper on the ground, etc.) indicated that the victim had begun to remove the outdated poster from the lower left portion of the billboard. It appears that the victim scraped that portion of the billboard that he could reach from the 14 foot ladder and then moved the ladder to the right portion of the billboard. The victim then removed a 24 foot hook ladder from the truck and was in the process of positioning the ladder so that he could scrape the upper left portion of the billboard, when the ladder contacted a 7200 volt overhead power line located approximately 8 feet above the top left side of the billboard. A 32 foot extension ladder was also available on the truck. This ladder would have been of sufficient length to perform the job and may have been a better choice of ladders for this task. Contact between the 24 foot hook ladder and the 7200 volt power line resulted in the electrocution of the billboard worker. Two passing motorists witnessed the incident, summoned help, and began to administer CPR. The victim was flown by helicopter to a local hospital where he was pronounced dead-on-arrival.

RECOMMENDATIONS/DISCUSSION

1. Employers should identify all safety hazards at the work site.

A job site survey, which would identify any safety hazards present at a given job site, should be performed periodically on all company billboards. This job site survey should minimally include the identification of hazards such as: a) high voltage power lines close to a billboard, b) terrain around the billboard that would cause the billboard worker to set up his ladder in an unsafe place or manner, c) traffic, d) board conditions, e) any other special conditions that may impact safety. A record of these hazards should be maintained and billboard workers should be made aware of any hazards they might encounter on the billboards they are to post on a given day. Any hazards identified on a given board could be listed on a warning sign or sticker and placed in clear view on the lower face or frame of the board. Once these hazards are identified, they can be controlled.

2. Employers should provide proper equipment to perform all job related tasks.

The 24 foot hook ladder used in this instance was not the proper equipment for the task. The use of scaffolding or a long handled brush would have eliminated the need for ladders and would have minimized the hazard with the power line. In the past, these methods of bill posting were commonly used; however, the use of aluminum hook ladders has generally replaced both of these methods of bill posting. The employer should assure that changes in bill posting methods do not result in the creation of additional hazards to which the employees would be exposed. Additionally, the employer should consider the use of fiberglass ladders when posting billboards in the presence of electrical hazards. Fiberglass ladders, because of their lack of conductivity, would greatly minimize the risk of injury due to contact with electrical power lines.

3. Employers should develop written safe job procedures that are task specific.

The employer has a written safety policy; however, this policy does not contain any specific guidelines concerning the procedures to be followed or the equipment to be used when posting billboards and does not identify specific safety hazards. A safety policy specific to the posting of billboards and other high risk tasks should be developed and detailed procedures should be included that address the various safety hazards associated with these tasks. Once these specific procedures have been developed, the employer should assure that they are implemented and enforced.

FACE 85-22: Fireman Electrocuted While Rappelling Down Building in West Virginia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injury for selected employees.

When the accident occurred on May 13, 1985, at 9:00 p.m., four volunteer firemen were removing the siren from atop their fire station. After the siren had been lowered to the ground (approximately 35 feet), three of the firemen were going to rappel down the front of the building. The first fireman to descend attached his rope to a support rod on the roof and, as he tested the rope, contacted a 7200 volt power line. The fireman was electrocuted.

CONTACTS/ACTIVITIES

The Deputy Chief Medical Examiner for the State of West Virginia requested technical assistance from NIOSH/DSR and this case has been included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On May 20 and 21, 1985, the DSR research team, which consisted of an epidemiologist and research industrial hygienist, conducted a site visit, met with the assistant fire chief, interviewed firemen who were at the fire station at the time of the accident, and photographed the accident site.

SYNOPSIS OF EVENTS

On the evening of the accident, four volunteer firemen decided to remove the station house rooftop siren for repairs. The firemen ascended to the top of the fire station (approximately 35 feet high) by climbing a radio transmission tower located at the rear of the building.

After reaching the rooftop, the siren was removed from its support structure and lowered to the ground by a rope. When the work was finished on the roof, three of the firemen decided to rappel down the front of the building (a practice which had been done for years). The fourth fireman (inexperienced in rappelling) was to descend by the rear tower, which was used to ascend to the rooftop.

The first fireman secured his rope and leaned out over the rooftop to test the rope before starting his rappel. One of the remaining fireman, who was going to rappel from the roof, said he heard "a loud buzz and looked up to see sparks flying." The victim's back contacted a 7200 volt power line; his feet were still on the roof of the fire station. (The 7200 volt power line was approximately 5' diagonally from the roof.) The second fireman grabbed the rope, attempting to pull the victim loose, when the victim fell to the ground. A nearby EMT was called and transported the victim to the hospital. The fireman was pronounced dead on arrival.

CONCLUSIONS/RECOMMENDATIONS

Recommendation #1: Fireman should be trained at specified locations that provide a relative degree of safety.

Discussion: The practice of allowing firemen to rappel down the front of a building (fire station) in close proximity (approximately 5' diagonally from the roof top) to high voltage lines was hazardous and fatal. Although this is a volunteer fire department and the firemen's time is donated, the city should provide training facilities and develop procedures that will prevent this type of accident from reoccurring. If the fire station is to be used for training (i.e., rappelling, ladder drills, etc.), the facility should be evaluated for safety hazards, particularly electrical hazards.

Recommendation #2: Firemen should be trained in recognition and appreciation of hazards and preventative measures for personal safety.

Discussion: Although firemen are trained in various firefighting techniques, it would appear additional training is needed in hazard recognition, particularly electrical hazards. This training should include recognition, awareness, and appreciation of electrical hazards, along with necessary preventative measures to avoid future accidents of this nature. Training of emergency service personnel in rappelling should address electrical hazards.

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FACE 85-24: Video Store Owner Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On May 27, 1985, one partner of a video store was electrocuted while remodeling a storage room. There were no witnesses to the accident and his body was not found until the next morning.

CONTACTS/ACTIVITIES

Subsequent to a request for technical assistance by the West Virginia State Medical Examiner, a research team, consisting of a supervisory safety engineer and an occupational health nurse, assisted in evaluating the incident. The team met with the remaining partner, a close friend of the victim, and the victim's son.

A small pharmacy had been remodeled to serve as a video rental store. Work in the sales area had been completed. Remodeling in the storage room and repair of the air conditioning system had not been completed, but the partners didn't feel that it was essential to have these tasks completed prior to the store's opening. The owners decided to take Memorial Day off and have the official opening on Tuesday, May 28.

On the Friday prior to the incident, an electrician had checked the air conditioning system and determined that the thermostat was faulty. He was going to replace it early the following week. While in the store, he disconnected service to the air conditioning unit and cut a wire on the same wall as the thermostat. The FACE evaluation team felt that this action on the part of the electrician may have misled the victim, so that he thought all power to this area was disconnected.

On the day of the incident the victim apparently decided to work by himself. He had framed in one wall and removed the faulty thermostat from that wall in the process. He had also taken the cover off the thermostat. It appears that at the time of the incident, he was removing the wires from the metal box when both wires made contact with the box. The victim, because he was standing on an aluminum ladder, was grounded. The city inspectors, who investigated the incident, estimated that he remained in contact with the electricity for four to five seconds until the fuse opened the circuit and the victim fell from the ladder to the floor.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical circuits should not be repaired, moved, or otherwise accessed unless de-energized and de-energization personally verified.

Discussion: The victim was unfamiliar with electricity and it can be concluded that he inadvertently came into contact with the electrical energy as he was constructing the wall. It is presumed the victim believed that the line to the thermostat was de-energized by the electrician and did not present a hazard as he relocated it. Personnel working around sources of electricity should personally verify that all power is disconnected. This verification should minimally consist of disconnecting the circuit at the distribution panel (i.e., circuit breaker, fuse, etc.) and testing the circuit to assure de-energization. Although not a factor in this accident, access to the distribution panel should be restricted if necessary (i.e., a lockout system).

FACE 85-25: **Contract Worker Electrocuted While Repairing 13.2 kV Power Line in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 6, 1985, a 38-year-old, first-class lineman was electrocuted while repairing a 13.2 kV power line. The lineman was standing in an aerial bucket.

CONTACTS/ACTIVITIES

The Division of Safety Research received a request for technical assistance from officials of North Carolina's Occupational Safety and Health Program to evaluate this electrocution as part of the FACE project. A research team consisting of a safety specialist and an engineering consultant visited the accident site and the electrical construction company that employed the victim. The accident site was photographed by the DSR research team. FACE survey instruments were completed for the comparison workers and the victim. Interviews were conducted with the next of kin, company representatives, and comparison workers.

SYNOPSIS OF EVENTS

High winds and severe thunderstorms in this area on June 5, 1985, severely damaged overhead, high voltage power lines. At approximately 11:00 p.m., the line service supervisor of the local power company requested that an electrical construction company supply a crew to help repair the damage. A foreman and three crewmen were assigned this task. The crew arrived with an aerial bucket truck at the work site at approximately 4:00 a.m. on June 6, 1985. A power company official instructed the crew to replace, a pole insulator and a 13.2 kV power line, which had been "downed" by a fallen tree. In order to restore service to as many customers as possible, the power company had previously isolated the "downed" line by cutting the pole jumper on line B of pole A (see drawing #1). Service was then restored to all customers up to the pole jumper that had been cut.

The electrical flow and circuitry that resulted in the electrocution of the lineman is illustrated in drawing #1. When the power line and the insulator had been replaced, the victim, a first-class lineman with twenty years of experience, was instructed by the superintendent to open the last of three fused disconnects (FC-6) on pole A, where the jumper splice was to be made. (Two other fused disconnects (FC-4, FC-5) on pole A were opened by a power company worker before the crew arrived at the accident site.)

While the victim was opening the fused disconnects on pole A, a power company worker was replacing fuses (damaged during the storm) in two of the three fused disconnects (M-2, FC-3) on pole B. Pole B was located approximately one-half mile to the south of pole A. These three lines fed a bank of three transformers (illustrated by the windings in drawing #1) that supplied power to a general store. The superintendent then left his crew and traveled to pole B to inform the power company worker that preparations to make the jumper splice were complete, and the fused" disconnects (F-1, F-2, F-3) on pole B could be opened in order to de-energize the entire line. The power company worker then opened the fused disconnects (FC-2, FC-3) in lines B and C in which the fuses had been replaced. He did not open the fused disconnect (M-1) for line A. Voltage from line A then fed through the line transformer and the store's electrical system to line B, the line on which the splice was to be made. Although the exact voltage could not be determined, power company representatives estimated that the voltage on this line ranged from 4000 V to 7500 V. When informed that the line was de-energized, the superintendent contacted his foreman by truck radio and instructed him to make the splice, but to "buzz" (test) the line first to ensure that it was de-energized. Buzzing a line is a standard practice to test for the presence of high voltage in power lines; however, it could not detect the lower voltage level present in this line. The victim buzzed the line by touching it with pliers he held in his gloved hand. When the victim did not see an arc or hear a buzzing sound, he apparently removed his glove and began to splice the jumper wire. He inserted the supply side of the jumper wire into the splice tube and crimped it. When he grasped the load side of the jumper wire, he completed an electrical circuit between the supply and load sides of the jumper causing the current to pass through his arms and chest. A crewman heard the victim groan and saw his hard hat fall to the ground. The crewman lowered the aerial bucket using controls on the truck, removed the victim from the aerial bucket, and began to administer CPR. The foreman contacted the superintendent on the truck radio and told him to summon the rescue squad. The rescue squad arrived at approximately 4:30 a.m. and transported the victim to a local hospital, where he was pronounced dead on arrival. The splice was later completed by another crewman, after a power company worker de-energized the line by opening the third fused disconnect.

RECOMMENDATIONS

Recommendation #1: Employers should provide linemen with equipment and procedures to address all magnitudes of voltages to which they may be exposed.

Discussion: To "buzz" a power line to determine if high voltage is present is a standard procedure followed by linemen. However, the "buzz" method did not detect the lower voltages present. Procedures to perform a dual voltage check should be established. Once it is determined by the "buzz" method that high voltage is not present, a low voltage testing device (such as the glowing neon type or the light emitting diode type) should be used to determine if a lower range of voltage is present. The use of a low voltage testing device in this case may have prevented this accident and the establishment of procedures for a complete voltage check may prevent future accidents.

Recommendation #2: During training programs for linemen, employers should emphasize proper procedures for working with multiphase distribution systems and also the hazards associated with these systems.

Discussion: Training programs for linemen should include basic electrical theory sessions that address multiphase distribution systems including the identification, evaluation, and control of the hazards associated with these systems. Due to the possibility that any one phase can serve as the supply for the transformer, the only absolutely safe way to de-energize a three-phase system is to open the fused disconnects in all three phases. Only two of the three fused disconnects were opened in this case. The closed disconnect on the third phase allowed the other two phases to remain energized.

Recommendation #3: Electrical lines should not be repaired, moved, or otherwise accessed without adequate personal protective equipment unless personally de-energized and verified.

Discussion: Linemen should be instructed not to consider another workman's word as verification that a line is de-energized. Linemen should be specifically instructed to wear proper protective equipment (i.e., gloves, sleeves, etc.) and to treat all lines as energized unless they personally de-energize these lines or verify that the lines have been de-energized and proper grounding has been provided.

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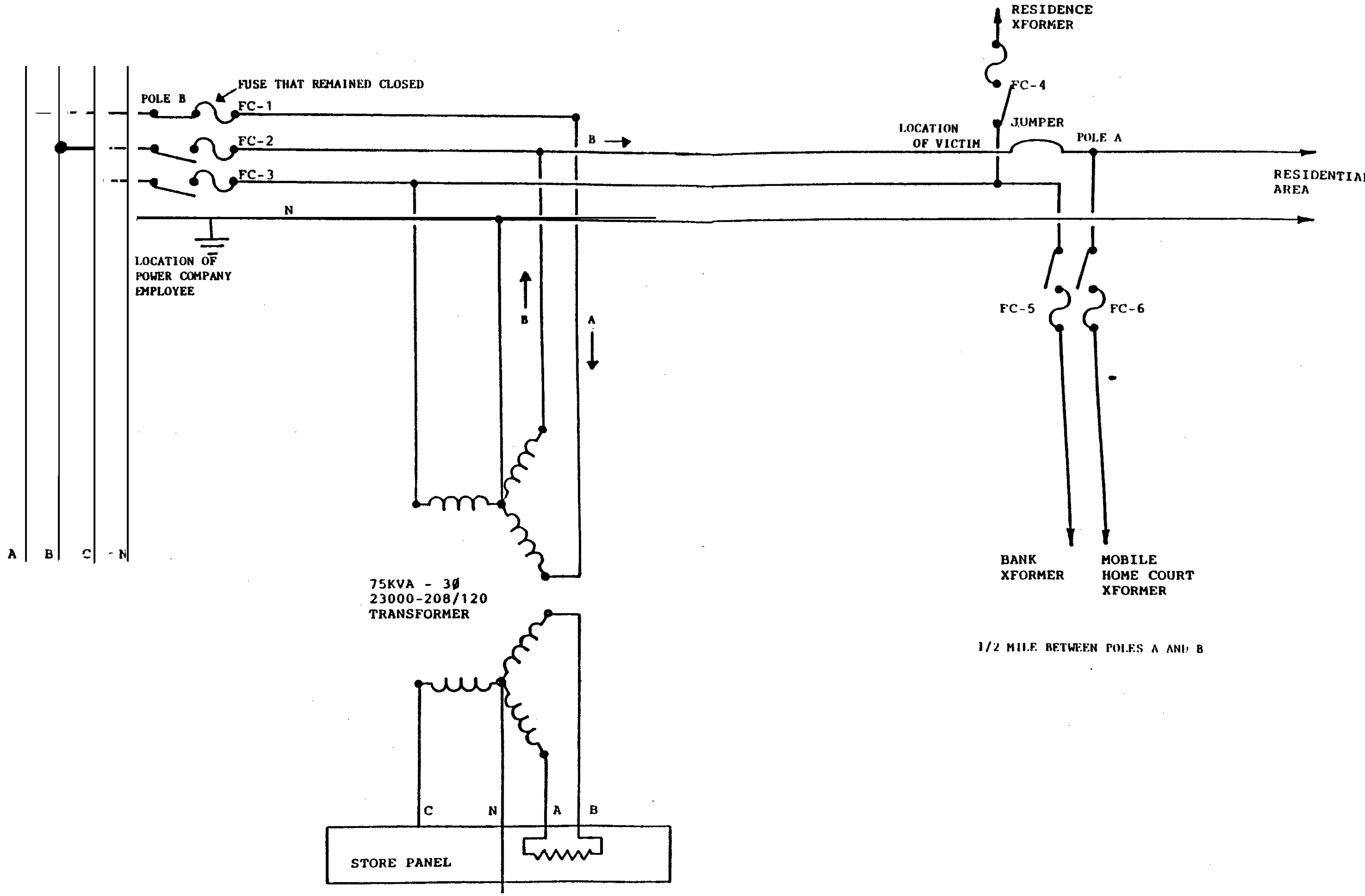

Drawing 1.

FACE 85-28: **29-Year-Old Welder Electrocuted in Ohio**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related, and confined space fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 18, 1985, at approximately 3:45 a.m. a 29-year-old maintenance worker was electrocuted as he attempted to turn off a welder.

CONTACTS/ACTIVITIES

The Division of Safety Research received an invitation from the Industrial Commission of Ohio to provide technical assistance in the evaluation of this fatality. It was determined that this incident would be included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. A research team consisting of two safety specialists and an engineering consultant held discussions with representatives of the Ohio Industrial Commission's Division of Safety and Hygiene. Two Industrial Commission Safety Consultants accompanied the research team to the local police department, where they examined and photographed the welder and the receptacle that the welder was plugged into at the time of the accident. An interview was conducted with the plant engineer of the steel treatment plant that employed the victim. However, photographs of the accident site and co-worker interviews were precluded in this case. A telephone interview was conducted with the coroner to determine electrical entry and exit points and other information applicable to the FACE project. The next of kin interview was postponed until a later date due to the emotional state of the victim's wife.

During the interview with the plant engineer, it was learned that the plant had no written safety policy or safety program.

SYNOPSIS OF EVENTS

Since co-worker and eye witness interviews could not be conducted, the local police "Casualty Case Report" was used to summarize the facts surrounding this incident.

On June 18, 1985, at approximately 3:45 a.m. a maintenance man at a steel treatment plant was walking along a metal walkway in the plant, when he discovered the victim lying on his back in a convulsive state. The maintenance man alerted other employees of the victim's condition and returned to the accident site. Upon return he noticed that the pull handle of the four wheel, wagon style cart (on which the welder was sitting) was lying in water on the concrete floor. Electrical arcs were visible from the handle of the cart to the floor. As other employees arrived at the scene, one pulled the plug on the welder. The police and the fire department rescue squad were called. The rescue squad transported the victim to a local hospital, where he was pronounced dead at 5:08 a.m.

The examination of the welder at the local police station revealed that the cables on the welder (particularly the positive or electrode cable) had exposed conductors. Numerous cuts and abrasions exposed large areas of the conductor cables. Continuity checks on the four terminals of the welder plug indicated that the wiring of the plug cable provided an adequate ground path. The insulation on the welder's electrode holder was broken with large pieces of insulation completely missing. Inspection of the receptacle box revealed that the cover plate was designed for a different style receptacle. Additionally, the receptacle box did not have a conductor (wire) attached to the ground terminal. A continuity check on the receptacle indicated an open circuit (no ground connection). Undisturbed paint on the screws and around the cover plate of the box indicated that the box had not been opened and it can be concluded that the ground connection was not present at the time of the accident. Without a complete ground connection, the victim could have completed an electrical conducting path from the frame of the welding machine or any one of the uninsulated areas on the cables. Water on the floor increased the area that could result in a ground fault and reduced the resistance of the path to ground.

The coroner stated that a severe burn compatible with an electrical burn was present on the victim's right index finger. This would lead to the conclusion that the victim's finger came into contact with the welding machine's frame when the victim was trying to turn the welding machine off. This action completed the conductive path and resulted in the electrocution of the victim.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical systems should satisfy the requirements of the National Electrical Code.

Discussion: Although only one receptacle from the plant was examined, the lack of a grounding conductor in that receptacle suggests there may be a serious problem with the plant's electrical system. The plant's electrical system should be inspected and modified to satisfy the applicable requirements of the National Electrical Code. The existence of a proper grounding system in this case would have greatly reduced the risk of serious injury.

Recommendation #2: The employer should initiate a safety policy that addresses specific tasks and stresses safety training and hazard awareness.

Discussion: The company did not have a safety policy that addressed safety training and procedures specific to maintenance work and other high risk tasks performed in the plant. Written procedures should detail the various safety hazards associated with these tasks. Once these procedures and safety training are developed, the employer should assure that they are implemented and enforced.

Recommendation #3: The employer should implement a preventive maintenance program to assure that equipment is in safe operating condition.

Discussion: Periodic inspections should be performed on all plant maintenance and production equipment. These inspections should identify any hazards present and management should take appropriate corrective action. These inspections should be complemented by daily inspections of equipment by qualified personnel before the equipment is put into use. These daily inspections should include the identification of such hazards as cuts or abrasions on conductive cords, loose plug connections or cable entrances on machines, or any other unsafe conditions. Had a preventive maintenance program been utilized at the plant, it is unlikely that the welding machine involved in the incident would have been in such a state of disrepair.

FACE 85-29: Two Construction Workers Electrocuted When Crane Contacts One Phase of a 13.4 kV System in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related, excavation-related, and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Tennessee notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 8-11, 1985, the DSR research team, which consisted of a mechanical engineer and a safety specialist, met with employer representatives, conducted a site visit, interviewed comparison workers, discussed the incident with the State OSHA Compliance Officer, and photographed the accident site.

OVERVIEW OF EMPLOYERS SAFETY PROGRAM

The victims were employed by a construction, engineering, and development firm that has been in operation for approximately 74 years. The firm competitively bids on various construction projects. The company has the capability to provide in-house architectural design or will construct according to design specifications provided by the customer. On the day of the incident, the firm employed approximately 350 workers with approximately 30 working at the accident site.

The company employs a collateral-duty safety director and utilizes payroll inserts and weekly safety meetings to promote safety awareness. Each new employee is issued a safety manual for maintenance and general construction and participates in a safety orientation program prior to their first day of work. A safety inspector, present at each job site, fills out a daily report that includes two safety related checklists. (One checklist addresses personal protective equipment, the second addresses the condition of equipment.)

SYNOPSIS OF EVENTS

Since February, the firm has been the general contractor responsible for the construction of a department store. At the same construction site, the city's utility company was simultaneously installing a three-phase 13.4 kV distribution line that would service an adjacent mall and the department store.

On June 26, 1985, three workers ware in the process of pouring a concrete "footer" in a drainage ditch (approximately 8 feet deep and 30 feet wide). A concrete box culvert was to be erected on the footer. A rubber-tired, rough-terrain crane supporting a two yard (capacity) steel bucket was used to supply concrete for pouring the footer. The crane operator was instructed to exercise caution when working in the vicinity of the overhead power lines in order to prevent damage to the power lines. The bottom phase of the line was 31' above the ground and was parallel to the drainage ditch (above the work area). The presence of electrical energy was never considered. Since there was no immediate need for electricity at the work site and the workmen had not been notified that the power line had been energized by the city utility, the construction workers were unaware that the power lines presented a hazard. (Officials of the firm later learned that the lines had been energized on June 19, 1985.) The process of pouring the concrete "footer" involved filling the two yard (capacity) steel bucket with concrete, raising and swinging the bucket into position, then lowering it until signaled to stop by one of the workers in the ditch. Two workers would hold the suspended bucket in position while a third worker pushed down on the bucket's door handle to dump the concrete. By approximately 3:30 p.m. the workers had successfully dumped two buckets of concrete and the crane operator had lowered a third bucket into the ditch. The crane operator then set the crane. Two workers (laborers) were holding the loaded bucket in position while the third worker (a concrete finisher) had just grasped the bucket's release handle, when the crane and power line came into contact. Upon hearing a 'loud pop' and 'crackling noises', the crane operator looked down and saw the three workers lying in the ditch. He immediately raised the bucket and swung the crane away from the overhead lines. He then entered the ditch along with other workers to render first aid to the three injured workers. CPR was administered and local ambulances were summoned.

An ambulance arrived on the scene within ten minutes and transported the workers to a local hospital where the two laborers were later pronounced dead by attending physicians. The concrete finisher, who had been wearing rubber boots, received severe electrical burns to his right hand, which was in contact with the bucket's release handle, and to his right foot. Eyewitness accounts state arcing was visible between the crane boom and the bottom phase of the distribution line. Photographs taken by state OSHA officials revealed corresponding burn marks on a metal plate covering the end of the crane boom and on the bottom phase of the distribution line. This suggests momentary contact could have been made and that arcing was initiated when contact of the surfaces was broken. It is possible that the excessive weight of the loaded bucket may have momentarily pulled the extended crane boom into the power line, when the downward momentum of the bucket was halted by the crane operator.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA standards 1926.550(a)(15) and 1910.180(j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers, which cannot be part of the crane. Standard 29 CFR 1926.550(a)(15)(iv) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means. Additionally, 1926.550(a)(15)(vi) requires that any overhead line shall be considered to be an energized line unless and until the person owning such line or the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded. The accident may have been prevented had these requirements been satisfied.

Recommendation #2: Utilities should notify property owners or contractors, who may be affected by the energization of a newly installed distribution system, that the system has been energized.

Discussion: This incident occurred because crane-related operations were being performed too close to overhead power lines. However, it is unlikely that these workers would have attempted to perform this work in close proximity to overhead power lines had they known the lines were energized. Utilities should notify property owners or contractors, whose safety might be endangered, before energizing power lines (particularly newly installed distribution systems).

FACE 85-30: Sign Serviceman Working Off of a Truck Mounted Platform Ladder Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 27, 1985, a sign serviceman, working off of an aerial ladder truck, was electrocuted when he contacted a 7.2 kV power line.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 21, 1985, the DSR research team (a fire protection engineer and two safety specialists) interviewed comparison workers and witnesses present at the incident site, discussed the incident with the OSHA Compliance Officer, and photographed the accident site and the aerial ladder truck involved in the incident.

OVERVIEW OF FACILITY'S SAFETY PROGRAM

The victim was employed at a branch office of a lighting systems company that provides maintenance service for outdoor and indoor lighting systems and illuminated signs. This branch office had been in operation since 1978. The branch manager is responsible for safety on a collateral-duty basis. A contact for safety-related issues is provided at corporate headquarters. The company has a written safety policy that outlines procedures to be followed when working in proximity of power lines. These procedures state that local electric authorities should be contacted to de-energize power lines located within ten feet of a work area. Periodic safety meetings are utilized to promote safety. Personnel protective equipment (i.e., safety lanyards and safety glasses) is provided by the company. Disciplinary action, including suspension, is initiated by the company, if employees do not wear this personal protective equipment. Each new employee is trained on the job by a senior sign technician. New employees do not undergo any outlined safety training.

SYNOPSIS OF EVENTS

Maintenance of an illuminated sign consists of an inspection of the internal electrical connections, the repair of those connections determined to be faulty, and the painting of the sign's exterior framework. Occasionally, completion of this task requires more that one day. Because this sign was approximately 33 feet above ground, the service work was performed from an aerial ladder truck. The controls for the ladder were located at the base of the ladder on the back of the truck and on the collapsible platform from which the serviceman works at the top of the ladder. The truck was parked parallel to the front of the sign. A three-phase, 7.2 kV power line was located approximately seven feet perpendicular to the side of the illuminated sign. The power line involved in the incident was 34 feet above ground level.

During his first day at the accident site, the victim completed the internal cleaning and service work on the sign. On the morning of the second day, the victim painted the framework of the sign. He then lowered the ladder to the truck where he obtained a camera. The company requires each serviceman to photograph the top and one side of a sign, upon completion of the service work. The victim then began to extend the aerial ladder up and away from the sign and toward the power line in order to properly position himself to take the photograph. (During co-worker interviews, one of the servicemen stated that due to the electrocution hazard, he photographed the side opposite the power lines, when he serviced the sign involved in the incident. Electrocution hazard warning stickers were affixed to the base of the ladder in clear view.) The victim extended the aerial ladder to a point where the back of his neck and shoulders contacted the power line. The current passed through his body and down the ladder, causing the left front tire to explode and burn. A witness stated that the victim remained in contact with the power line until the heat generated by the resistance of the victim's body to the electric current melted the power line in two. The heat also caused the victim's clothes to catch on fire. The lanyard hooked to the victim's safety belt and the collapsible platform burned and the victim fell to the ground. A rescue squad was called by witnesses from a nearby business. The victim was transported to a local hospital where he was pronounced dead by the attending physician.

CAUSE OF DEATH

The official cause of death had not been received by DSR at the time this report was finalized.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should identify all safety hazards at the work site.

Discussion: A job site survey, which would identify any safety hazards present at a given job site should be performed on all company-serviced lighting systems and illuminated signs. This job site survey should minimally include the identification of hazards such as: a) high voltage power lines close to an illuminated sign, b) terrain around an illuminated sign that would cause the serviceman to position an aerial ladder truck in an unsafe place or manner, c) traffic, d) illuminated sign conditions, and e) any other special conditions that may impact safety. A record of these hazards should be maintained and servicemen should be made aware of any hazards they might encounter on an illuminated sign or lighting system they are to service that day. Once these hazards are identified, they can be controlled.

Recommendation #2: Employers should assure that personnel assigned to perform a specific task are thoroughly trained in the performance of this task, are trained to recognize any associated hazards, and are periodically evaluated to assure compliance with proper safety procedures.

Discussion: The serviceman assigned to perform maintenance on the illuminated sign was trained in the proper procedures of sign maintenance; however, precautions noted in the safety policy were not implemented (i.e., contacting the utility company to de-energize power lines). Servicemen do not receive extensive training concerned with working near power lines or the recognition of electrical hazards generally associated with these tasks. (A serviceman stated during a co-worker interview that he "had no idea contact with a power line could kill you.") Servicemen working near or around power lines should receive training, so that they would be able to recognize and control the hazards present.

FACE 85-32: **20-Year-Old Construction Worker Electrocuted when Backhoe Contacts 7200 Volt Power Line at Construction Site in Kentucky**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 8, 1985, the owner of a construction company was driving a crawler backhoe through a partially developed residential subdivision. The raised boom of the backhoe struck the bottom three lines (cable TV, phone, and neutral) of a four-wire utility line (approximately 26 feet above the road), breaking a 40 foot utility pole located approximately 70 feet from the point of contact (east of the road). The top line (a 7200 volt single-phase primary distribution line) fell to the ground after striking the rear of the backhoe. A 20-year-old construction worker was approaching the backhoe from the rear and was electrocuted when the 7200 volt line fell a few feet away from him.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Kentucky notified DSR of this fatality and requested technical assistance. This case has been included in the FACE Project. On July 17, 1985, the DSR research team (the project director, a research occupational health nurse, a safety specialist, and an epidemiologist) conducted a site visit, met employer representatives, interviewed comparison workers, discussed the incident with the Kentucky OSHA Compliance Officer, and photographed the accident site.

The construction company, which has seven employees, specializes in excavation, carpentry, residential construction, and landscaping. All safety training is on-the-job with no written safety procedures. Employees work approximately 40-45 hours per week.

SYNOPSIS OF EVENTS

The construction company had been building houses in a residential subdivision for over a year. A four-wire utility line had been installed perpendicular to the road approximately one month before the accident. The top line was a 7200 volt single-phase primary distribution line. The owner of the construction company stated that although he had moved the backhoe through the subdivision many times before the installation of the utility lines, he had only travelled the road once, since the lines were installed.

On July 8, 1985, at approximately 7:45 a.m. the owner entered the cab of the backhoe and raised the boom. This was done at the beginning of each workday to eliminate air pockets in the boom's hydraulic system. He then began to drive the backhoe along the road with an empty concrete bucket suspended from the raised boom. Since the owner was concerned with damaging the curb, his attention was focused on the location of the backhoe tracks, not the boom. Additionally, his view of the top hinge of the raised boom may have been obscured by the roof of the cab. As the vehicle moved forward, the boom contacted the three bottom utility lines (cable TV, telephone, and neutral) creating enough tension on the lines to break a forty-foot utility pole at the base and causing the pole to fall towards the backhoe. Two construction workers saw the backhoe hit the lines. The victim was approaching the rear of the backhoe when it hit the utility lines. The three lower lines were held up by the boom of the backhoe. However, enough slack was created, in the top line when the utility pole broke, that the top energized line fell, hit the rear of the backhoe, and came to rest in the street perpendicular to traffic flow. The backhoe operator felt a tingle in his hands, arms, and legs. He immediately released the controls, allowing the backhoe to stop, then jumped clear of the vehicle. A witness stated that the victim was "only a few feet" from the energized line when it fell. The victim apparently staggered from this location and was found lying face down approximately 19' from the downed power line.

The victim was pronounced dead at the scene of the incident. Police measurements indicate the height of the backhoe boom top hinge to be 26' above the ground.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees should be trained to recognize the hazards associated with the operation of equipment around power lines.

Discussion: The operator of the backhoe was concerned about damaging the curb along the road and disregarded the hazard presented by the overhead power lines. Employers should train employees to recognize all hazards associated with the tasks that they are to perform. This would require surveying the area for overhead obstructions prior to moving the backhoe.

Recommendation #2: The design of heavy duty equipment should incorporate design criteria that eliminates/minimizes safety hazards associated with the use of this equipment.

Discussion: The operator may not have been able to see the entire boom of the backhoe, because his vision was obstructed by the roof of the cab. Design criteria for this equipment should quantitatively address visibility and other design aspects related to safety.

Recommendation #3: A signalman/guide should be used to assist in the performance of tasks that may overextend the capabilities of an operator.

Discussion: The operator's attention was diverted to the tracks of the backhoe. A signalman/guide would have assisted the operator and provided him with another pair of eyes and ears.

Recommendation #4: Construction sites should be constantly assessed for hazardous conditions.

Discussion: Construction sites often change very rapidly. These work sites should be continually evaluated to assure that employees are made aware of hazardous conditions as they develop and that these conditions are abated as soon as possible.

FACE 85-34: Billboard Worker Dies when Scaffold Makes Contact with Power Line in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 20, 1985, at approximately 11:25 a.m. a 39-year-old billboard poster for an outdoor advertizing company was electrocuted as he prepared to post a billboard. The billboard was over 30 feet above the ground and was a "back-to-back" board (having two signs), with separate catwalks three feet below the individual billboards.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Tennessee notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 6, 1985, the DSR research team (which consisted of an industrial hygienist and a safety engineer) conducted a site visit, met with an employer representative, interviewed comparison workers, interviewed the next of kin, and photographed the accident site.

OVERVIEW OF FACILITY’S SAFETY PROGRAM

The employer is an outdoor advertizing company that has 25 employees at this office and has similar offices throughout the United States. The local office constructs, maintains, and posts approximately 1300 billboards in a metropolitan area. The supervisor of operations is assigned safety responsibilities on a collateral-duty basis for the facility and a contact for safety-related issues is provided at corporate headquarters.

The company has written safety policies; however, these policies are not specific to bill posting. Monthly safety meetings are conducted. Recently, such topics as crane safety and falls have been discussed. Personal protective equipment (i.e., safety lines, hardhats, etc.) is provided; however, prior to the accident this equipment was not routinely used. Subsequent to the accident, the facility has initiated disciplinary actions for employees not wearing this equipment. Planning of billboard location (i.e., nearness to power lines) is the responsibility of the supervisor of operations, but the bill posters are responsible for identifying hazards associated with the individual billboards as they post the boards. The local facility does not periodically analyze its accident history.

SYNOPSIS OF EVENTS

The victim had not posted a sufficient number of boards during the week to satisfy his quota; therefore, he had two boards to post on Saturday, July 20, 1985. He reported to work at 6:45 a.m. With the exception of a brief visit to the company's office, his whereabouts are unknown until 11:25 a.m. (the time of the accident). The victim had thirteen years of experience posting billboards and had posted this billboard approximately 20 times.

The billboard poster climbed to the catwalk using a ladder from his truck and a fixed ladder on the billboard. He removed loose paper from one of the billboards and then used a rope to raise materials and equipment needed to post the billboards. He raised two new signs and two hangers to the catwalks. Apparently he had propped his 20 foot stage against the center support of the billboard. (The stage is supported by a hanger on each end and provides a work platform for the bill poster.) From the inside of the catwalk on which he was standing, the victim raised the stage using a rope. The billboard poster was facing the inside of the sign with his back to the 13.8 kV power lines. When the stage was raised to where he could reach it, the victim grasped the stage and continued to lift it to the catwalk. This required the billboard poster to "thread" the stage through the area between the billboard and the catwalk. As he lifted the stage, he contacted the 13.8 kV power line that was located approximately eight feet horizontally and one foot vertically from the catwalk. The victim provided a path to ground and was electrocuted. A witness stated in a local paper that the victim "stumbled ... and fell to the street." The stage remained balanced between the wire and the catwalk.

The circuit breaker tripped at 11:25 a.m., as a result of the above contact. The accident site was directly across from a hospital. EMT response is estimated to be three minutes and an ambulance responded within eight minutes. The victim was pronounced dead on arrival at the hospital. The cause of death was cardiac-respiratory arrest due to electrocution. The victim also suffered multiple chest and head injuries as a result of the thirty-foot fall.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The power lines that the victim contacted or the billboard should be moved to eliminate this hazard.

Discussion: The victim raised his equipment from the catwalk on the same side as the fixed ladder and the power lines. Comparison workers stated that they raise their equipment on the side away from the ladder to avoid its obstruction. In general this appears to be a better work practice. Although at this specific billboard this improved work procedure may reduce the possibility of a future incident, it will not eliminate the potential for an accident. Even when moving the stage to the other catwalk or, when lowering the equipment, these same power lines may be contacted.

Recommendation #2: Employers should identify all safety hazards at the work site.

Discussion: A job site survey that would identify any safety hazards present at a given job site should be performed periodically on all company billboards. This job site survey should minimally include the identification of hazards such as: a) high voltage power lines close to a billboard, b) terrain around the billboard that would cause the billboard worker to set up his ladder in an unsafe place or manner, c) traffic, d) board conditions, and e) any other special conditions that may impact safety. A record of these hazards should be maintained and billboard workers should be made aware of any hazards they might encounter on the billboards they are to post on a given day. Any hazards identified on a given board could be listed on a warning sign or sticker and placed in clear view on the lower face or frame of the board. Once these hazards are identified, they can be controlled.

Recommendation #3: Employers should develop written safe job procedures that are task specific.

Discussion: The employer has a written safety policy; however, this policy does not contain any specific guidelines (i.e., job safety analysis) concerning the procedures to be followed or the equipment to be used when posting billboards and does not identify specific safety hazards. A safety policy specific to the posting of billboards and other high risk tasks should be developed and detailed procedures should be included that address the various safety hazards associated with these tasks. Once these specific procedures have been developed, the employer should assure that they are implemented and enforced.

FACE 85-35: **24-Year-Old Textile Worker Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, the FACE Project will identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 23, 1985, a 24-year-old male employee of a textile mill in North Carolina was performing routine duties involved in adding a new supply roll of warp to a weaving loom, when at approximately 5:00 a.m. he contacted a loom and a feeder that was operating with an electrical fault. The employee was electrocuted.

CONTACTS/ACTIVITIES

On July 23, 1985, officials of the North Carolina Occupational Safety and Health Administration in cooperation with NIOSH notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. The DSR research team consisted of a safety engineer, a safety specialist, and a consulting engineer. The FACE evaluation consisted of a site visit, interviews with witnesses, and an interview with the North Carolina OSHA Compliance Officer.

OVERVIEW OF EMPLOYER'S SAFETY FUNCTION

The facility employs approximately 850 workers and is owned by a national corporation. The personnel officer is responsible for plant safety on a collateral-duty basis. The organization employs a corporate safety officer at corporate headquarters.

Job Safety Analyses (JSA) have been developed for all tasks including the task being performed at the time of the accident. Safety is actively promoted and periodic safety meetings are conducted. A plant-wide routine preventative maintenance schedule (every 60 days) is followed. This schedule includes inspection of the loom, feeders and receptacles.

SYNOPSIS OF EVENTS

Two employees on the third shift had completed the task of tying the leading edge of a new supply roll of warp to the trailing edge of the completed roll of cloth. The victim was moving the feeder so that he would have enough room to insert a crank onto the driving lug of the loom. (To manually advance the knots through the machine and permit weaving operations to resume, the loom is equipped with a removable crank. This crank provides power to the drive mechanism at a faster rate than the weaving speed.) The victim's co-worker detected a burning odor and saw the victim draped over the feeder. The co-worker called to a nearby technician to "kill" the power. The technician disconnected the power at the end of the loom, and the co-worker eased the victim to the floor. Fellow employees attempted unsuccessfully to revive him. (Although a medical facility employing two registered nurses exists on the premises, neither were on duty at this time.) The victim was transported by ambulance to a local hospital where he was pronounced dead by a staff physician.

The feeder power is supplied from a receptacle located on the end of the loom adjacent to the feeder. The power source is three-phase, 550 VAC, 6OHz and provides power to the feeder through a four-prong "twistlock" plug and receptacle. The installation of the receptacle was a modification by the employer to permit changing feeders in the event of feeder problems. This design eliminated the need for an electrician to disconnect the "hard wiring." The facility electrician found the receptacle broken, upon inspection after the incident. The receptacle apparently was broken when undue force was applied to the plug and receptacle. The electrician related that he removed the plug from the receptacle, but did not notice the relative position of the plug to the receptacle. Prior to removal of the plug, he measured a voltage greater than 300 volts between the feeder and the loom.

Evidence indicates that the plug was inserted in the receptacle with the ground prong turned 90 degrees clockwise from the ground terminal. This is not possible with a receptacle that is complete and intact; however, because the melamine insulator was cracked, sufficient space was available for the tang on the ground prong to enter the x terminal of the receptacle. (The x, y, and z terminals are the three-phases, 550 VAC power and the ground terminal is the system ground.) When the plug is rotated 90 degrees the ground prong on the plug becomes energized. The frame of the feeder is then energized with a 550 volt potential. The feeder is electrically isolated, because it is mounted on rubber wheels; however, the victim established a path to ground when he contacted the grounded loom frame. The control cabinet on the feeder contained a stepdown transformer to reduce the three-phase, 550 VAC power to 64 VAC and the transformer was connected in a delta configuration. With the plug rotated 90 degrees the transformer had two phases and a ground terminal connected. Electrically it is feasible for the system to operate, but at some reduced efficiency.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should install a strain relief grip on all feeder power cables and replace all melamine receptacles with industrial rated nylon receptacles.

Discussion: The strain relief grip is so designed to eliminate any possible stress on the electrical connection when undue forces are applied. Nylon receptacles can better tolerate the strain and abuse at contact than the existing melamine units.

Recommendation #2: The employer should mechanically bond the feeders to the looms by use of flexible bonding straps.

Discussion: Mechanical bonding straps will eliminate dependence upon the electrical ground conductor in the power cable for grounding protection.

Recommendation #3: Employees should be trained to recognize the hazards of electrical energy. Scheduled safety meetings and safety orientation for now employees could be used to provide this training.

Discussion: The employees interviewed did not appear to have adequate knowledge of electrical hazards. Training should include proper plug removal methods and the identification and reporting of electrical hazards.

Recommendation #4: The employer should instruct and require the employees to disconnect the power to the feeder using the toggle switch located next to the receptacle on the loom before removing the plug. Energizing and de-energizing tasks should be addressed in existing job safety analysis.

Discussion: The employer modified the electrical system to the feeder with the addition of a toggle switch and receptacle. However, the employees usually do not make use of the switch to de-energize the feeder when it is necessary to remove the plug. This safety hazard should be included in the existing job safety analysis.

FACE 85-36: Employee of an Electrical Contracting Firm is Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related fatal injuries and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

CONTACTS/ACTIVITIES

On July 31, 1985, the NIOSH Region III consultant notified DSR of this fatality. DSR set up a meeting with the investigating compliance officer for August 5, 1985. On the evening of August 5, 1985, the DSR research team (a mechanical engineer, an EIS officer, and an engineering consultant) discussed the details of the accident with the compliance officer. The following morning an opening conference was held with the electrical contracting company's owner and safety officer, who provided background information about the company's history, type of work performed, and the company's safety and training programs. Several interviews were held and a site survey was conducted to better understand the events surrounding the accident and the daily activities performed by the victim.

OVERVIEW OF THE EMPLOYER’S SAFETY PROGRAM

The employer is an electrical contracting firm that was contracted by the local utility. The electrical contractor employs approximately 150 workers.

The employer's safety program is patterned after the safety program of the utility. An employee is assigned safety responsibility on a collateral-duty basis and promotional literature was periodically distributed. All training is on-the-job.

SYNOPSIS OF EVENTS

On July 30, 1985, the victim was at a townhouse development wiring an energized 7200 - 240/120 volt single-phase, step-down transformer. The employee had been with the company for nine months and had no electrical experience prior to accepting this job. The transformer provides power to a complex of four townhouses. The employee was to perform the work to provide electrical power to the end townhouse (no. eight) then to townhouses six and seven. The victim was wearing insulated lineman's gloves.

The foreman observed the employee make the two "hot" terminal connections to the transformer spade lugs and then instructed him to make the three neutral connections. (Proper work procedure would require covering the two "hot" terminal connectors with rubber boots or a rubber blanket. This would provide electrical insulation and protect the worker from inadvertent contact.) The foreman then proceeded to the end townhouse to confer with the residential electrician. The employee permanently secured two neutral connections and loosely assembled a third connection. This loose connection would enable an additional neutral terminal connection to be completed after a cable was installed for townhouse five. Terminal connectors were not covered with rubber insulating boots.

The electrocution took place shortly after 9:00 a.m. Photos taken after the accident revealed the trench leading to the townhouses was open and evidence indicated the victim's left foot slipped into the trench, causing him to fall into the transformer. The area was very muddy and slippery at the time of the accident. It was reported that the victim had burn marks on the left side of his stomach and his right forearm, indicating probable contact with a terminal and the transformer box. Ambulance personnel were summoned and they transported the victim to a county hospital where he was pronounced dead.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees should not perform tasks on or around energized electrical equipment unless adequate work areas are provided.

Discussion: Working on electrical equipment constitutes a hazardous work condition. It is essential that all possible risks be reduced. This will require the use of good housekeeping procedures around the work area. The employee must be provided an adequate area to access equipment being installed. The victim did not have an adequate area on which to stand in front of the transformer, because of the trench. Construction of a 30-inch extension to the concrete transformer pad at the time of installation would provide an adequate work area and would be relatively inexpensive. Additionally, standing on non-conducting, safety grates will provide a structurally safe area from which to work and will serve to electrically insulate personnel working on the transformer. The anti-slip surface will provide safe footing. Safety grates are available in a variety of shapes and sizes and can be leveled by wood or concrete blocks usually found around a construction site.

Recommendation #2: The employee should make use of the available terminal boots and/or rubber blankets to provide electrical insulation while working in close proximity to energized terminals.

Discussion: Rubber insulating boots are for personal protection from energized spade terminals and should be used at all times when direct cable attachment to the spade terminals is not in progress.

Recommendation #3: Employers should hold management and first-line supervisory personnel accountable for job site safety.

Discussion: A foreman witnessed the hazardous condition that resulted in a fatality and did not intervene. Safety responsibilities that require accountability for all levels of supervision should be developed and supervisory personnel should be held accountable for all safety responsibilities. Performance evaluations and other incentives should address safety.

Recommendation #4: Employees should be assigned tasks commensurate with their level of experience, training, and skills.

Discussion: The employee involved in this incident had only nine months' experience. All electrical-related training was on-the-job. On-the-job training should be carefully evaluated to assure that it is complete and reinforces the policies of management (i.e., safety concerns).

FACE 85-37: **Brick Worker Electrocuted in Georgia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

An employee for a brick sales and delivery company was electrocuted when the boom on a truck-mounted crane he was operating contacted a 7200 volt power line.

CONTACTS/ACTIVITIES

A NIOSH staff member notified DSR of an electrical-related fatality that occurred near his home. The Georgia Department of Human Resources was notified and they requested technical assistance. This case has been included in the FACE Project. On August 13 and 14, 1985, a DSR occupational health nurse conducted a site visit and met with employer representatives, the District Environmental Health Specialist, the County Sheriff, and the County Coroner.

OVERVIEW OF THE EMPLOYER'S SAFETY PROGRAM

The employer is a brick sales and delivery company that has been in business for ten years. The company employs four full-time drivers and nine other employees.

All drivers must have a Class-V driver's license and complete at least one week of on-the-job training. The company has no written safety program, but safety is considered to be very important by company management. On rainy days and during slow periods, the drivers meet to discuss problem and to recommend solutions. The safety aspects of the work are considered at this time.

SYNOPSIS OF EVENTS

In the process of widening a portion of the interstate highway between two major cities, a series of manholes were to be constructed. The land contours required that these manholes be of various sizes; therefore, the contractor decided to build each manhole out of bricks, rather than buying them in a standard size. A load of bricks had been previously delivered to the accident site (near the interstate frontage road). The first load of bricks was unloaded using a fork-lift device mounted on the delivery truck.

On the morning of the accident the driver of the company's only truck-mounted crane with a raising boom delivered another load of bricks to the contractor. He parked in approximately the same position as the previous delivery truck. After turning on the sixteen-horsepower motor that ran the crane, the driver picked up the pendant controller, and inadvertently raised the boom into the 7200 volt power line, which was directly over the truck. He was electrocuted and collapsed on the ground near the truck.

The Sheriff's Department was called by workers at the site. The Sheriff responded, followed by the emergency squad and the County Coroner, who pronounced the driver dead. Upon arrival, the Sheriff contacted the power company and kept everyone (including emergency squad personnel) away from the body until the power company confirmed that the power was off. The victim had burns on his hands and chest resulting from his contact with the controller. Also he had an exit wound on his back. Sixteen of the eighteen steel-belted truck tires were blown out by the surge of electricity.

CAUSE OF DEATH

Coroner's report not available at this time.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should develop methods to increase driver awareness of job site hazards.

Discussion: Since drivers work independently, it is difficult for an employer to identify all hazards to which a driver will be exposed. Because of this it is extremely important that employers take every opportunity to make drivers aware of potential hazards. Safety training, promotion, periodic safety meetings, warning labels on the dash of a vehicle and/or at the boom controls, checklists, etc. can all be used to increase driver awareness. The victim in this fatality was an experienced driver. This fact reinforces the need to continually promote safety awareness to all drivers and highlights the need for employers to enforce safety requirements (i.e., disciplinary action, etc.).

Recommendation #2: Employers should enforce existing regulations concerning crane operations.

Discussion: Standards such as OSHA's 1926.550(a)(15) and 1910.180(j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been de-energized and visibly grounded at the point of work or physical contact between the lines, equipment, or machines is prevented by the erection of insulating barriers which cannot be part of the crane.

FACE 85-38: Production Welder Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 29, 1985, a 29-year-old male production welder, an employee of a metal fabrication company, was plugging the cord to a portable welder into an extension cord when he was electrocuted.

CONTACTS/ACTIVITIES

During the week of August 5, 1985, officials of the Industrial Commission for the State of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE project. The research team (two safety specialists and a physician) visited the facility and met with the president of the corporation. Two co-workers of the victim were interviewed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The organization consists of a metal stamping division and a tooling division that employs a total of 50 workers. Managerial control of production, safety, and health-related activities is the responsibility of the vice-president of the individual divisions. The organization employed three welders, who provided welding services for both divisions. A preventative maintenance program had been implemented prior to this incident and includes routine inspection of all electrical equipment. Responsibility for all maintenance of both divisions was assigned to one electrician.

SYNOPSIS OF EVENTS

The 29-year-old production welder began work at 7:00 a.m. on July 29, 1985. At approximately 10:00 a.m. he was assigned to work on a cement platform immediately outside the facility. The platform was normally used for spray painting, metal cutting, and welding operations. Using a torch, he cut off brackets from a conveyor. He then reentered the facility and wheeled a portable arc welder outside onto the work platform. The distance from the outside work area to an appropriate internal receptacle (three-phase, 480 volt power source) required the use of an extension cord. The male end of the extension cord was four-pronged and the female end was spring-loaded.

The victim plugged the male end of the extension cord into the receptacle. Upon completion of this connection, the worker picked up the plug of the welder and the extension cord, and proceeded to connect them together. As the victim completed the connection, the outside metal casing of the plug on the welder became energized and the production welder was electrocuted.

A thorough investigation of the fatality conducted by the corporation's officers revealed that the female end of the extension cord had been broken and that the spring, the cover plate, and a piece of the melamine casing were completely missing from the face of the female connector. Additionally, the ground prong of the welder was inserted 90 degrees clockwise from the ground terminal, so that the normally grounded metal cover on the welder plug was electrified. Improper insertion of the plug into the connector is not possible with a plug that is complete and intact; however, because the spring-loaded cover plate was missing from the casing and the melamine was broken, improper insertion was possible and the grounding circuit became energized. The victim established a path to ground when he contacted the metal casing of the plug on the welder. The power switch on the arc welder was in the "on" position when the victim was discovered. The center spring and melamine fragments were found at the accident site.

The victim was totally deaf in one ear and suffered from diminished hearing in the other ear. It is conceivable that the extension cord may, have been dropped at the accident site (since the plug fragments were found there) and that the plug was damaged by the victim. If this scenario is accepted, the victim could not hear the plug break.

CAUSE OF DEATH

The official cause of death, as established by the coroner, was not available at the time this report was finalized.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees should be trained to recognize the hazards associated with electrical energy and to inspect electrical parts before use.

Discussion: Training for electrical hazard recognition should include inspection of all plugs, cords, and switches before systems are energized and before final connections are made by the operator. Visual inspection of the equipment is necessary for all employees. The fact that the victim had decreased hearing, increases the importance of the visual inspection. Employees should be cautioned about the hazards associated with the use of electrical equipment. In general, electrical equipment was well maintained and in excellent condition at this facility with the exception of the extension cord plug.

Recommendation #2: Extension cords should not be used as a substitute for fixed wiring of a structure.

Discussion: The victim was preparing to work in the area normally set aside for welding operations. The extension cord was required because an appropriate receptacle was not located in this area. A weatherproof receptacle should be installed on the outside of the building in the area where welding operations are conducted. The employer should eliminate the use of extension cords, where possible.

Recommendation #3: The melamine connector should be replaced with a connector that can absorb the abuse to which it is subjected, particularly during welding operations.

Discussion: This is the second fatality investigated as part of the FACE program that resulted from a broken melamine connector. These connectors should not be used in areas where they will be exposed to abuse. NIOSH is investigating this problem in more depth and will publish an ALERT, if warranted.

FACE 85-39: Worker in Rubber Products Plant Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

A maintenance laborer was carrying a 20 foot piece of angle iron from a welding shop to an outside storage rack. As he was negotiating a 90 degree turn next to a bank of transformers, the front end of the angle iron struck against an uninsulated supply wire at the top of one of the electrical transformers.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 20-22, 1985, a safety specialist from DSR met with employer representatives, conducted a site visit, interviewed comparison workers, discussed the incident with the next of kin, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The company is a supplier of quality rubber and vinyl products to the automotive, domestic, and industrial market and employs 280 workers at the rubber products plant. An additional 470 workers are employed in several subsidiaries, all located within the same county.

The plant foreman serves as the plant engineer and is assigned safety responsibilities. The safety program consists of a monthly walk-through inspection, by a committee of three: a union worker, a representative of personnel and the plant engineer. Also, the plant engineer meets with a representative from the Industrial Commission of Ohio on a monthly basis. The company provides preplacement physical examinations to all new employees. Occasionally a safety topic will appear in the monthly company publication. Workers receive their training from co-workers and the foreman. The employer experiences an annual labor turnover of approximately 10%, depending on economic conditions in the area. The firm has no written safety or training program, and rarely uses occupational safety and health consultants. The company does not periodically evaluate its safety program.

SYNOPSIS OF EVENTS

On December 17, 1984, the 20-year-old victim was hired as a press operator. Two months later he was reclassified as a maintenance laborer. His primary responsibility was custodial and janitorial in nature. Prior to working in the rubber products plant, the victim had worked twenty-one months as a janitor in a school and for eighteen months he worked as a fork lift operator and truck driver. The victim's work schedule was 7:00 a.m. to 3:30 p.m., Monday through Saturday.

On July 8, 1985, the victim reported to work at 7:00 a.m. His first assignment was to clean and resupply the restrooms. At 8:30 a.m. the foreman told the victim to clean up the welding shop. He went to the shop, picked up a piece of angle iron (20' x 1 1/2" x 1 1/2") and was in the process of carrying it to a steel rack located in the outside yard. The 135 pound victim carried the angle iron (weighing approximately 47 pounds) on his right shoulder. The piece of metal was slightly elevated in front of him (not parallel to the ground), as he walked to the outside rack (approximately 250 feet). Forty feet from the rack, the victim had to make a 90 degree left turn, around a bank of three high voltage transformers. The transformers were enclosed by a 6 foot high Cyclone fence with a top border of barbed wire, which extended the height of the fence another twelve inches. The transformers were approximately 3 feet higher than the fence enclosure. Each transformer carries 4160 volts. As the worker negotiated the turn, the angle iron turned horizontally approximately 130 degrees. The front tip of the angle iron struck the uninsulated supply wire at the top of the center transformer. This contact resulted in the electrocution of the victim.

At approximately 8:45 a.m. a fork lift operator in the yard heard the sound of metal dropping on concrete. Five minutes later on his route he noticed the victim on the ground beside the transformer. He checked the victim's pulse and found none. Co-workers performed CPR until the EMS arrived. The victim was transported to a local hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

According to the Certificate of Death, the immediate cause of death was electrocution, due to contact with 4160 volts.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: These transformers should be protected in accordance with existing regulations concerning transformer installation and maintenance.

Discussion: OSHA Standard 29 CFR 1926.402(d)(1) requires that transformers over 150 volts to ground be protected to prevent accidental contact. Protections should be provided by individual integrated housing or by an enclosure, such as an electrical substation fence, which accommodates a group of such equipment. 29 CFR 1910.303(h)(2) states "A fence less than 8 feet in height is not considered to prevent access unless it has other features that provide a degree of isolation equivalent to an 8 foot fence. " The fence provided was six feet in height and obviously did not prevent accidental contact. (It should be noted that subsequent to the electrocution, the company has complied with this recommendation.)

Recommendation #2: The company should develop and implement a comprehensive occupational safety and health program.

Discussion: There is no corporate policy, commitment, or resources designated for a comprehensive safety program. Training is not given to supervisors or workers concerning the implementation of safe work practices or hazard recognition and correction. The company rarely uses outside safety services even though the Industrial Commission of Ohio provides free consultation services to employers located within the State of Ohio.

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FACE 85-41: Mobile Home Assembly Line Worker is Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

A mobile home assembly line worker was electrocuted when he contacted the exterior of a mobile home that was electrified as a result of a short in the wiring of another mobile home on the assembly line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 22, 1985, the DSR research team (two safety specialists and a fire protection engineer) conducted a site visit, met with employer representatives, interviewed comparison workers, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a mobile home manufacturing firm that has been in operation for approximately 13 years. On the day of the incident, the firm employed approximately 95 laborers and 18 office personnel. This plant was one of eight such plants owned by the firm throughout the United States.

The production manager is responsible for safety on a collateral-duty basis. The company utilizes monthly safety meetings to promote safety awareness. Additionally, the company receives weekly safety topics from the Industrial Commission of Ohio, which are used in the safety meetings.

SYNOPSIS OF EVENTS

On August 13, 1985, four workers were in the process of installing the metal roof on a mobile home (designated home #1) in the metal roof station of the assembly line in the windows and door station (the next production station) another mobile home (designated home #2) had hot-to-ground short due to an exterior nail piercing the wiring in the wall of the mobile home. The power cord entering mobile home #2 did not have the ground wire connected to the electrical panel box of the home. The frame of home #2 became energized, because of the connection made by the nail piercing the wiring. The metal frame of home #1 was connected to the frame of home #2 by line-roll chains. This chain is used to move a the home between stations on the assembly line. Since home #1 had the metal siding in place, the complete exterior of the home became electrified. Four workers at the metal roof station were preparing stretch to the roof onto the frame of home #1, using a "come a long" attached to a steel post. One of the workers attached a vise-grip clamp to the edge of the metal roof, and as he grabbed the "come-a-long" to connect to the vise-grip clamp, he provided a path to ground for the energized home. The electricity traveled through his arms and upper chest. One his follow workers made an unsuccessful attempt to pull him away from the energized clamp, prior to disconnection of the electricity to home #2.

Electrical power (120 volts) is connected to mobile homes on the assembly line, after the electrical system has been installed, in order to use interior lights and electrical outlets during the remainder of assembly. In accordance with requirements in OSHA standards and the National Electrical Code, NFPA 70, a dielectric strength test of either 900 volts for one minute or 1080 volts for one second must be performed prior connecting electricity to the homes. The 1080 volt test was being used on the assembly line at the time of the incident. This test, performed prior to the incident, did not locate any shorts in home #2. In this case the hot-to-ground short (nail in the wiring) could have occurred after the test was performed, because exactly when the short occurred was never established; however, after the incident both voltage tests were performed on home #2 and only the 900 volt test located the short.

On the day of the incident, the environmental conditions were hot and humid and workers on the assembly line were very sweaty. These conditions may have contributed to the accident (i.e., moisture on the victim's body decreasing the electrical resistance of his body, thus creating a better electrical path to ground).

CAUSE OF DEATH

The coroner determined that the cause of death was "electrocution due to 110 volts or less of electricity."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations for grounding of mobile homes.

Discussion: OSHA Standard 29 CFR 1910.309 and NFPA Standard 70, article 550, require that both electrical and nonelectrical metal parts in a mobile home be grounded. In this incident, the unconnected ground wire was a major contributing factor to the accident occurring. This led to the electrical short electrifying the exteriors of the mobile homes when power was connected. The accident may have been prevented if the mobile home had been properly grounded. Following this incident the firm designated one individual to make the electrical connection including the ground wire to the mobile home panel box and assigned a foreman to check the electrical connections before the home is connected to electrical power.

Recommendation #2: Prior to connecting power to mobile homes, the wiring should be subjected to a one minute, 900 volt, dielectric strength test between live parts and the mobile home ground. This should be done after all exterior screws and/or nails are in place.

Discussion: OSHA Standard 29 CFR 1910.309 and NFPA Standard 70, paragraph 550-10, require a dielectric strength test of either 900 volts for one minute or 1080 volts for one second. In this incident, the hot-to-ground short was detected by the 900 volt test, but not by the 1080 volt test. The accident may have been prevented if the 900 volt test was conducted prior to electrical power being connected to the mobile home. After the incident, the firm decided to use only the 900 volt dielectric strength test on all mobile homes prior to electrical power being connected.

FACE 85-42: **Utility Company Employee Electrocuted in California While Drilling Under a Road**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 18, 1985, crewmen for a gas utility company were using an air-driven machine to drill horizontally under a road to provide new gas line service. One worker was electrocuted and a second was injured when the drill contacted a 4160 volt power line.

CONTACTS/ACTIVITIES

Union officials notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case has been included in the FACE Project. A research team (a nurse and a physician) visited the city where this fatality occurred and met with company and union representatives and OSHA officials. A meeting was held with officials from both unions representing the employees of the utility company. A separate meeting was held with company representatives (the supervisor of employee safety and a member of the industrial relations safety staff). The actual accident site was not visited because substantial changes had occurred to the area since construction had been completed. However, the drilling procedure was observed at another work site. This procedure was photographed by the NIOSH team. A meeting was held at the district OSHA office where the OSHA investigation records were reviewed and discussed with the compliance officer assigned to investigate this fatality. A closing conference was held with representatives of the union.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This gas utility company has over five thousand employees who are represented by two separate unions. The company is divided into two major organizational elements: six transmission divisions maintain pipeline operations bringing natural gas to the area; thirteen distribution divisions provide service to residential and commercial consumers. The crewmen involved in this incident worked for one of the forty-seven distribution facilities (under one of the distribution divisions). A crew, consisting of a crew leader and one or two crew assistants, receive formal classroom training prior to working in the field. A crew assistant receives ten days of classroom training concerning field operations and a crew leader has approximately eight weeks of additional classroom work which includes welding and plastic fusion training. The company safety staff consists of two safety supervisors, four safety representatives, and an industrial hygienist (recently hired). There are also six facility safety engineers concerned with safety of existing facilities (meters, equipment, etc.).

All job operations are addressed by three levels of information needed to perform a specific task (i.e., job practices, job procedures, and job instructions) and are written. Job instructions are carried on the crew truck. If questions arise about job instructions, support is obtained from a supervisor at the local distribution facility, who is responsible for safety at the local distribution facility. It is the responsibility of these supervisors to see that all job instructions are followed.

SYNOPSIS OF EVENTS

On July 18, 1985, crewmen of a gas utility company were assigned to provide new service to an apartment building that was under construction. The crew consisted of three people, since the procedure to bore underground requires a crew of this size. The crew leader had sixteen years of experience on the job and the victim had four years of experience.

A service line was to be installed to connect an apartment building to the main (which is located under the street). See figure 1. The area had been previously inspected by the crew leader. Telephone and street light electrical utilities were excavated and identified in the parkway. Power to the apartment was supplied by above ground lines. A non-profit organization that is responsible to alert utilities when excavation may affect their equipment had been notified. The local telephone company had marked their lines in response to this notification; however, the underground electric lines had not been marked by the local municipality. The municipality does not routinely mark their underground electric lines.

Partial excavation of the site had been completed by the gas company so that the procedure to bore under the street could take place. A trench had been excavated from the apartment building to the sidewalk. One hole had been dug in the parkway to expose telephone and street light service lines. Another hole had been dug in the street to expose the gas main. Although the crew had the equipment and training to electronically identify other underground metal structures, this was not done because the crew questions the reliability of the equipment currently being used.

The crew was attempting to bore under the sidewalk and under the street to install a service line. The equipment used to bore this hole was an air driven, water-lubricated, low RPM drill with a carbide bit (see figure 2). Pipe extensions are added as required. This equipment is usually operated by two crew members, but is occasionally handled by three when difficulty is encountered. Three attempts to bore a hole under the street were made with the fatality occurring on the third attempt. The first attempt resulted in the drill bit coming up through the street approximately two feet from the hole that exposed the gas main. The second attempt was not successful because resistance was met and the drill could not be advanced. All three crewmen were pushing on the machine during the third attempt because excessive resistance was encountered. A 4160 volt power line, encased in four inches of concrete, was contacted at approximately 2:10 p.m. resulting in one fatality and one serious injury. The third crewman felt a shock in his hands and released the equipment. The crew leader tried to release the equipment and fell to the ground unconscious. He suffered third degree burns on his hands and shoulders. The victim went into convulsions and slumped over the equipment. The victim had burn marks on both hands and the front of his right thigh and was pronounced dead at a local hospital after resuscitation efforts failed.

Excavation of the site done during the post-accident investigation revealed a four inch thick concrete conduit approximately twenty-six inches below the street surface. The concrete was chipped near the top edge (presumably from the first attempt to bore under the street) and another damaged area was noted on a lateral of the conduit (presumably from the second attempt). A hole was found on the lateral side of the conduit where the drill bit pierced the cement and came into contact with the power line. The line was located prior to excavation using the underground metal locating device present on all underground service trucks. (It should be noted that a similar incident occurred in 1983 involving a 110 volt line. No serious injuries occurred.)

CAUSE OF DEATH

The medical examiner determined the cause of death to be electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A thorough survey of the job site should be made prior to any excavation or drilling procedures. This should include locating all underground utilities.

Discussion: An organization exists that provides information to all service utilities that excavation is to occur which may involve their equipment. No excavation or drilling procedures should be initiated unless all utilities have marked their service lines. In addition, the underground metal locating device should be used prior to any excavation or drilling procedure to verify that a clear path exists and that all utilities have been identified. A metal locating device that is easier to operate and that more reliably differentiates underground service lines from miscellaneous metallic substances may improve its acceptability among the crew.

Recommendation #2: Drilling procedure instructions should be amended to include excavation and exposure of all service utility lines and to excavate and expose all points of resistance.

Discussion: This particular incident involved three attempts. The second attempt was unsuccessful because resistance was met. The third attempt involved three men pushing on the machine. If the point of resistance had been excavated and exposed, the electrical conduit would have been identified. The gas company has implemented this recommendation.

Recommendation #3: The company's safety program should include hazard recognition and follow-up of previous accidents.

Discussion: As mentioned, a previous incident involving this drilling procedure and contact with a power line occurred in the past (1983). Apparently little or no investigation occurred at the time of this incident. The potential for serious injury and death should have been recognized at the time of this previous incident. Follow-up of all accidents should enable better hazard recognition so preventive measures can be implemented. The establishment of a local health and safety committee, involving both labor and management, should ensure that all accidents are adequately investigated.

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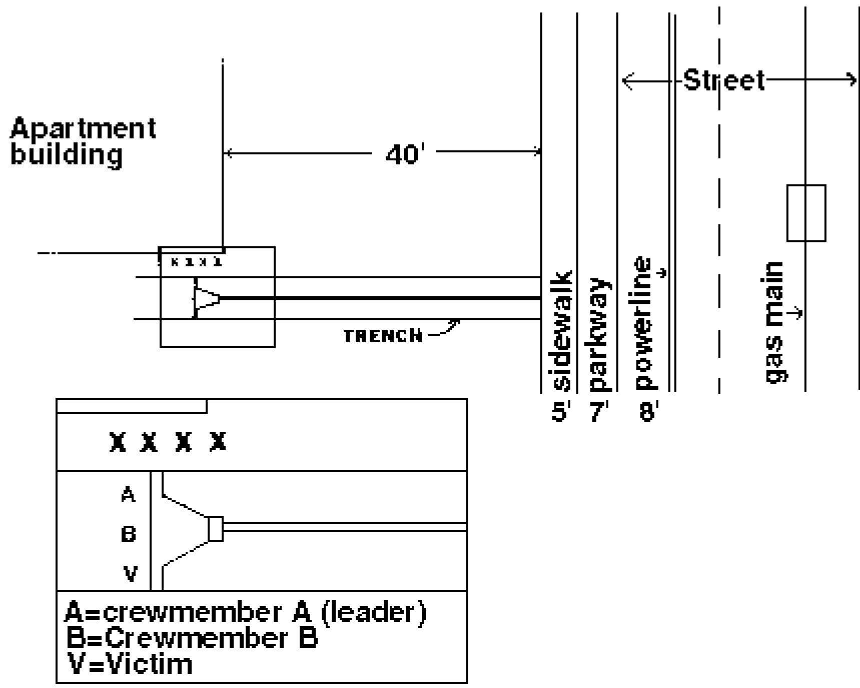

Figure 1. *Construction Area of Fatality*

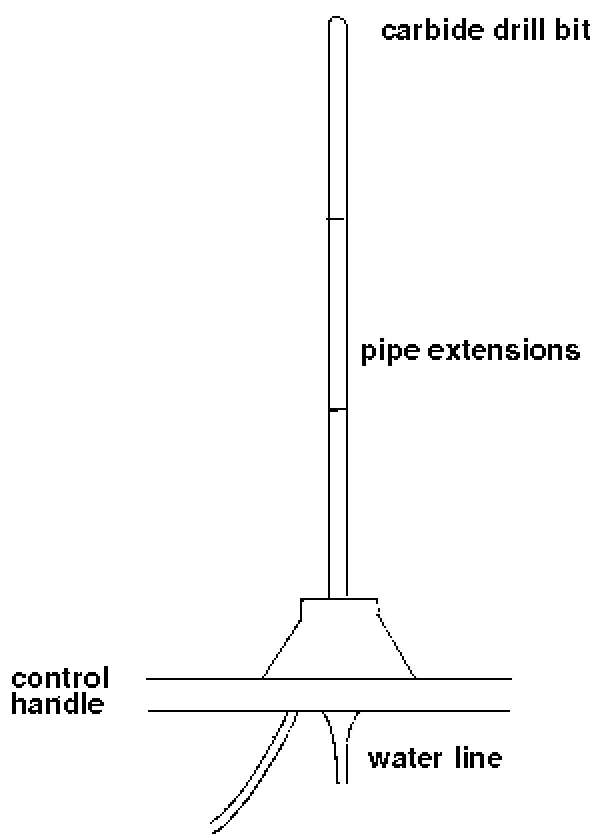

Figure 2. *Schematic of Bore Motor*

FACE 85-43: **County Worker Dies In Tennessee**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which in focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 28, 1985, a 25-year-old county highway worker was electrocuted when the 20 foot steel handle of a modified post hole digger he was holding made contact with a 7200 volt power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Tennessee notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On September 3 and 4, 1985, a safety specialist conducted a site visit, met with the county safety director, interviewed comparison workers and eyewitnesses, discussed the incident with the OSHA Compliance Officer, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

Approximately 70 workers are employed by the County Highway Department. The highway department in responsible for the maintenance and repair of all existing county roads, culverts, and drainage ditches, and for the construction of new roads within the county. The Personnel, Zoning, and Maintenance Director is assigned safety responsibilities for all county departments on a collateral-duty basis. With the exception of the road supervisor, the supervisors of the various county departments have worked in conjunction with the safety director to establish standard operating procedures and safety policies for their departments. The highway department has no existing written safety policy, safety training procedures, or standard operating procedures.

SYNOPSIS OF EVENTS

On the day of the incident the road crew was performing maintenance work on a clogged section of pipe in an open drainage ditch. The pipe was 20 feet in length and 24 inches in diameter. The ditch was located approximately three feet horizontally from the side of the road. A 7200 volt power line was located approximately 20 feet above and perpendicular to the midpoint of the drain pipe. (Neither the foreman nor the two co-workers present noticed the power lines, before work began on the clogged section of drain pipe.) The highway department routinely used a modified post hole digger when working on clogged drain pipes. The jaws of the post hole digger were welded in an open position and the wooden handles were replaced by a 20 foot section of steel pipe two inches in diameter. Due to the weight of the modified post hole digger, it was common practice for the road workers to clean the drain pipe from each end (one-half at a time).

After the victim had cleaned out one-half of the drain pipe, he removed the modified post hole digger from the drain pipe and held them on end at the side of the ditch. He then began to guide the modified post hole digger to the opposite end of the drain pipe. The road crew foreman (sitting in his truck) saw that the handle of the modified post hole digger was going to contact the 7200 volt power line and issued a verbal warning to the victim. The handle of the modified post hole digger then contacted the 7200 volt power line. The victim provided a path to ground and was electrocuted. The road crew foreman radioed for the rescue squad. CPR was initiated immediately by co-workers. The rescue squad arrived within thirteen minutes and transported the victim to the local hospital where he was pronounced dead by the attending physician.

CAUSE OF DEATH

The official cause of death had not been received by DSR at the time this report was finalized.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should initiate a safety policy that address specific tasks performed by the employees, identifies safety hazards, and stresses safety training.

Discussion: The County Highway Department did not have a safety policy that addressed safety training and procedures specific to road maintenance and other high risk tasks performed by county highway department personnel. Written procedures should detail the tasks to be performed and should identify the safety hazards associated with these tasks. Training should be developed and implemented that addresses these proper work procedures. The employer should assure that safety policies are enforced.

Prior to the performance of a given task the crew foreman should perform a job site survey, which would identify any safety hazards present at a given job site (i.e., overhead power lines). Workers should then be made aware of the hazards they might encounter at a given job site. Once these hazards are identified, they can be controlled.

Recommendation #2: Employers should provide proper equipment to perform job-related tanks.

Discussion: The twenty foot section of two inch diameter steel pipe used as a handle for the tool, made the tool heavy, awkward, and hard for one man to maneuver. Since half of the pipe is cleaned from each of its ends, the handle could be shortened. A shorter handle would reduce the weight and improve maneuverability. Additionally, the county should consider using a non-conductive material such as fiberglass for tool handles when working in the presence of electrical hazards. A non-conductive material would greatly minimize the risk of injury due to contact with electrical power lines.

FACE 85-46: Soldier Electrocuted While Installing Communication Wire in Georgia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 24, 1985, a 23-year-old soldier was stringing WD-1 communication wire across a gravel road on a military firing range when he was electrocuted. He apparently decided to suspend the wire over the road by throwing it over 440 volt power lines that diagonally crossed the road. He stripped one foot of insulation off the WD-1 wire, wrapped the malleable metal wire securely around a rock, and successfully threw the rock over the power line. The soldier, unaware that contact with the 440-volt power line had energized the WD-1 communication wire, crossed the road and was electrocuted when he picked up the rock.

CONTACTS/ACTIVITIES

Officials of the Health Department for the State of Georgia notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On September 17-18, 1985, the DSR research investigator (a mechanical engineer) conducted an epidemiologic evaluation, met with military representatives, interviewed comparison soldiers, interviewed the victim's best friend (a fellow soldier at the base), discussed the incident with civilian and military personnel who were in the vicinity of the accident, and photographed the accident site.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

This incident occurred at a major military installation. This installation has 6 full-time safety professionals who implement a comprehensive safety program. These safety professionals are responsible for training soldiers to perform their duties in a safe manner, to make sure weapons and equipment are functioning properly, to disseminate field manuals that instruct soldiers on safe and efficient techniques for performing their duties, and to observe maneuvers in the field to ensure that soldiers are executing their orders safely. The safety staff is also responsible for post safety and has initiated post-wide safety regulations, such as a mandatory requirement that all personnel on base wear their seat belts.

SYNOPSIS OF EVENTS

On the day of the incident, a staff sergeant and his men were to install a ground wire telephone communications system on a tank firing range. When the staff sergeant and two communications specialists arrived at the range, they realized that two other communications specialists had not yet arrived. The sergeant ordered one of the men to go pick up the other communications specialists and he instructed the victim to wait until the rest of the team arrived before "laying" any communication lines. The sergeant then climbed to the top of the range tower to check the quality of radio communications.

The victim was described as a soldier who performed his duties enthusiastically and would often take the initiative to complete a mission without specific orders. Unknown to the sergeant and without his expressed order, the victim began laying wire from the site of a temporary field motor pool towards the range tower. Just short of the range tower, the victim had to cross a gravel road with the communication wire. He apparently chose to suspend the wire over the road by throwing it over power lines that diagonally crossed the road. The victim accomplished this by stripping a one foot section of insulation off of the WD-1 communication line, wrapped this section of wire securely around a rock, and apparently threw the rock over the 440 volt power line. Proper procedure for this task would have required burying the line under the road, thus eliminating the hazard posed by the power lines. He then walked over to where the rock had landed unaware that the wire had become energized. When he picked up the rock wrapped with the exposed wire, he was electrocuted.

Shortly thereafter the sergeant went out on the cat-walk of the tower to request that the victim bring up a volt/amp meter. When the sergeant looked down, he observed the victim laying on the ground with smoke coming from his hands and boots; he immediately ran to where the victim was laying. The sergeant observed a rock with a stripped section of WD-1 communication wire tied to it in the victim's hand. The victim was also entangled in the wire. The sergeant looked for a stick to remove the wire, but could not find one. He then grabbed the insulated part of the wire, pulled the wire away from the victim, and immediately began resuscitation procedures.

Less than two minutes after the accident a medical evacuation unit and Company's medics were summoned. CPR revival procedures were continued by military personnel until relieved by medical personnel on a medical evacuation helicopter, which arrived approximately 20 minutes after the accident. At that time medical personnel were able to detect a faint pulse after the administration of adrenaline. The victim was then transported to the hospital, where he died one and a half hours later.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Power lines should not be used to support communications lines.

Discussion: When using electrical distribution poles to support communication wire, the communication line should be below the lowest power line and there should be a minimum clearance of four feet between the lines. When communication lines are not supported by poles, these lines should be buried when required to cross roads, etc. (see the Department of the Army's Field Manual: Field Wire and Field Cable Techniques). The written policies were adequate for the safe completion of this task; however, the victim did not comply with these policies (i.e., the communications line should have been buried under the road).

Recommendation #2: Training for all communications specialists should address the potential hazards to which they may be exposed while performing their duties.

Discussion: The victim apparently did not realize that the communication wire would become energized as a result of contact with the overhead power line. The tasks performed by communication specialists should be evaluated, hazards identified, and these hazards addressed by training programs for these specialists.

FACE 85-47: Iron Worker Electrocuted in Indiana

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

An apprentice iron worker was being transported in a truck-mounted aerial bucket from his 65 foot high work station to the floor. As the aerial bucket retracted, the victim reached out to push away a ceiling light. The light fixture provided a path to ground and the worker was electrocuted. The source of electricity apparently was a short located at a receptacle in the aerial bucket.

CONTACTS/ACTIVITIES

Officials of the Indiana Occupational Safety and Health Administration (IOSHA) notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. During the week of September 9, 1985, a safety specialist from DSR met with representatives of IOSHA, witnesses, employer representatives, contractor representatives, and the coroner's office. As part of this field evaluation, the evaluator conducted a site visit, interviewed comparison workers, and discussed the incident with the next of kin.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The company was founded in 1961 as a general contractor of commercial, industrial, and institutional construction. Employment levels vary from as many as sixty during peak periods to as few as fifteen during slower periods. The contractor had no recordable injuries in 1985 and had only one lost time injury during the past three years. The job supervisor provides job progress reports to the president of the company. In addition to scheduling and cost, injuries are part of this report. The president of the company was aware that IOSHA provides free consultative services, but the contractor has not used this service.

The company provides each new employee with a sixteen-page safety booklet. Some of the topics covered in the safety booklet are housekeeping, personal protection, hand tools, machinery and equipment, electricity, and cranes and hoisting equipment. Because most iron workers are hired from the union hall, very little training is provided by the contractor. The contractor provides goggles and safety belts. The workers provide all other protective equipment including boots, gloves, and helmets. The workers also provide non-powered hand tools. The employer does not approve or check the equipment furnished by the union workers.

SYNOPSIS OF EVENTS

On July 21, 1985, the 18-year-old victim was hired as an apprentice iron worker. He was assigned to work with his father, the job supervisor. In the six weeks the victim worked as an apprentice iron worker he received no formal training. He was scheduled to enroll in a union-sponsored three year iron worker training program in October, 1985. On September 4, 1985, the victim reported to work at 7:00 a.m. On this job he was working with four journeymen iron workers. At the time of the incident the workers were installing a vertical wind screen (20') in the gable end of an airport hanger (65' high). The job was approximately 40% completed. The twenty gage sheet metal used to construct the screen was 3 feet by 30 feet and weighed 200 pounds. An iron worker on the ground would cut the sheets in half and would hoist the sheet (using a rope and pulley) up to the work crews. Two two-man crews would screw the sheet metal to the metal roof trusses. One crew, which consisted of the victim and a journeyman iron worker, worked from a two-point suspended scaffold. The second crew, which consisted of two journeymen iron workers, worked out of a truck-mounted aerial bucket. This aerial bucket was not designed for use around electrical power lines and had caution labels attached to the boom and the truck.

At 2:00 p.m. the workers began to take a 15 minute work break. As was customary for the past three weeks, the operator of the aerial bucket would swing over to the scaffold, take the two workers on board, and all four workers would be lowered to the ground. As the aerial bucket was descending through the roof trusses, it approached a metal light fixture dangling from the roof. The light was attached to the ceiling by a twenty foot long linked chain. To prevent the aerial bucket from striking the metal light shade, the victim reached out and grabbed the chain. When the victim grabbed the chain, he was electrocuted. A co-worker pulled the victim away from the chain and the victim slumped to the floor of the aerial bucket.

The operator lowered the aerial bucket to the floor and the victim was removed. While the father administered CPR, other workers summoned medical assistance. The EMS arrived within five minutes and transported the victim to a hospital where he was pronounced dead on arrival.

The electrical equipment being used by the contractor was generally in poor condition. Extension cords had poor splices, no grounds, and reversed polarity. One of the two hand drills being used was not grounded and the other drill did not have a safety plate. The receptacle in the aerial bucket had reversed polarity. Additionally, this receptacle had the cover removed. Electricians, who evaluated the accident scene shortly after the accident, stated that the light fixture and chain served as a path to ground and that there was no power to the fixture at the time of the accident. (The circuit breaker would not remain on for more than 10 seconds because of a short in the secondary of the ballast.) The large number of deviations from good electrical practices makes it difficult to determine the precise cause of the short at the receptacle. However, insurance investigators stated that the short could have resulted from contact between the hot lead of the drill and a screw that protruded from the receptacle. Although re-creating a short similar to this was difficult, it was done by evaluators at the scene of the accident and could have resulted from the crowded conditions in the aerial bucket at the time of the accident. Due to the large amount of electrical hazards cited, several other scenarios could also have resulted in creating the short.

CAUSE OF DEATH

According to preliminary medical reports, the immediate cause of death was cardiac arrest due to electrocution, as a result of contact with 110 volts.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should enforce existing regulations concerning the use of electrical equipment.

Discussion: Existing OSHA construction standards (1926.400(h)) requires that employees on construction sites be protected by ground-fault circuit interrupters (GFCI) or have an assured equipment grounding conductor program. This requirement includes tools, extension cords, receptacles that are not a part of the permanent wiring of the building, and other equipment connected by cord and plug that is available for use by employees. This would include the receptacle in the aerial bucket. The receptacle in question was not protected by a GFCI and the employer did not have an assured equipment grounding conductor program.

Recommendation #2: Field modification of equipment should be performed by a competent person and all recognized electrical hazards should be corrected.

Discussion: The plug on the electric screw driver was not making a good contact with the receptacle in the aerial bucket. As a result of the poor contact, the job supervisor removed the thick receptacle cover and replaced it with a thin cork cover. A protruding metal screw securing the cork cover created a hazard when coupled with the electric screw driver plug that did not have a safety plate.

Recommendation #3: Electrical equipment should be maintained in proper working condition.

Discussion: The large amounts of faulty electrical equipment that were being used by the employees made it only a matter of time before an accident occurred. Electrical equipment should periodically be inspected and maintained as necessary.

Recommendation #4: Electrical faults should be corrected immediately.

Discussion: The electrical light fixture had been identified as being faulty for at least five months before the accident. The 20 amp breaker serving the light fixture would not remain on more than ten seconds. Electrical equipment that is not functioning properly should be immediately repaired or replaced.

FACE 85-48: Service Technician Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrically-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 29, 1985, a service technician was electrocuted in the crawl space of a private residence while performing pre-winter maintenance on an oil furnace.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On September 11, 1985, the DSR research team (two safety specialists) conducted a site visit, met with the owner of the company, the assistant county coroner, police detectives, and the OSHA Compliance officer. Photographs taken by police department personnel were examined at the police station. However, photographs of the accident site, co-worker interviews, and the next of kin interview were precluded in this case.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The victim was employed by a firm that installs and services air conditioning and heating systems. The firm employs eleven people and has been in operation for 33 years. The victim was one of four service technicians employed by the firm. The owner of the firm assumed safety responsibilities on a collateral-duty basis. During the interview with the owner, it was learned that the firm had no written safety policy or safety program. Employees of the firm are selected from the graduating classes of two local technical colleges. New employees are trained on-the-job for a period of two to three years by a senior service technician.

SYNOPSIS OF EVENTS

On the day of the incident the victim was to perform pre-winter maintenance on an oil furnace in a private residence. Service technicians receive work orders each morning prior to the start of their shift. Additional work assignments are relayed to the service technicians through a company dispatcher by two-way radios in the service trucks.

The victim arrived at the private residence at approximately 3:00 p.m. The home owner escorted the victim to the back of the residence and pointed out the location of the furnace in the crawl space underneath the house. The owner of the residence then left in his car to run some errands. Upon his return, approximately one and one-half hours later, the home owner noticed the service truck was still in his driveway. The home owner had his oil furnace serviced yearly and the operation usually lasted less than one hour. The home owner became concerned when, after two hours, he heard no noise from underneath the house. He obtained a flashlight from the house, went to the crawl space, and called for the victim. He received no answer and could not see the victim. The home owner then called the firm thinking that one of the victim's co-workers may have picked him up. The owner of the firm arrived at the residence at approximately 6:30 p.m. He entered the crawl space with a flashlight and found the victim on his stomach, leaning on his elbows, in front of the furnace. The assistant county coroner was summoned and pronounced the victim dead at the scene. The victim was then transported to the local hospital by the county rescue squad. Electrical burns were found on the victim's scalp and right elbow.

By order of the assistant county coroner the electric meter was pulled from the house. Once the power to the house was completely disconnected the county electrical inspector, the firm owner, and an electrician from the firm inspected the accident site. A toggle switch attached to a floor joist in front of the furnace was in the off position. With the toggle switch in this position there should not have been power to the furnace. The owner of the firm stated that it was common practice for the service technicians to de-energize a furnace before beginning the maintenance work. From the evidence present at the scene the owner of the firm estimated that twenty minutes of maintenance work had been completed before the victim contacted the energy source. During this initial inspection, the wiring was identified as being "haphazard and confusing." On September 12, 1985, the electric meter was again pulled from the residence and the county electrical inspector and consulting engineers re-entered the crawl space. At this time it was determined that incorrect wiring through the toggle switch that supplied power to the furnace energized the ground lead. This incorrect wiring allowed current to flow to the furnace even though the toggle switch was in the "off" position. The homeowner stated that problems of this sort were never encountered during previous yearly maintenance. The owner of the firm stated that the victim was a very conscientious and meticulous employee. Perhaps the victim performed more thorough maintenance on the furnace than the previous service technicians and in so doing exposed himself to the electrocution hazard.

CAUSE OF DEATH

The assistant county coroner and the medical examiner listed the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should alert employees of hazards that they may encounter performing specific tasks and employees should be provided with the means to determine if these hazards are present.

Discussion: The employer should initiate electrical hazard awareness training that would alert employees of the electrical hazards they might encounter in their workplace (i.e., crawl space). Exposed conductors, open junction boxes, faulty wiring, and proper grounding should be discussed. Service employees, such as in this case, are daily exposed to new and unknown hazards in the workplace (i.e., crawl space). These employees should be trained to recognize all hazards that might be encountered while working in crawl spaces. Once the employees are able to recognize these hazards, they will be able to control them. Employers might also provide employees with instruments that would allow them to detect energized equipment. This would have reduced the risk of serious injury in this incident and should prevent future accidents.

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Recommendation #2: Residential wiring should satisfy the requirements of the National Electrical Code.

Discussion: The residential wiring in this incident was referred to as being "haphazard and confusing" by a member of the inspection team. The improper wiring present in the toggle switch allowed current to flow to the furnace even though the toggle switch was in the "off" position. The electrical system in the residence should be inspected and modified to satisfy the applicable requirements of the National Electric Code. The existence of proper wiring in this incident would have greatly reduced the risk of serious injury. It is recognized that the National Electrical Code is not retroactive; however, the public should be encouraged to periodically review residential systems to assure that a safe system is maintained.

FACE 86-01: Electronics Plant Employee Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On September 19, 1985, an employee of an electronic component manufacturing company was electrocuted while explaining a test procedure to a fellow employee.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A DSR research team (a research industrial hygienist and a physician) visited the site of this fatality in cooperation with North Carolina OSHA officials for the purpose of conducting an epidemiologic evaluation. A meeting was held with representatives of the company and the State Occupational Safety and Health Program compliance officer who investigated this case. The job site was photographed by the NIOSH team. Interviews were conducted with two employees having the identical job classification as the victim. A next-of-kin interview was not conducted.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The company manufactures electronic components and employs approximately 650 workers. About 500 workers are employed in manufacturing departments. The victim worked in the testing department, which employs twenty workers with similar job classifications.

This company employs a manager with collateral duties in both quality assurance and safety. A safety committee also exists with members from both management and labor. Each department has a biweekly meeting, a portion of which is committed to safety. Employees are encouraged to suggest safety topics to be discussed.

This company has a written safety policy which is given to each new employee. It is read and signed by both the employee and the supervisor for which that employee will work. Safety training begins with orientation of the new employee to the manufacturing facility. This is done by supervisors who explain the safety policy and all rules and regulations. The safety training in the testing department then encompasses a three-phase process:

Phase 1: The new employee is paired with an experienced employee to observe the testing process. No actual testing is done by the new employee. This phase lasts approximately one month.

Phase 2: This phase allows the new employee to work along with experienced employees. This is done mostly by the new employee telling the experienced worker what to do prior to the experienced employee performing the task. This phase also lasts about one month.

Phase 3: This phase allows the new employee to do the work while being observed by the experienced worker and varies in length of time needed for completion.

The testing department has a written safety review that is specific to testing. Portions of this review state:

-- Never assume that voltage is not present. Always verify this yourself.

-- Never take anyone's word that voltage is not present. Always verify this yourself.

-- Verify that all applicable electrical disconnects are open, then confirm absence of voltage using a known functioning and calibrated electrical voltage measuring instrument.

Each electronic component requires individualized testing procedures.

SYNOPSIS OF EVENTS

On September 19, 1985, the victim (a 24-year-old male electronic technician) was performing tests on electronic equipment. At approximately 2:30 p.m. , a co-worker asked the victim for direction concerning the proper method to make hook-ups to the bus bars. (The bus bars are conductors that collect electrical current and distributes it to outgoing feeders.) The victim, who had just completed testing an identical component, responded by reaching into the component to indicate the bus bars to which the feeders were to be connected and inadvertently touched two of the bus bars. The victim came into contact with 380 volts. The power was disconnected by a co-worker and the victim dropped back from the equipment. He was treated with cardiopulmonary resuscitation at the testing site and was transported to a local hospital where he was pronounced dead. Burns were noted on fingers of each hand where he had contacted the bus bars.

The victim did not follow standard operating procedures in that he did not verify that voltage was not present. Employees are instructed to assume that voltage is present and to always check for voltage using a known functioning and calibrated electrical voltage measurement instrument. The victim was in his last week of the third phase of his training and had worked for the company six months. He was being observed by an experienced co-worker and should have been familiar with proper testing techniques.

CAUSE OF DEATH

The "official" cause of death is not known at this time since the coroner's report has not been received.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Hazard awareness should be stressed at safety meetings in such a manner that employees are totally cognizant of all energized sources.

Discussion: The company provides equipment, devices, and training to assure safety during electrical testing of components. Basic precautions about working around hazardous voltages are clearly stated in that each employee is responsible for checking that voltage is not present. The company expects work to be discontinued should any questions arise about testing procedures, proper use of electronic equipment, or safety. The victim violated standard operating procedure for reasons unknown.

Recommendation #2: The testing procedure should be evaluated in an effort to eliminate any unnecessary exposure to unguarded live electrical parts.

Discussion: Employees are exposed to live electrical parts in excess of 50 volts during the testing procedure. This procedure varies for the individual system/component being tested and for this reason adequate protection from unguarded live parts can be extremely difficult to implement. However, the testing procedure should be further evaluated in an effort to identify methods to provide adequate safeguards to employees (i.e., interlocks, barriers, the use of automatic test equipment, etc.).

FACE 86-02: **A Journeyman Electrician Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On September 19, 1985, an electrician was electrocuted while making a connection in a 4-inch junction box at a construction site.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A research team (a research industrial hygienist and a physician) visited the site of this fatality in cooperation with North Carolina OSHA officials. A meeting was held with representatives of the company who employed the victim, the victim's foreman, and the North Carolina Occupational Safety and Health Program compliance officer who investigated this case. This meeting was held at the job site. An interview was conducted with the victim's work partner, who witnessed the incident. Interviews were also conducted with two workers with the identical job classification as the victim. A next-of-kin interview was conducted.

OVERVIEW OF THE EMPLOYER’S SAFETY PROGRAM

The victim worked for an electrical contractor that employs 110 employees, thirty of whom work at the job site where the accident occurred. These employees, who are classified as either journeymen electricians or electrician apprentices, normally work in pairs. The victim was considered a journeyman electrician. All journeyman electricians are expected to have had extensive training before they are hired; therefore, no safety training is provided by the employer. The foreman at the job site is responsible for job site safety and he conducts weekly safety meetings where various safety issues are discussed.

The job foreman and job manager were not aware of any safety problems in the past. The company apparently did not have a written safety policy.

SYNOPSIS OF EVENTS

The construction site is a large office building in a corporate office park. Interior wiring was being completed by the electrical contractor.

On September 19, 1985, the victim was pulling electrical wire for the 277 volt emergency back-up lighting system. This task required the installation of a 4-inch junction box in the ceiling. At approximately 8:15 a.m., the victim was standing on a wooden ladder preparing to strip a "hot wire." The victim's partner told him the wire was hot; the partner is certain that the victim understood his warning. (Interviews with the foreman and other electricians revealed that making connections while the wires are "hot" is not an unusual practice and may be done fifty percent of the time.) The co-worker walked away from the victim to complete other work. A short time later the partner heard a groan. He ran back, stepped up on the ladder that the victim was using, and attempted to pull him down. The victim appeared to be caught on the metal support bars for the drop ceiling. Unable to pull the victim down, the partner kicked the ladder out from under him. The victim then fell to the floor.

Cardiopulmonary resuscitation was started at the accident site and was continued by emergency medical personnel. The victim was pronounced dead at a local hospital. Burns were noted on the victim's right thumb where he apparently contacted the metal of the stripping tool. Another burn was noted on the left lateral chest wall.

CAUSE OF DEATH

The "official" cause of death is not known at this time since the coroner's report has not been received.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Wiring should not be done while the lines are energized.

Discussion: The victim was working with an energized wire. It is apparent that this is not an unusual work practice among electricians. Had the system been de-energized, this fatality would not have occurred.

Recommendation #2: The company should develop and implement a comprehensive occupational safety program.

Discussion: Worker safety is a primary responsibility of employers. In order to optimally carry out this responsibility, an employer should: 1) develop a company policy which expresses management's commitment to providing a safe workplace, and 2) develop, document, and enforce the adoption of safe work procedures and practices for all employees.

Recommendation #3: Upon initial hiring and at regular intervals thereafter, all workers and supervisors should receive training in hazard recognition and safe work practices.

Discussion: Workers who perform hazardous tasks, who work at precarious work stations, and/or who work in close proximity to sources of hazardous energy can develop a cavalier attitude over time. Therefore, it is particularly important that not only apprentice workers, but also experienced and highly skilled workers, be trained in hazard identification, safe work practices, and emergency response; this training should be periodically repeated.

Recommendation #4: When hiring personnel, who are expected to perform jobs or tasks which present high risk, experience should be verified and skill level (with particular regard to company safety practices) should be determined.

Discussion: The field evaluation of this incident did not identify this problem area as contributing to this accident; however, several similar accidents have identified employees that were hired to perform hazardous activities that had not been adequately trained and the employers were unaware of this lack of training. It is in the best interest of the employer to determine (i.e., by certification, training, or demonstration) that newly hired employees can safely complete the duties assigned.

FACE 86-03: **Electric Company Lineman Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On September 26, 1985, a 35-year-old electric company lineman was electrocuted while installing a guy wire to a utility pole.

CONTACTS/ACTIVITIES

Officials of the Indiana Occupational Safety and Health Administration (IOSHA) notified DSR of this fatality and requested technical assistance. This case has been included in the FACE Project. On October 9 and 10, 1985, a safety specialist conducted a site visit, interviewed comparison workers and the next of kin, and met with an employer representative. The incident was discussed with the IOSHA compliance officer and the vendor of the aerial truck. Photographs were taken of the accident site.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The electric company (a rural electric cooperative) employs 46 people and supplies electricity to 16,000 customers within a 2000 square mile area. The company's incident and severity rates are higher than the "electric services" industry rate. The company has an improving safety record.

The employer has developed and distributed a comprehensive safety manual to each employee. However, since responsibility for the safety program has not been established, the safety function is not managed. All linemen must complete a five year apprenticeship program. The program provides new employees an opportunity to identify, evaluate, and control hazards associated with electricity.

SYNOPSIS OF EVENTS

A four-man crew (a foreman, a groundman, a lineman, and the victim - a lineman) was installing a conductor between two adjacent poles. The span between the two poles was 341 feet. The potential voltage was 7200 volts to ground. Truck mounted aerial buckets were used by the victim and the foreman to work on their respective poles.

The pole on which the victim was to attach the conductor supported a three-phase power system. This three-phase power system was located in the immediate vicinity of the victim's work area and ran perpendicular to the conductor being installed by the victim and the foreman. During this construction activity all conductors between the two poles were de-energized and the bottom phase of the three-phase power system was covered with an insulated rubber line hose. After the victim connected the conductor to the pole he energized the lines and lowered the aerial bucket to the ground. The victim was then to connect a guy wire from the pole to a ground anchor. After attaching the guy wire to the ground anchor, the victim attached the guy wire to the outside of the aerial bucket and raised himself into position to attach the guy wire to the pole. At the time of the incident the victim was not wearing insulated gloves or sleeves although both were present in the aerial bucket.

Witnesses stated that as the victim maneuvered the bucket into position, the front section of the aerial boom contacted an energized conductor. The groundman, cleaning excessive dirt from around the ground anchor, heard an arc, looked up, and asked the victim if he were all right. The victim stated that he was fine. The groundman looked up a second time, could not see the victim in the aerial bucket, and immediately summoned the foreman. Upon hearing the groundman, the foreman looked up and saw the end of the boom "in or near" an energized conductor. He could not see the victim in the aerial bucket and assumed that the victim's truck was energized. The foreman instructed the lineman working with him to open the circuits and to park their truck parallel to the victim's truck. Once this was accomplished, the foreman jumped from his truck to the victim's truck and proceeded to lower the bucket. At this time the local ambulance was called. The victim was removed from the bucket and placed on the ground where CPR was administered by co-workers until the ambulance arrived. The victim was transported to a local hospital where he was pronounced dead on arrival.

The pathologist report indicates that burns present on the victim's back are compatible with an entrance wound. Burns on the victim's hands indicate that the fingers were wrapped around an object. Apparently, the victim's back contacted a live conductor (possibly an exposed hot clamp connected to the bottom phase) while grasping the guy wire in his hands. The current flowed through him down the guy wire to ground causing his electrocution.

CAUSE OF DEATH

Accidental Electrocution

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees working from aerial trucks should position their truck so that they are not required to work through power lines to perform the work task.

Discussion: The victim's truck was parked on a macadam road opposite the working area of the utility pole. To attach the guy wire to the pole the victim (standing in the bucket) had to pass under the primary line and elevate the boom. The truck could have been parked in an open field facing the work area.

Recommendation #2: Employees working with energized conductors should wear required personal protective equipment.

Discussion: OSHA standards require employees to wear protective equipment when working around electrical hazards (1910.132). These standards identify specific types of insulated protective equipment to be worn by electrical workers (1910.137). Protective equipment includes insulating gloves, blankets, hoods, line hose, and sleeves. Had the victim been wearing insulated gloves, he may not have been electrocuted. Rubber gloves and sleeves were found inside the aerial bucket. As part of this accident investigation, several power companies were asked if operators of aerial buckets had dexterity problems while wearing insulated gloves. The three companies surveyed reported their workers had no problems operating an aerial bucket while wearing insulated gloves.

Recommendation #3: Employees should recognize all possible phase-to-phase or phase-to-ground contact.

Discussion: Apparently, the victim's back contacted an exposed hot line clamp that was connected to the bottom phase of the main line. Either the victim was not aware of the location of the hot line clamp or he did not recognize the danger associated with the hot line clamp when working with energized conductors. Employees working around power lines should be continually reminded of the dangers associated with any potential phase-to-phase or phase-to-ground contact.

Recommendation #4: All exposed conductors, clamps, etc. should be covered with rubber hoses, boots, or blankets.

Discussion: Although the bottom phase of the three-phase power system had been covered with a rubber line hose by the victim, exposed live conductors such as a hot clamp connected to the bottom phase were very close to the victim's work area. All exposed conductors in contact distance within a work area must be covered to eliminate the occurrence of an accident.

Recommendation #5: The procedure for the installation of guy wires to utility poles should be further evaluated.

Discussion: Attaching the guy wire to the ground anchor before attachment to the pole established a direct path to ground and a hazard because of the close proximity of live conductors. Connecting the guy wire to the pole prior to connecting it to the ground would eliminate a potential path to ground. Additionally, it may be beneficial to connect guy wires while power is disconnected or before construction, maintenance, or repair is begun (a procedure similar to that used for a new pole).

FACE 86-04: Electric Company Employee Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 19, 1985, a power line trouble-shooter was electrocuted while attempting to open a pole-mounted, ground-level air switch on a three-phase, 69 kV power line.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On October 18, 1985, a safety specialist met with employer representatives and discussed the incident with the OSHA compliance officer and the safety consultant for the Industrial Commission of Ohio. Co-worker and next-of-kin interviews were precluded in this case.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electric power company serving a 9000-square-mile area that includes two states and employs approximately 7500 people. A written safety policy has been developed and implemented. A safety professional is present at each branch office and a contact for safety-related issues is provided at corporate headquarters. The company promotes safety through the use of periodic job safety analysis, safety meetings, and monthly training sessions. Training in CPR and defensive driving are also provided.

SYNOPSIS OF EVENTS

The three-phase, 69 kV transmission line involved in the incident connects two divisions of the company. This line is approximately 28 miles long and serves three company substations and five customer stations. Because access to an air switch (approximately at the midpoint of the line) was difficult, it had been removed from service. A new switch was relocated the week before the accident. The relocated air switch was installed on a more accessible pole at ground level (approximately eight-tenths of a mile north of its previous location). Each of the individual phases were controlled by a separate pole-mounted air switch assembly, located with each phase at the top of the pole. The middle phase of the three-phase, 69 kV transmission line was attached to the side of the pole opposite the other two phases. The three pole-mounted air switch assemblies were bonded together and connected to a common ground wire that ran down the pole to a ground rod at the base of the pole. The handle of the new air switch was also connected to this common ground. Company standards state that pole-mounted air switch assemblies should not be grounded, and that the air switch handles should be grounded independently. The foreman of the crew involved in the relocation of the air switch had misinterpreted the air switch blueprint. A vertical line that represented the center line on the pole was present on the blueprint. The foreman thought that this vertical line represented the ground wire and used the ground wire as a common ground for the air switch assemblies.

On the day prior to the incident, the victim closed the new air switch and opened a switch controlling a customer tap at the old location. This switching was performed so that work might be completed on the customer tap. The next day when work was completed on the customer tap, the victim closed the switch at the customer tap, then proceeded to the relocated air switch location. When the victim grabbed the handle of the relocated air switch, he was electrocuted.

Evidence present at the site indicated that a "flashover" arc occurred between the middle phase of the transmission line and its pole-mounted air switch assembly. This contact caused a fault current to flow down the common ground wire on the pole. At an undetermined point in time the common ground wire burned off at the ground rod at the base of the pole. This broken connection interrupted the path to ground for the current. The victim supplied a path to ground when he grabbed the handle. (Since the incident, the company recommends the use of rubber lineman's gloves and overshoes when operating pole-mounted switches and is studying the feasibility of placing ground mats at the base of poles with air switches. Additionally, the company has developed a form to assist personnel inspecting newly installed air switches.)

CAUSE OF DEATH

The deputy coroner ruled electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should have qualified personnel inspect new installations prior to entering them into service. This will assure adherence to company and manufacturer's standards.

Discussion: Prior to entering newly installed air switches or other systems into service, an inspection should be conducted by engineering personnel or other qualified personnel to assure compliance with company and manufacturer's standards. These inspections should identify and immediately correct any hazardous conditions present. Had this installation been inspected, the improper technique used to ground the pole-mounted air switch assemblies could have been identified and corrected. If the air switch handle had been independently grounded, the risk of fatal injury would have been greatly reduced.

Recommendation #2: Employers should assure that personnel involved in the installation of air switches, or any other pole assemblies, fully understand the blueprints from which they are working.

Discussion: Training should be implemented for all personnel involved in the interpretation of mechanical drawings or blueprints. This training should stress the proper identification of symbols used in mechanical drawings and blueprints. Additionally, engineering might review any mechanical drawing or blueprint to be used and label or identify any vague portion to diminish the chance of misinterpretation. Had the blueprint in this incident been interpreted correctly this incident would have been prevented.

FACE 86-05: School Maintenance Worker Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 11, 1985, a school maintenance worker was removing obsolete wiring from a room beneath the football field grandstand. A 15-foot section had been cut out and removed. A small section behind a 2400-volt transformer remained. In the process of removing this section, the maintenance worker apparently contacted one of the wires to the transformer. The victim walked approximately 10 feet to a room that a co-worker was cleaning, said "I got electricity," and fell on his face.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On October 16, 1985, the DSR research occupational health nurse met with the district superintendent of schools. The accident site was visited and photographed; however, significant changes had been made since the accident occurred. Since there was no comparison worker in the school district, this aspect of the study was precluded.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The employer is a school district that employs approximately 100 people, 77 of which are professionals. There are six custodians. One of these, the victim, also served as the maintenance advisor to the superintendent. The victim informed the superintendent of any maintenance problems. Major maintenance is contracted out.

There is no formal safety program in the school district. There is "safety awareness," as is demonstrated by locked doors to hazardous areas, warning signs, and safe work procedures.

SYNOPSIS OF EVENTS

Several years prior to the accident, a light pole at the stadium had been replaced. In the process of changing the light system, a large cable was disconnected from the system, but left in place. It is not known why the victim decided to remove this cable on the day of the accident; however, the victim and the stadium maintenance man proceeded to cut the 3-inch cable with a hacksaw. They removed a 15-foot section and carried it outside. The victim then stated that he wanted to remove the remaining piece of cable. The stadium maintenance man commented that it was just a small piece and suggested that he let it go. The victim re-entered the transformer room by himself.

Because there were entrance/exit wounds on the bottom of the left upper arm and both hands, it is assumed that the victim had taken the cable in both hands and, while attempting to remove it from behind the transformer, inadvertently contacted one or more of the wires to the transformer. After being shocked,

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the victim walked out of the transformer room and into the equipment room (approximately 10 feet). He told the stadium maintenance man that he had "got electricity" and then fell to the floor on his face. The maintenance man turned him over and immediately called the principal of the nearest school.

The school nurse was sent to the stadium and began CPR within five minutes of the accident. The "first response" ambulance arrived and took over CPR until the paramedic ambulance arrived. The victim was given IV medications, an esophageal airway, and electrical shock at the site. Treatment continued enroute to the hospital and in the emergency room. The maintenance worker was pronounced dead without regaining consciousness.

CAUSE OF DEATH

The official cause of death is not known at this time, since the coroner's report has not been received.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Maintenance on or in close proximity to high-voltage transformers should not be performed unless the power supply of the transformer has been completely disconnected and locked out.

Discussion: The victim, an employee of the school system for 23 years, was aware of the hazardous energy sources in the transformer room; however, he elected to work in close proximity to the hazard. Any loss of balance or footing or inattentiveness to the task could cause direct contact with the hazard. Because avoidance of the hazard is the most efficient means of preventing an accident, the importance of having the power to the transformer completely disconnected and locked out must be continuously reinforced.

Recommendation #2: All hazardous energy sources should be guarded to prevent inadvertent exposure to the hazard.

Discussion: The transformers were in a locked room that was accessible only to a minimal number of employees; however, the power source itself (the transformer cables) were not guarded in any way. Inadvertent exposure to this source can only be prevented by a guard.

Recommendation #3: A safety program designed to recognize and correct hazards and to enforce procedures designed to prevent accidental injuries and illnesses should be developed.

Discussion: Although several high risk procedures have been identified and appropriate control procedures have been developed, the school district does not routinely identify hazards, provide training in hazard recognition and awareness, or enforce safe work procedures. A comprehensive safety program should be developed.

FACE 86-06: **Three Electrocuted on Farm in Georgia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 18, 1985, three men (the owner and two employees) on a small farm were moving a grain auger when it contacted a 7200 volt power line. All three workers were electrocuted. THIS INCIDENT IS ALMOST IDENTICAL TO FACE-86-7.

CONTACTS/ACTIVITIES

Officials of the Georgia Department of Human Resources notified DSR of these fatalities and requested technical assistance. This case has been included in the FACE Project. A research team (a medical officer and a research industrial hygienist) met with the local sheriff at his office and discussed the triple fatality. The sheriff requested that "no investigation" of the site be conducted for reasons that were not explained. The manager of the local power company was interviewed. The sheriff and the manager of the power company provided minimal information.

BACKGROUND/OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The farm (less than 200 acres) is a small family operation, employing two or three extra workers at harvest time. The owner of the farm (a 61-year-old male) usually worked the farm with his son. At the time of the accident two extra workers (a 21-year-old male and a 49-year-old male) were hired on a part-time basis The farm had no written safety policy.

SYNOPSIS OF EVENTS

On October 18, 1985, at approximately 8:00 a.m. two farm workers and the owner were moving a portable grain auger when the accident occurred. The auger is approximately 50 feet long, has inflatable-type car tires, and weighs several hundred pounds. The auger can be raised or lowered by a hand crank that is attached to a steel cable pulley system. Common practice for moving the auger is to have it lowered for stability (with the auger in the raised position it is unstable). The auger was to be moved from a grain bin, which is approximately 30 feet high to a different location to load grain on a truck. To move the auger it must be raised higher to allow the top flap to clear the bin and allow the bottom to telescope out of the ground loading ditch. It is estimated that the auger was raised to a height of 35 feet to enable the workers to back it away from the dryer bin. The workmen were positioned around the rear of the auger to move it to the new location.

The workmen lifted the rear of the auger and pulled it back approximately 15 feet from the grain bin. At this point the auger was on a 45^0 angle. The workmen then swiveled the rear of the auger 90^0 to allow a straight path to the truck that was to be loaded with grain. However, approximately 40 yards straight ahead of the auger (at an elevation of 25 feet) was a 7200 volt power line. As the workmen pushed the auger forward, it went between the 7200 volt primary and the neutral, contacting the primary line. All three workers were electrocuted.

CAUSE OF DEATH

The Coroner's report is not available at this time.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should identify safety hazards that may be encountered on the farm.

Discussion: A survey of the farm should be completed that identifies hazards. These hazards should be discussed with the workmen (i.e., the location of overhead power lines, etc.). Necessary precautions should be stressed to all farm personnel.

Recommendation #2: Employers should stress safe movement of farm equipment.

Discussion: Equipment that is moved to different locations on the farm may present a safety hazard, especially when moved under power lines. All equipment (augers) should be lowered to a safe transporting position before being moved from one location to another.

FACE 86-07: Two Electrocuted on Farm in Georgia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 14, 1985, workmen on a large farm were in the process of moving a grain auger when it contacted a 7200 volt power line. Two workers were electrocuted and three other workers were injured. THIS INCIDENT IS ALMOST IDENTICAL TO FACE-86-6.

CONTACTS/ACTIVITIES

Officials of the Georgia Department of Human Resources notified DSR of these fatalities and requested technical assistance. This case has been included in the FACE Project. A research team (a medical officer and a research industrial hygienist) visited the site of this double fatality in cooperation with the local county sheriff. A meeting was held with the local sheriff and the research team visited the accident site accompanied by a deputy. An interview was conducted with the farm operator and a farm worker. The site was photographed by the NIOSH team.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The 10,000 acre farm is leased by a local farmer and employs from 4 to 8 workers, depending on the season and the crop to be planted or harvested. One of the victims (a 39-year-old male) had been employed at the farm for approximately 8 years. The other victim (a 30-year-old male) had worked for the farm operator previously; however, this was his first day back to work for the farm operator.

The farm operator has no written safety policy. Safety is left up to common sense among the farm workers.

SYNOPSIS OF EVENTS

On October 14, 1985, at approximately 10:00 a.m. five farm workers were in the process of moving a portable grain auger when the accident occurred. The auger is approximately 60 feet long, is mounted on inflatable-type car tires, and weighs several hundred pounds. The auger can be raised or lowered by a hand crank that is attached to a steel cable pulley system. Common practice for moving the auger is to have it lowered for stability (with the auger in the raised position it is unstable). The auger was to be moved from the grain drying bin, which is approximately 30 feet high, to a different location. To move the auger it had to be raised to allow the top flap to clear the bin and to allow the bottom to telescope out of the ground loading ditch. It is estimated that the auger was raised to a height of 35 feet to enable the workers to back it away from the dryer bin. The five workmen were positioned around the rear of the auger to move it to the new location.

The workmen lifted the rear of the auger and pulled it back approximately 15 feet from the grain bin. At this point the auger was on a 45^{o} angle. The workmen then swiveled the rear of the auger 90^{o} and began pushing the auger to the new location. However, approximately 30 yards straight ahead of the auger at an elevation of 25 feet, was a 7200 volt power line. As the workmen pushed the auger forward, it went over the 7200 volt primary, contacting the line. Two workmen were electrocuted and the other three workmen were injured.

It was reported that the three workers, who survived the incident, were wearing new rubber soled shoes and that the two workers, who were killed, were wearing leather shoes in poor condition.

CAUSE OF DEATH

No autopsies were performed. Cause of death for both victims was listed as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should identify safety hazards that may be encountered on the farm.

Discussion: A survey of the farm that identifies hazards should be completed. These hazards should be discussed with the workmen (i.e., the location of overhead power lines, etc.). Necessary precautions should be stressed to all farm personnel.

Recommendation #2: Employers should stress safe movement of farm equipment.

Discussion: Equipment that is moved to different locations on the farm may present a safety hazard, especially when moved under power lines. All equipment (augers) should be lowered to a safe transporting position before being moved from one location to another.

FACE 86-08: **18-Year-Old Electrician's Apprentice Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 28, 1985, an 18-year-old electrician's apprentice was electrocuted when he attempted to work on an energized 277 volt lighting system at a newly constructed industrial park complex.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A safety specialist met with the state compliance officer, the company president, and co-workers of the victim. A next-of-kin interview was conducted.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical contractor and employs 43 persons. The company was established in 1958, but has been operating for the last five years under the present management. The company has no safety program and its president is the only state certified electrician employed by the company. All other employees received their electrical training in high school vo-tech classes or through on-the-job training. It is a common company practice to perform electrical work on energized electrical systems.

SYNOPSIS OF EVENTS

On October 28, 1985, two employees of the company (the victim and his supervisor) were in the process of relocating overhead junction boxes for a lighting system in a newly constructed industrial park complex. The initial electrical work at the complex was not done by this company. The two men were working in the same room while another contractor was installing dry wall in an adjacent room.

At approximately 9:30 a.m. the victim was standing on a fiberglass ladder and had just completed the connection on a 277 volt energized system. He proceeded to secure the connection with wire nuts when he came in contact with the uninsulated wires. He descended the ladder, took three steps, and collapsed. The supervisor called for help and the dry wall workers from the adjacent room immediately responded and began performing CPR on the victim.

The victim could not be revived. A burn wound on the victim's index finger suggested point of entry.

CAUSE OF DEATH

The coroner's report is not available at this time.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical work should not be performed on energized systems.

Discussion: Work was being performed on the electrical system while it was energized. Disconnecting the source of the power supply before working on the system would have prevented this fatality. Working on energized systems is not recommended even if working conditions appear to be ideal. This was not the case. The only source of working light in the room was the sunlight. Glare from the sun could have hampered the victim. The dry wall work also created a considerable amount of dust that limited visibility.

Recommendation #2: The employer should develop a written safety policy and a safety program.

Discussion: The company does not provide training in safe work procedures nor are there any rules or written policies governing safe electrical installations. None of the benefits that a safety program would provide (i.e., training, hazard identification, personal protective equipment, and safe operating procedures) were utilized. This is evident by the poor safety record for 1985 (290 lost work days excluding this fatality).

Recommendation #3: Employers should determine the capabilities of employees prior to job assignment and employees should be assigned tasks that they are qualified to perform.

Discussion: The victim had been employed by the company for approximately three months. He had received no previous electrical training and on-the-job training was very limited. In spite of his limited training, he was expected to perform the same work tasks as more experienced employees within this company. Employers should determine employee capabilities prior to job assignment and only tasks within those capabilities should be assigned.

FACE 86-09: Lineman Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 4, 1985, a lineman was electrocuted while working from an aerial-bucket truck when he came in contact with a 13.2 kV power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On December 17, 1985, the DSR Research Team Coordinator met with employer representatives, the North Carolina Occupational Safety and Health Program compliance officer, conducted a site visit, interviewed comparison workers, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim worked for a power company that employs 9579 employees, 60 of whom work as linemen in the district of the accident site. The victim was classified as a first-class lineman. All linemen are required to attend a lineman training school conducted by the company. The company has a written safety policy and program with a safety and health manager and 17 safety and health professionals. Safety training is accomplished by on-the-job training, simulation, and classroom courses with outdoor training activities. Safety committees are located at each of the company locations and meet monthly. All accidents are investigated at the local and corporate level.

SYNOPSIS OF EVENTS

On November 4, 1985, the victim (a 34-year-old male, first-class lineman) was attempting to install a 37.5 KVA transformer on a new pole. The new pole was installed next to the old pole and the 13.2 kV primary conductor had been transferred to the new pole. A "stirrup" (U-shaped connector) had been clamped to the primary conductor. The "stirrup" is used to connect the transformer input wire to the primary conductor. The primary conductor (including the "stirrup") remained energized during the transformer installation. An insulated line hose covered the conductor, but part of the "stirrup" remained exposed. The victim was working from the insulated bucket of an aerial-bucket truck; however, the aerial-bucket truck was not grounded per standard operating procedure. The transformer was attached to the hook of the steel cable rigging on the boom of the aerial-bucket truck. The victim was trying to install the transformer onto the two bracket bolts on the pole and was having difficulty because the bolts did not properly align with the holes on the transformer bracket.

As the victim was guiding the transformer with his right hand and operating the controls with his left hand, he contacted the "stirrup" of the primary conductor. His body was leaning over the steel cable rigging assembly when he contacted the "stirrup," which was only 2 feet 4 inches from the top of the bucket. The electricity entered his left shoulder and exited through his chest, into the steel cable of the rigging assembly, and to ground through the aerial-bucket truck. The victim was in contact with the power line for 10-20 seconds.

A co-worker, who was removing a tool belt from the truck at the time of the accident, was also injured due to electric shock. Two other co-workers were within the vicinity of the truck, but were not injured.

CAUSE OF DEATH

The coroner determined that the cause of death was due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All energized conductors and any connections to these conductors should be covered with insulating line hoses or blankets to assure proper protection for anyone working near these conductors.

Discussion: The insulating line hose in this situation did not completely cover the "stirrup." In addition to the line hose, an insulating blanket should have been wrapped around the exposed "stirrup."

Recommendation #2: The aerial-bucket truck should have been properly grounded.

Discussion: The aerial-bucket truck should have been grounded to the distribution system in order to provide protection for anyone near the truck (in case of a ground fault through the truck).

Recommendation #3: During transformer installation, the transformer should be raised to the proper installation height and then a worker positioned on the pole should guide the transformer onto the installation bolts, for a work situation such as involved in this accident.

Discussion: In this accident, the victim in the bucket was in an awkward position (leaning out of the bucket) in order to install the transformer. This placed him within a 2 feet 4 inch area near the primary conductor. A person on the pole would be in a better position to install the transformer and would be at a safe distance from the primary conductor.

FACE 86-11: Two Electrical Contractor Employees Electrocuted in Kentucky

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 18, 1985, two electrical contractor employees (a crew foreman and lineman) were electrocuted while installing electrical service to a mobile home.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Kentucky notified DSR concerning these fatalities and requested technical assistance. This case has been included in the FACE Project. A DSR research team (two safety specialists) visited the site of these fatalities in cooperation with Kentucky OSHA officials. A meeting was held with representatives of the company and co-worker interviews were conducted. Photographs were taken of the accident site and a next-of-kin interview was conducted.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This company has been in operation and under the present ownership for the past 40 years. The company is an electrical contracting firm that operates in fifteen states and employs 1300 people.

A written safety policy and safety programs have been developed and implemented. The staff of the safety department consists of a safety professional and two full-time, safety assistants. Field supervisors are held accountable for safety at the various field office locations. The company promotes safety through the use of safety evaluations, communications, and incentive programs.

SYNOPSIS OF EVENTS

On November 18, 1985, at approximately 7:30 a.m. a three-man crew (a crew foreman, lineman, and groundman) arrived at a private residence to install electrical service. At approximately 1:40 p.m. the crew had covered all three power lines with insulating hose, set a mid-span pole, and attached a cross bar to that pole in preparation for the installation of a transformer. The crew foreman and lineman were working from the bucket of an aerial truck while the groundman assisted them from the ground. After the crew foreman and lineman finished attaching the cross bar to the pole, they removed the insulating hoses from the power lines.

As the victims attempted to lower the bucket to attach a neutral bracket to the pole, the bucket raised bringing the victims into contact with the power lines (34.5 kV phase to phase - 19.9 kV phase to ground). Contact points were visible on two of the three power lines. After an undetermined amount of time, the groundman became aware of the problem and lowered the bucket containing the victims to the ground.

The victims were burned beyond recognition and were pronounced dead at the scene of the accident by the local deputy-coroner. An investigation by a representative of the boom manufacturer revealed that the upper boom "down" hydraulic line contained air. This could prevent the downward movement of the upper boom. Additionally, the design of the controller is awkward and may have been a major contributing factor in this incident. The operator may have been moving the controller from the down to the up position, repeatedly (rocking) the controller in an effort to lower the boom. By rocking the controller the operator was trying to free the boom so that it would operate properly.

CAUSE OF DEATH

The deputy coroner ruled electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should emphasize the importance of employees following safe job procedures. These procedures should include the identification and repair of defective equipment in accordance with the company's safe job manual.

Discussion: Since the possibility of faulty equipment may have contributed to the cause of this accident, employees must be aware of and follow all safe job procedures, as defined in the company's safe job manual. It is the responsibility of the employer to train all employees involved with aerial trucks so that they are aware of proper testing of control systems and proper work procedures. These procedures must be closely followed at all times.

Recommendation #2: The boom control system should be further evaluated to determine that human factor engineering considerations are addressed.

Discussion: Although this incident may have occurred because the upper boom was not operating properly (i.e., could not be lowered), the design of the controller appears to increase the potential for an operator error. One lever controls all movements of the boom. Lifting the lever up raises the boom while pushing the lever down lowers the boom. This single action control may not adequately prevent incorrect operation, when one considers that an incorrect movement could move the operator into contact with high voltage lines. DSR personnel will evaluate the controls of all aerial bucket trucks involved in future FACE evaluations to determine if this problem is widespread.

FACE 86-14: **21-Year-Old Technician Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On February 17, 1986, a plastic extrusion machine operator was electrocuted after he re-energized the corona treater on his machine. (This process is described in detail as part of the Synopsis of Events.)

Because FACE researchers were unavoidably delayed in responding to this incident, the evidence concerning the accident and the equipment involved were significantly altered by the time this FACE field evaluation was conducted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On March 18, 1986, the DSR Research Team (a safety specialist and a safety engineer) met with employer representatives, conducted a site visit, interviewed comparison workers, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim had been employed for eight months by a plastic extrusion company that employs 175 workers in three plants. In 1984 and 1983 the company employed 125 and 92 workers, respectively. The company does not have a written safety policy or program. The manager of manufacturing is assigned safety responsibility on a collateral-duty basis and spends between 5%-10% of his time on these duties. The safety committee consists of employees from all three plants and its membership consists of management, supervisors, and employees. The committee meets every six weeks to inspect the facilities and discuss the hazards identified.

All new employees are given a brief orientation and are assigned to a supervisor from the production area. The supervisor provides on-the-job training. Based upon the workers compensation experience modification rate, the company has reduced work-related injury costs over the past three years and is rated slightly better than the industry as a whole.

SYNOPSIS OF EVENTS

On February 16, 1986, the victim (a 21-year-old male, plastic extrusion machine operator) worked the third shift (midnight to eight a.m.). The victim's machine was equipped to provide a corona treatment to plastic sheeting. Without this treatment it is not possible to print on the plastic sheet. The corona treatment is accomplished by charging a steel treater bar with a D.C. current. A grounded conductive roller is located near to the treater bar, so that a corona is established between the roller and the bar. The plastic sheet is passed through this corona. This treatment does not visibly change the sheet's appearance. Two treater bars (one above and one below the sheet) are used in this process. Each treater bar has height adjustment screws so that a gap of .055 inch can be maintained between the bar and the surface being treated. (See attached figure.) The plastic treater is designed to operate at 9600 Hz. This is accomplished by converting the three-phase input to DC and inverting the DC to a high frequency sinusoidal output. This high frequency output is then fed to the high voltage transformer (10 kV) and stepped up to a level sufficient to initiate and maintain an adequate corona for the process.

The victim operated the machine without incident until 7:45 a.m. at which time the corona treater was de-energized while a maintenance man installed a bonding strap from the machine to a nearby electrical panelboard. To make the connection safely, the maintenance man de-energized the transformer that supplied power to the treater bars. However, the extrusion machine remained energized. As a result, the plastic sheet was being extruded from the machine, but the sheets were not receiving the corona treatment. After the maintenance man connected the bonding strap, the victim re-activated the transformer. While standing on a metal step on the operator's side of the machine, the victim touched the treater wire/cable or the treater bar with his right hand and came into contact with a potential 10 kVDC, 9600 Hz source of electricity.

The victim fell to the concrete floor. Two co-workers administered CPR until the EMS arrived. He was transported to a county hospital where he was pronounced dead one hour later.

CAUSE OF DEATH

The Coroner reported that the cause of death was due to electrocution and reported entry wounds on the back of the victim's right hand and exit wounds on his right foot.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Insulated conductors supplying power to this equipment should be enclosed in accordance with the manufacturer's recommendations to assure proper protection for anyone working near these conductors.

Discussion: The treater wire from the transformer to the upper treater bar and the jumper from the upper treater bar to the lower treater bar were insulated, but were not enclosed in 4" grounded aluminum conduit with acrylic supports inside the conduit (as required by the manufacturer). Additionally, the treater wire was not certified by the wire manufacturer for this application. The upper and lower treater bars should be partially enclosed to prevent personnel from coming in contact with the high voltage. A commonly used practice is to enclose the bars in a 3" PVC tube with the ends capped. (The requirement to enclose the treater bar was addressed at the time of the FACE field evaluation.) The employer did not have an owner's manual for the equipment and the equipment was not installed in accordance with the manufacturer's specifications.

Recommendation #2: The company should develop and implement a comprehensive occupational safety program.

Discussion: Employee safety is a primary responsibility of employers. In order to carry out this responsibility, an employer should:

1) Develop written company safety policies and procedures;

2) Provide training in job procedures, including hazard identification;

3) Correct recognized hazards;

4) Conduct periodic inspections of the facility and evaluations of the safety program; these inspections/evaluations should be performed by qualified safety personnel;

5) Encourage employees to identify and report all hazardous conditions and accidents, including close calls; action should be taken to correct those conditions determined hazardous.

Numerous safety problems were observed during the site visit. This suggests that a comprehensive safety program is needed. Field evaluators received several reports that employees were routinely "tingled" (shocked) when they contacted conductors, but management had taken no action to resolve these problems.

Recommendation #3: After making adjustments/modifications to equipment or processes, maintenance personnel should test the equipment to assure that the equipment is operating safely before placing the equipment back into service.

Discussion: Maintenance personnel apparently did not verify that the equipment was operating properly prior to placing it back in service. Although it is doubtful that the installation of the bonding strap played a major role in this fatality, testing of equipment prior to its being placed back in service is a good work practice.

Recommendation #4: Personnel should be adequately trained and equipped to install, operate, maintain, and repair plastic extrusion and corona treater equipment.

Discussion: Corona treater equipment requires the use of high voltage electricity. Maintenance personnel and machine operators require a certain level of expertise to install, maintain, repair, and operate this equipment. The manufacturer suggests that specific pieces of test equipment be available for these functions. The employer should provide test equipment and should insure that personnel are trained properly concerning the maintenance and use of this equipment.

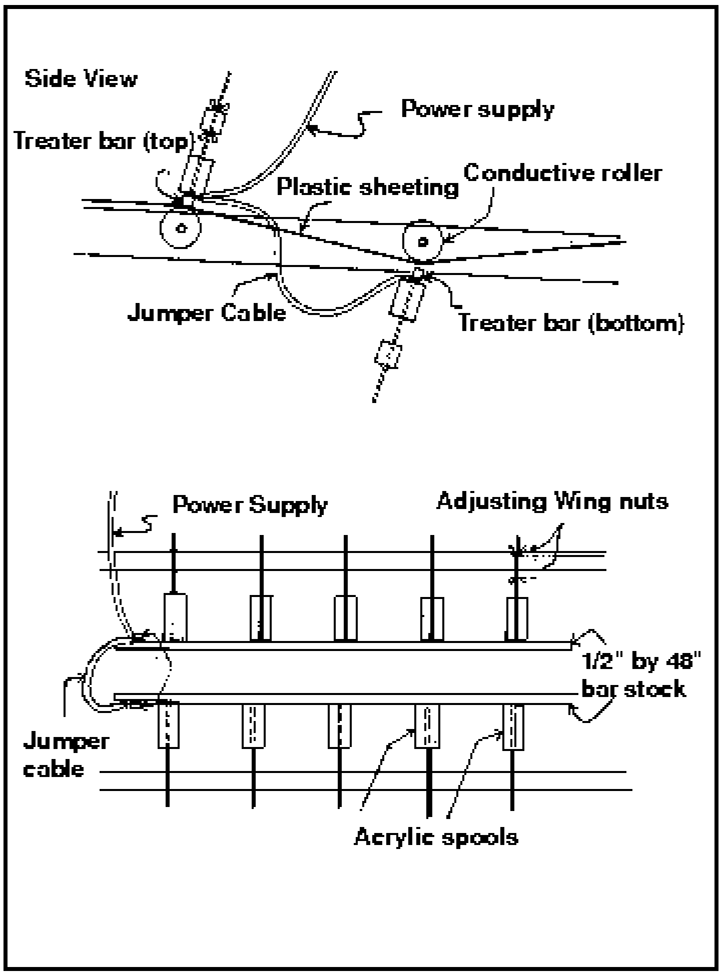

Figure. *Corona Treatment of Polyurethane Sheets*

FACE 86-16: Printing Machine Operator Electrocuted in Indiana

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On January 15, 1986, a 32-year-old gilter operator was electrocuted when he entered the electrical panelboard, supplying his machine, to reset a circuit breaker. A gilter is a conveyor process that sands and gilts (lays gold) on book edges.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A safety specialist and a medical officer met with the state compliance officer, company officials, and co-workers of the victim.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a large printing company that employs over 17,000 persons nationwide and approximately 2300 at the fatality site. The company was established in 1921 and has maintained an excellent safety record since that time. The company employs a corporate safety director who oversees the safety efforts of all the plants. In addition, the plant employs a full-time safety officer who is responsible for implementation of the site specific safety program. The company has a written safety policy and safety program.

SYNOPSIS OF EVENTS

On January 15, 1986, the gilter operator stopped his machine to change the sanding belts, a routine procedure. When the operator completed the belt change, he began "inching" the conveyor to evaluate the sanding and gilting process. The conveyor stopped, and the operator could not get it to restart.

The operator left his machine and approached the 480 volt electrical panelboard (approximately 30 feet from his normal work location), and opened the unlocked right hand door. With his right hand the operator attempted to reach behind the closed left door in an apparent effort to release the safety lock on the inside of the door. This method was used to keep the power to other circuits supplied by this panel while he looked for a circuit breaker he thought had tripped. The left door of the panelboard is designed to permit entry only after the power handle on the face of the door is turned to the "off" position, simultaneously releasing the locking mechanism. This insures that the panelboard is de-energized before entry. As the operator reached behind the closed door, his right hand came in contact with an energized 480 volt conductor. The victim provided a path to ground across his chest and through his left hand, which was in contact with the metal door handle of the left door.

A co-worker working approximately 25 feet away witnessed the incident and responded by turning the power handle to the "off" position; two co-workers then administered CPR to the victim. Emergency medical technicians responded to the accident scene within 10 minutes and transported the victim to the local hospital where he was pronounced dead after resucitation efforts failed.

CAUSE OF DEATH

The coroner reported the cause of death to be cardiopulmonary arrest due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The doors of electrical panelboards should be locked and keys supplied only to qualified electrical maintenance personnel.

Discussion: All plant personnel had access to the 480 volt panelboard and to the electrical hazards associated with the energized system. While locks were present in the door handles of both doors, keys were apparently not available and the doors were not kept locked. The planned addition of padlocks to the doors should rectify this problem, if they are kept locked and keys supplied only to authorized personnel. Additionally, the company has decided to post warning signs.

Recommendation #2: The doors of electrical panelboards should be interlocked so neither door can be opened without disabling the panel.

Discussion: This panelboard is more than fifteen years old and the design is out of date. The ability to open the right door exposed the worker to hazardous electrical energy; it allowed him to reach behind the left door and attempt to release the safety lock and open the door without turning the power handle to "off." A minor modification to the doors would resolve this problem and would prevent either door from being opened while the power switch was "on."

Recommendation #3: Existing company safety rules should be communicated and enforced.

Discussion: The company has safety rules that prohibit the employees from attempting to make electrical repairs themselves; however, the machine operator did not hesitate to attempt electrical repairs and apparently had done so in the past. All maintenance, whether electrical or mechanical, should be the sole responsibility of those persons designated as maintenance personnel. The breakdown of the gilter was later determined to have been the result of a mechanical failure and not an electrical problem. All safety rules should be periodically discussed with employees and strictly enforced.

FACE 86-17: 28-Year-Old Truck Driver Electrocuted in Georgia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On February 5, 1986, a truck driver was electrocuted while unloading concrete manhole assemblies from the trailer of a tractor trailer truck. The boom of the crane mounted on the trailer contacted a 7200 volt overhead powerline. This accident was unwitnessed.

CONTACTS/ACTIVITIES

Officials of the Georgia Department of Human Resources notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case has been included in the FACE Project. On February 20, 1986, a member of the DSR research team met with representatives of the company. The site of this fatality was visited and photographed. An interview was conducted with a co-worker, who operates the same equipment as the victim. The next-of-kin interview was precluded, because researchers were unable to contact any potential surrogates. The medical examiner's report was obtained. On February 21, 1986, a meeting was held with the Atlanta Area Occupational Safety and Health Program compliance officer responsible for investigating this fatality.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim worked for a company that manufactures precast concrete products (i.e., manholes and concrete pipes). These products are reinforced with steel. The company employs 18 to 20 people on a full-time basis and has been in existence for 18 years and under present ownership for approximately 2 years. Safety training is done on the job; the plant manager is responsible for training.

The victim worked as a truck driver delivering precast concrete products. This job involves driving a truck to delivery sites and unloading the concrete products. Unloading is done using a hydraulic crane that is mounted on the rear of the trailer. The boom of this crane can extend approximately 28 feet vertically. The precast concrete is unloaded using a chain hooked to a metal bolt on the concrete manhole assemblies and to the cable of the crane boom. The crane is operated using the controls as shown in Figure 1. The operator usually stands on the bed of the truck to operate the controls. The victim had approximately 5 years of experience in this job and had worked for the present management on an intermittent basis over the past 2 years. The owner of the company stated that the victim was well aware and had been frequently warned about the danger of overhead powerlines.

SYNOPSIS OF EVENTS

On the morning of the accident, the victim was to make two deliveries. The victim had completed the first delivery and was to deliver precast concrete manhole assemblies to the second location, a construction site. The victim felt that the original site selected to unload the delivery at the construction site was too muddy. He called the business office and was told to use an alternate site which was on level ground, easily accessible, and away from overhead powerlines. However, the victim did not use this site for the delivery, instead he chose to unload the precast concrete at a site approximately 200 yards away from the site he was told to use. This area was not on level ground and was close to overhead powerlines. The entire area was extremely wet.

At approximately 9:30 a.m. the victim unloaded two concrete manhole assemblies and was in the process of unloading the third when the accident occurred. The third manhole assembly was between the two that had already been unloaded. The first two assemblies were farther away from the truck and farther under the powerline than the third one. The third assembly was on the ground with the chains used to unload the product disconnected, but "welded" to the metal bolt used to connect the chain to the manhole assembly. The victim was found lying between the manhole assemblies and the truck and was in contact with one of the concrete manhole assemblies. The police report states that his elbow was burned into the concrete. The crane cable (approximately ten inches below the tip of the boom) was in contact with a 7200 volt powerline, located twenty-five feet ten inches above the ground. The powerline had to be de-energized and grounded by the local electric service utility before emergency care could be administered to the victim, who was pronounced dead at the accident site.

Since the accident was unwitnessed, the exact circumstances are unknown. Reviewing the known facts of this accident raises the question of why the victim had not made contact with the overhead powerline while unloading the first two manhole assemblies, since they were farther under the powerline and there did not appear to be enough room between the truck and the powerline to have unloaded the manhole assemblies. It appears likely that the truck was moved between the unloading of the first two assemblies and the third one. After moving the truck to unload the third assembly, the victim lowered the assembly to the ground. With the weight of the load removed, the boom may have drifted into the overhead powerline. If this occurred while the victim was holding onto the chain, the victim would have provided a path to ground and he could have been thrown onto the ground between the manhole assemblies and the truck. Electrical energy continued to flow through his body from his contact with the manhole assembly, since the chain attached to the boom was in contact with the manhole assembly.

CAUSE OF DEATH

An autopsy was performed. The cause of death was stated as electrocution. The coroner felt that the majority of the victim's burns occurred after he fell to the ground.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead powerlines.

Discussion: OSHA standard 1926.550(a)(15) requires that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines, have been "de-energized and visibly grounded" or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers.

Recommendation #2: Hazard awareness regarding overhead powerlines should be stressed and routinely reviewed so that all employees using cranes are cognizant of these energized sources.

Discussion: The danger of overhead powerlines appears to be obvious; however, contact with powerlines and the subsequent occupational-related fatalities continue. Employers must stress and routinely review the hazards associated with overhead powerlines. The fact that the victim in this case was "well aware of these hazards" emphasizes that employers must demonstrate that they are truly concerned about this aspect of job site safety and will not tolerate even one instance of unsafe conduct.

Recommendation #3: Loading, unloading, and storage sites should be chosen to avoid possible contact with overhead powerlines.

Discussion: Loading, unloading, and storage sites away from overhead powerlines decreases the chance of inadvertent contact between crane booms and these lines. The need for safe storage sites is particularly true at construction sites and at areas used for permanent storage areas. The owner of the company instructed the victim to unload at an area away from the overhead lines. Had the victim followed these instructions, this fatality would not have occurred.

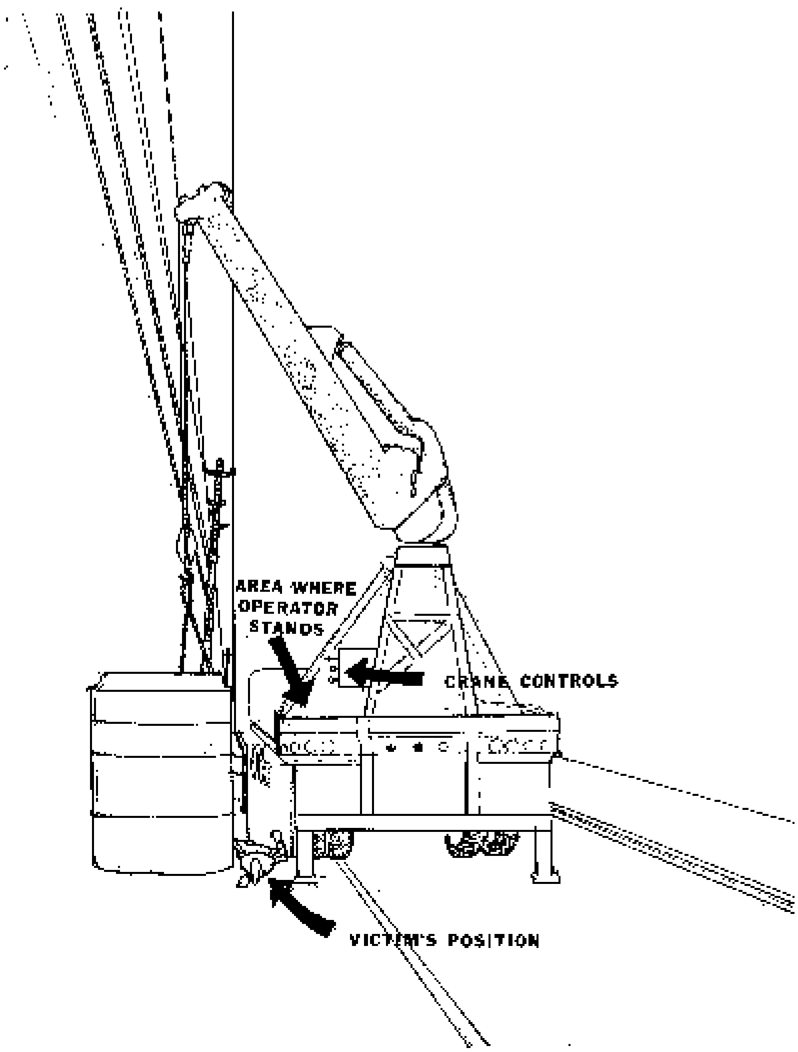

***Figure 1**. Accident Scene*

FACE 86-18: **Telephone Construction Worker Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On February 5, 1986, a groundman for a telephone construction contractor was electrocuted when the boom from a truck crane contacted a 7.2 kV power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of North Carolina, in cooperation with the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) notified NIOSH of this fatality and requested technical assistance. This case has been included in the FACE Project. On February 19, 1986, the DSR research team (a safety specialist and a medical officer) conducted a site visit and met with representatives of the company which employed the victim. Interviews were conducted with the victim's foreman and a co-worker; both of them witnessed the incident. The accident site was visited and photographs were taken. A surrogate interview was conducted to obtain personal characteristics of the victim.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim worked as a groundman for a telephone construction company that employs 250 people and contracts with the local telephone company to construct outside telephone lines. The construction company's safety program is totally administered by the telephone company. There is a written safety policy and safety meetings are held at the beginning of every work week.

SYNOPSIS OF EVENTS

On February 5, 1986, a construction crew was to place a guy wire between a power company pole and a ground anchor. The ground anchor unit consisted of a guy wire anchor rod attached to a screw type anchor. The crew consisted of five people: two groundmen (including the victim), one lineman, one operator, and a foreman.

The temperature at the time of the accident was slightly above 50 degrees F. The ground at the work site was saturated with water after heavy rainfall.

The truck crane used by the crew had an auger attachment on the hydraulic boom. After the auger was removed, the ground anchor could be inserted into the auger attachment and rotated. This action would screw the anchor into the ground and was done to avoid digging a hole and backfilling around the anchor. The projected location of the anchor was almost directly under a 7.2 kV power line, which was 23 feet above the ground at the pole. The hydraulic boom could potentially reach a height of 39 feet above the ground.

The operator was standing on the back of the truck at the control panel. As he rotated the boom (with the anchor unit suspended), the boom contacted the high voltage line. The operator realized he had contacted the line and jumped from the truck. He was not injured until he reached back to the control panel in an effort to move the boom away from the line. The operator received electrical burns to his left foot and was sent to the regional burn center.

The victim (a groundman) was repairing the frayed end of the wire to be used as the guy wire. A section of this wire was lying across the extended outrigger of the truck crane. When the crane contacted the power line the guy wire became energized. The victim, who was holding one end of the energized guy wire, fell to the ground. When the circuit opened, the foreman began pulling the victim away from the truck. However, the recloser closed the circuit automatically and the foreman received an electrical shock. The foreman, who was wearing rubber boots, was not seriously injured. After the circuit opened for the second and final time, the foreman began cardiopulmonary resusitation on the victim. The ambulance arrived within approximately 10 minutes. The victim was pronounced "dead on arrival" at the local emergency room.

The lineman, who was in contact with the anchor unit and guiding it towards the marked location, was also injured. He received electrical burns to his legs and scalp, and apparently had a respiratory arrest. He was revived by mouth-to-mouth resusitation given by the foreman. He was sent to the local hospital by ambulance and subsequently transferred to a regional burn center.

The other groundman was standing on the driver's side of the truck putting on his equipment belt. He felt the voltage, but was not seriously injured.

CAUSE OF DEATH

The coroner reported the cause of death to be cardiac arrest secondary to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA Standard 1926.550(a)(15) requires that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load be ten feet, unless the electrical lines have been "de-energized and visibly grounded" or insulating barriers have been erected "to prevent physical contact with the lines, equipment or machines." When it is necessary to work closer than 10 feet (horizontal distance) from an energized line, the power company should be contacted to comply with this standard. In many cases, the power company will send an engineer or safety specialist to assure the safety of the operation.

Recommendation #2: When working near a high voltage line, if visibility could be obstructed, an observer should be used to help the operator maintain the required clearance. This is required by OSHA Standard 1926.550(a)(15)(iv).

Discussion: The boom of the crane was rotated into a position that obscured the operator's view of the power line. Additionally, the sun may have played a significant role. Re-creation of the operator's line of sight indicated that it was very difficult to see the power lines at that time of day from the operator's position. Also, the operator was preoccupied with positioning the anchor. If an observer had been present, he could have warned the operator of his proximity to the power line, and the accident could have been avoided.

Recommendation #3: The procedures to be followed in the event of an emergency should be familiar to every crane operator. Specific training should be given concerning the procedures to be followed if electrical energy is contacted.

Discussion: A crane operator who contacts a power line should stay on the vehicle and attempt to move the boom away from the power line. If the operator must dismount the vehicle while it is in contact with the power line, he should jump from the vehicle and walk away from the electrical source. He should take short steps to avoid contacting different ground surface potentials and receiving an electrical shock. He must not "step down" from the vehicle, as that would provide a path to ground and cause serious or fatal injury. No one should return to the crane until the power company has de-energized the line. When the operator realized he had contacted the power line, he apparently jumped from the crane. While standing on the ground he reached back to the control panel, which was energized. He received electrical shock and serious electrical burns that could have been avoided if he had not returned to the truck. If he had moved the boom before dismounting the truck, he could have avoided his own injury and may have lessened the severity of injury to co-workers.

FACE 86-20: **23-Year-Old Lineman Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On March 21, 1986, a lineman was electrocuted when he contacted a lightning arrestor conductor while working from an aerial bucket. The lineman was attempting to splice a wire cable into a connection box which was attached to the upper cross member of the utility pole.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A safety specialist and an industrial hygienist from DSR met with company representatives, interviewed comparison workers and next of kin, conducted a site visit, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a major electric utility in the southeastern United States and employs 21,000 workers in nine fossil fuel plants, three nuclear plants, and numerous field and administrative offices.

The safety program is structured as a line function within each department (i.e., linemen, construction workers, office workers, etc.). Throughout the company safety responsibilities are implemented by management and supervisory personnel on a collateral-duty basis. Each department conducts its own safety inspections and audits. Training and safety councils are also structured along departmental lines. The company produces and distributes to each employee a written safety manual. The Chief Executive Officer establishes annual goals for the corporation. Of the 11 goals established for 1986 two are safety related. The two corporate safety goals are: 1) no more than one lost work day injury per 1,000,000 hours of work, and 2) no more than 3.5 vehicular accidents per 1,000,000 miles driven.

SYNOPSIS OF EVENTS

The victim (a lineman technician) reported to work at 8:00 a.m. Friday, the day of the accident. The victim had been a lineman technician for three months. As such the victim was permitted to climb poles and make electrical connections. Prior to traveling to the job site, he met with his supervisor who assigned the work crew its activities for the day. The supervisor verified that the crew had the appropriate equipment and materials required to complete the job assigned.

The two-person crew (the victim and a supervising lineman) returned to the location where they had worked earlier in the week. They were to remove and replace a capacitor bank from a utility pole located in a flat rural area. (See Diagram A.) The upper cross member supported three 7200 volt conductors and each conductor had attached to it a lightning arrestor. (See Diagram B.) The crew's specific task on the day of the accident was to splice a #16 wire cable into a LB 90° connection box which was attached to the upper cross member of the utility pole. The purpose of the splice was to bring electricity from the conductor to a service meter attached to the pole five feet above the ground.

At 8:45 a.m. the victim positioned himself in a one-person articulated, truck-mounted aerial bucket 25 feet above the ground and slightly below the upper cross member of the utility pole. (See Diagram C.) Protective insulating hoses were placed over two of the primary conductors; however, the lightning arrestor conductors attached to the primary conductors prevented the hoses from slipping all the way to the cross member on the utility pole. The victim did not use any boots, blankets, or other insulating material to cover the lightning arrestor conductors or other live conductors. The victim's insulated rubber gloves were in the tool tray located on the floor of the bucket. Immediately before the accident, the victim was in the process of splicing the 3-conductor #16 wire cable into the LB 90° connection box. The victim's splicing knife was found on the floor of the bucket.

The supervising lineman on the ground did not witness the accident. However, the physical evidence suggests the victim was holding the #16 wire cable with his left hand when his right hand came in contact with the lightning arrestor conductor. The lightning arrestor conductor was located within 11 inches of the LB 90° connection box. The victim cried out when his hand came in contact with the lightning arrestor conductor. The lineman on the ground looked up and saw the victim slumped in the bucket; he then ran to the truck and radioed for assistance.

By using the controls on the truck, the lineman lowered the victim to the ground and removed him from the aerial bucket. Within five minutes a nearby crew from the same utility company responded to the call for help. Finding the victim unconscious, the co-workers began CPR until the local EMS arrived. The victim was transported to a nearby hospital where he was pronounced dead at 9:55 a.m.

CAUSE OF DEATH

The cause of death was cardiac arrest due to contact with 7200 volts of electricity. The coroner reported electrical burns on the victim's right palm (entry wound) and electrical burns on the victim's left palm (exit wound).

RECOMMENDATIONS/DISCUSSION

Recommendation #1: When working with electricity, workers should wear appropriate protective equipment and use insulating boots, blankets, and hoses where appropriate.

Discussion: At the time of the accident the victim was not wearing rubber gloves which were provided by the employer. The victim did not cover all exposed electrical parts with blankets, boots, or covers as is required by the company's safety manual. The victim should have been required to follow the safe job procedure as stated in the company's safety manual. If the victim had worn protective clothing and covered energized parts, the risk of an electrocution would have been greatly reduced.

Recommendation #2: Corporate safety management should assess the effectiveness of its comprehensive corporate safety program.

Discussion: Corporate management should take an active role in assessing the effectiveness of its safety program. Corporate management should develop an audit instrument designed to assess the adherence to elements of the company's safety program. At least the following five areas should be included in a safety audit: safety management administration, education and training, safety allied services, supervision, and evaluation.

Recommendation #3: Upon initial hiring and periodically thereafter, all workers and supervisors should receive training in hazard recognition, safe work practices, and emergency response.

Discussion: It was determined during the investigation that, other than on-the-job training and tail-gate meetings, the company has no structured pre-placement training, continuing education, or remedial training of workers. New employees need to know the hazards associated with electricity, and they should be able to recognize electrical hazards and implement effective countermeasures. All workers performing hazardous tasks should be adequately trained to perform all tasks assigned. All field supervisors and workers should be certified in CPR.

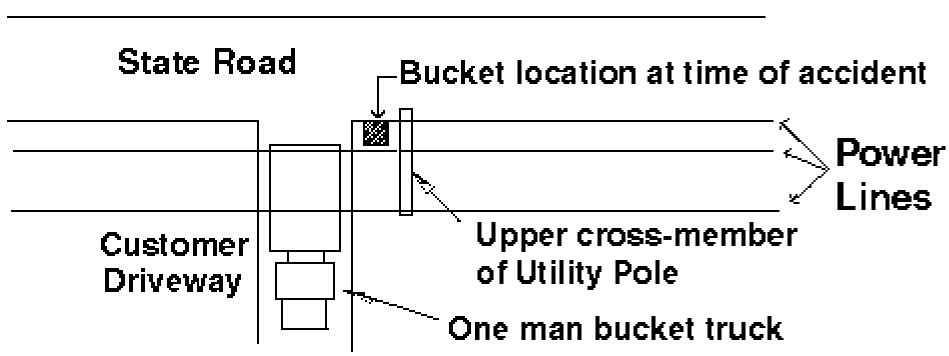

***Diagram A**. Location Sketch*

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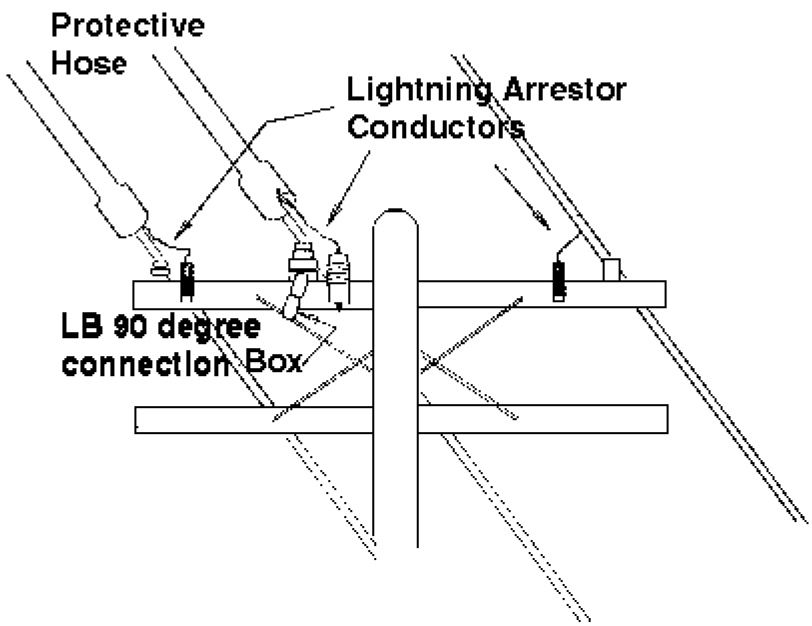

Diagram B. *Upper Cross-member of Utility Pole*

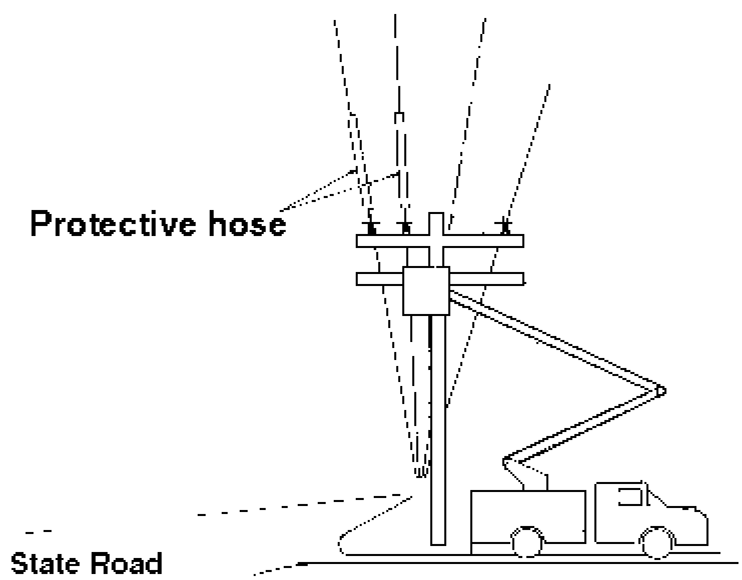

Diagram C. *Location of the Aerial Bucket*

FACE 86-21: Lineman Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On March 23, 1986, at 9:30 a.m. a lineman was electrocuted when he contacted a 7200 volt power line at an electrical substation. The line was assumed to be dead because the substation had been de-energized.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On April 9 and 10, 1986, a DSR research team met with employer representatives, interviewed comparison workers, interviewed the next of kin, conducted a site visit, discussed the incident with the OSHA Compliance Officer, and photographed the accident site. Eye witnesses were interviewed and the county coroner and county police were contacted.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical co-op that employs 70 people. The employer has an established safety program. A comprehensive safety manual is distributed to each employee. Each new employee undergoes an orientation period and all employees attend yearly training sessions. An employee safety committee meets at least bi-monthly with management personnel to discuss safety issues. The safety program is managed by the operations manager on a collateral-duty basis. This has been the first fatality at the co-op in its 46 year existence.

SYNOPSIS OF EVENTS

At 7: 30 on the Sunday morning of the incident, the operations manager received a call at his residence from the co-op's emergency answering service, alerting him of a major power outage that involved two areas and two substations serviced by the co-op. The operations manager contacted the co-op's standby service crew to obtain the details surrounding the outage. The operations manager was informed that one phase of a bus structure had burned in two and fallen across two phase jumpers at one of the substations. This resulted in the fuses being blown in these outgoing lines and killed the power at both substations. It was decided by the operations manager and the standby crew to isolate the two substations from each other so that while repair work was being performed on the damaged, de-energized substation, power could be restored to the second substation and to the areas that it serviced. The standby crew replaced the two blown fuses, re-energized the feeder line to the second substation, and then proceeded to the second substation to "bring its circuits back on line." This would allow power to be restored to all areas being serviced by the second substation. The operations manager then called in a second two man crew to perform the necessary repairs to the damaged substation. The operations manager and the second crew met at the co-op office to obtain all supplies needed for these repairs. A third employee monitored the calls over a scanner and called to volunteer his help. He was told to meet the other men at the substation.

Upon their arrival at the substation, the men surveyed the damage that had been done and identified the supplies that would be needed to complete the repair work. Grounds were placed on the incoming lines of the bus and were connected to the structure. All reclosers were locked in the open position and the bypass switches were opened. Once assured that the work area was protected, the victim (a first class lineman with 26 years of experience) climbed the support column of the substation to a level on the substation structure (approximately 15 feet above ground) where he could work on the bus. The second crew member (a line crew leader) positioned an aerial bucket through the substation structure so that he could work on the bus from the aerial bucket. The operations manager and the third worker remained on the ground to prepare the materials that would be needed to complete the repairs.

At approximately 9:00 a.m. work on the bus was almost complete and the operations manager decided to travel to the undamaged substation to discuss with the standby crew the methods to be used to bring both substations "back on line" as they were before the power outage.

The victim informed the line crew leader in the aerial bucket that his work was completed and that he was going to climb down the substation support structure to help the third worker on the ground clean up the remaining supplies. Rather than climbing down the substation support structure he had utilized at the beginning of the repair job, the victim decided to cross the substation and descend the support structure on the opposite side of the substation. As he began to climb down the support structure, his right leg contacted an ungrounded jumper on what was thought to be an "outgoing" feeder line. The victim provided a path to ground for the current from the jumper to the substation support structure, causing his electrocution. The victim fell approximately 12 feet to the ground. He was pronounced dead at the scene. Later it was determined that the "outgoing" line involved in the incident was actually energized with 7200V of backfeed electrical energy from a third substation on the "line."

CAUSE OF DEATH

The county coroner stated the official cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All work areas within substations in proximity to electrical conductors that are to be accessed by workers should be isolated (i.e., grounded and de-energized) and verified to be safe by qualified personnel, and all work should be performed within these protected areas.

Discussion: All conductors in the vicinity of the work area should be visibly grounded and de-energized. Work should not begin in these areas until they are verified as being protected by qualified people at the scene. If uncertainty exists, engineering personnel should be contacted to ensure the safety of all concerned. Employees should be instructed that if they must leave this protected area for any reason extreme caution should be exercised and all conductors should be treated as hot.

Recommendation #2: Employers should identify all safety hazards that might be present at a given job site and provide training to address these hazards.

Discussion: Engineering personnel should perform periodic surveys of substations and identify any safety hazards such as backfeed electrical energy that might be present at a given job site. A record of these hazards should be maintained and workers should be made aware of any hazards they might encounter. Additionally, hazards present at a job site, such as a substation, should be listed on a warning sign and placed in clear view of anyone entering the premises. Although a 1/4 inch strip of labeling tape was present on a leg of the support structure stating that the line was "fed" from another substation, it was very small and ineffective. Training programs should emphasize proper procedures for performing work at electrical substations and also the hazards associated with these substations. Training programs should include basic electrical theory sessions that address electrical substations including the identification, evaluation, and control of the hazards associated with work at these substations. Because of the ever present danger of feedback electrical energy, the proper method of de-energizing and protecting a work area within a substation should be stressed.

Recommendation #3: Employers should assure strict adherence to existing safety rules.

Discussion: Employer safety rules state that a qualified "checker" be appointed by the supervisor to oversee an employee who is performing work in an area where the hazard of contact with an energized conductor exists. This "checker" would be thoroughly instructed and familiarized with specific, existing safety hazards and would assure that the workers would remain in their protected work area. Had the victim stayed in his protected work area and descended the substation support structure that he had used to access the work area, the incident would have been prevented.

FACE 86-22: **21-Year-Old Electrocuted While Moving Grain Auger in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 7, 1986, two employees for a local grain company were attempting to move a grain auger when the accident occurred. One worker was using a tractor to pull the auger away from the grain storage bin while the other worker (the victim) was on the ground guiding the auger when it contacted two phases of a 12,470 volt distribution system (see Figure). The worker on the ground was electrocuted.

This is the third auger related incident investigated by DSR in the last six months. These incidents have resulted in a total of six electrocutions.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR of this electrocution and requested technical assistance. This case has been included in the FACE Project. A site visit was conducted by the FACE Project Director where information was collected from the plant manager, the driver of the tractor, and the plant owner. Interviews were conducted with comparison workers and the plant foreman. Photographs were taken of the accident site and outside plant area.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The local grain company is a family owned business that started in 1944. This is the first occupationally-related fatality for the grain company. The company has 40 employees, which include the office staff (2), owners (2), plant manager (1), foremen (2), truck drivers, warehousemen, and general laborers. The company has no written safety policy except for the small booklet that is given to all new employees that states "Safety is everyone's responsibility." Training of new employees is done on the job by a supervisor or an experienced employee. The owners appear to be conscientious and want to do whatever possible to provide a safe work environment. The owner stated "If something doesn't work or appears to be unsafe, then the employee is to notify him (owner), the plant manager, or the foreman and report the condition immediately."

SYNOPSIS OF EVENTS

On April 7, 1986, after lunch two workers for the grain company were given orders to go to one of the grain storage areas (approximately 10 miles from the plant) and bring back a truck load of grain for processing. The two workmen (a truck driver and a warehouseman) proceeded to the grain storage area to load the grain from the storage bin into the truck for transport to the plant. The truck driver had been working for the grain company for one month. The warehouseman had worked for the grain company for seven months. Neither worker had transferred grain at this location previously.

When the workmen arrived at the site (around 3:00 p.m.), the auger (61' long) was in the loading position (upright) against the grain bin. Both workmen had commented on the overhead power lines when they arrived at the site and were aware of the hazard while moving the auger. To unload the bin, it was necessary to pull the auger away from the grain bin, lower the auger, and turn the auger 180^{o} so the lower end would be at the bottom of the bin. The workmen attempted to pull the auger back by hand but were unsuccessful. Attempts to lower the auger were also unsuccessful, since the auger had been in the upright position for some time and could not be lowered. The workers attached a chain between the tractor and the auger and started to pull the auger back away from the grain bin. The truck driver was operating the tractor, and the warehouseman was on the ground guiding the auger. The chain between the auger and tractor was adjusted and the workmen decided to turn the auger in the upright position. As the tractor pulled the auger back, the warehouseman guided the auger with both hands. The auger contacted two phases of a 12,400 volt distribution system, electrocuting the warehouseman on the ground. The driver on the tractor saw the man on the ground fall, he immediately jumped off of the tractor, and was shocked (briefly stunned) when he hit the ground. The truck driver then flagged down a passing vehicle and requested the driver call for help. The rescue squad arrived shortly thereafter, and the warehouseman was pronounced dead at the scene.

CAUSE OF DEATH

No autopsy was performed. The cause of death was listed as "Electrocution." The victim had entry burns on both hands and an exit wound through the left foot.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should identify safety hazards that may be encountered at the plant and off site work locations.

Discussion: A survey that identifies safety hazards of the plant and off site work locations should be completed. These hazards (i.e., the location of overhead power lines, etc.) should be discussed with the employees. Necessary precautions should be stressed to all personnel.

Recommendation #2: Employers should stress safe movement of grain augers.

Discussion: Grain augers that are moved to different locations at the plant or off site work locations may present a safety hazard, especially when moved under power lines. Augers should be lowered to a safe transporting position before being moved from one location to another.

Recommendation #3: Employers should affix a safety warning sign to each auger that warns the user - LOWER BEFORE TRANSPORTING, AND LOOK UP FOR OVERHEAD POWER LINES.

Discussion: The grain auger is a portable piece of farm equipment that has the ability to be raised to heights above 25 feet. This capability makes the piece of equipment dangerous in two ways; first, it can tip over if being moved in the upright position, and secondly, when elevated it is high enough to contact high voltage lines. Therefore, a warning sign affixed to the auger alerts workers to the overhead danger - powerlines.

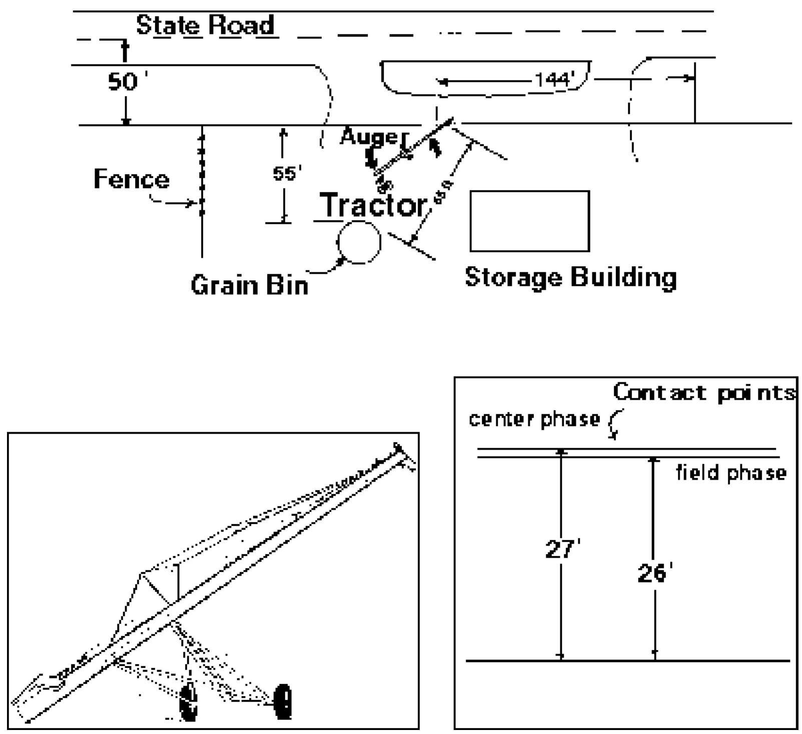

Figure. *The Accident Scene*

FACE 86-24: **37-Year-Old Scale Technician Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 16, 1986, a scale technician was electrocuted while assisting a crane operator that was preparing to lift a platform scale frame. The wire winch cable, extending from the boom tip, contacted a 7200 volt overhead powerline.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case has been included in the FACE Project. On May 1, 1986, a DSR research team (consisting of two safety specialists) met with representatives of the company. The site of this fatality was visited and photographed. An interview was conducted with co-workers, who perform the same tasks as the victim, and an interview with the next of kin was also conducted.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This company has been in operation and under the present ownership for the past 28 years. The company employs seven personnel that sell, service, and rent platform scales.

No written safety policy exists and safety performance depends largely on the common sense of the employees.

SYNOPSIS OF EVENTS

On the day of the accident (April 16, 1986), a two-man crew consisting of a crane operator and a scale technician (the victim) was dispatched to a private residence to remove an abandoned truck platform scale and return the scale to the employer's place of business. The scale consisted of three parts, the wooden platform (top section used to support weight), the scale frame (housing for the scale), and the scale (weighing mechanism).

The removal of the scale and wooden platform, that was located in a pit 20 inches x 10 feet x 15 feet, was accomplished in the morning and early part of the afternoon. At approximately 2:30 p.m. the victim entered the pit in order to attach a chain sling to remove the scale frame that remained. The crane operator had positioned the truck crane and crane boom to lift the scale frame from the pit. The wind was gusting up to 25 mph with overhead electrical lines located 23 feet directly above the pit. The boom had been positioned within 10 feet of the electrical line, which is in violation of the OSHA standards regarding electrical lines rated 50 kV or below.

Apparently the victim, while attempting to attach the chain sling to the scale frame, swung the sling which was attached to the wire winch cable extending from the tip of the boom. This swinging motion of the sling and the winch cable, coupled with the wind gusts and the close proximity of the winch cable to the electrical lines, put the winch cable in contact with one phase of the 7200 volt overhead electrical lines. The electricity entered the victims right hand and exited through his feet to ground. The victim was in contact with the electrified sling for 5-10 seconds, until the electric line burned through and separated from the wire cable, thus breaking the flow of current.

CAUSE OF DEATH

The coroner determined that the cause of death was due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA standards 1926.550(a)(15) and 1910.180(j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers, which cannot be part of the crane. Standard 29 CFR 1926.550(a)(15)(iv) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means. Additionally, 1926.550(a)(15)(vi) requires that any overhead line shall be considered to be an energized line unless and until the person owning such line or the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded. The accident may have been prevented had these requirements been satisfied.

Recommendation #2: Employers should develop written safe job procedures that are task specific.

Discussion: The employer has no written safe job procedures. Safe job procedures specific to the tasks performed by the employees should be developed and detailed procedures should be included that address the various safety hazards associated with these tasks. Once these specific procedures have been developed, the employer should assure that they are implemented and enforced.

FACE 86-25: **34-Year-Old Superintendent of Manufacturing Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On Sunday, April 27, 1986, a superintendent of manufacturing was electrocuted while attempting to reset electrical relays in an electrical control box.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 28-29, 1986, a safety specialist from the DSR research team met with employer representatives and health care providers, conducted a site visit, photographed the accident site, and interviewed comparison workers, witnesses, and family members.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim (34-year-old superintendent of manufacturing) had been employed for six years by a company that produces mulch fibers from wood chips. The 50-year-old company employs 31 workers - 24 in manufacturing, six in administration, and one salesman. The plant normally operates three shifts per day, five days a week. Because the plant was behind in production, management increased production time by 16 hours per week, raising production time from 120 to 136 hours per week.

The company was purchased by a conglomerate in August, 1985. Prior to this purchase the victim simultaneously performed the tasks of superintendent of manufacturing, plant manager, and manager of the facility. In December, 1985, the victim was relieved of his duties as manager of the facility and plant manager.

Recently the company contracted with noise specialists to conduct a noise survey in the plant and to determine compliance with occupational safety regulations. As a result of the noise survey, each worker is required to wear ear plugs. The safety program consists solely of this hearing protection program.

SYNOPSIS OF EVENTS

On Sunday, April 27, 1986, the victim (a 34-year-old male, superintendent of manufacturing) was notified at home by workers and told that the 800 horsepower refiner motor at the plant would not start. This powerful refiner grinds wood chips into fibers. Thirty minutes later (at approximately 3:00 p.m.) the victim arrived at the plant. The victim met with the plant manager and shift foreman and discussed the electrical outage. The three men then began to search for the electrical failure in a control panel located on the exterior of the building. Not finding any problems with the control panel, the victim began checking a control panel box on the inside of the facility. This control panel box houses relays and circuitry for 110, 220, and 480 volt circuits and is located in a restricted room adjacent to the production area.

The victim opened the double metal doors of the control panel box (7'x3'x9') and began a visual check of the relays. The victim, while standing on a metal stool, visually checked the upper half of the panel box. As the victim checked the circuitry inside the panel box, the shift foreman assisting him held an amp meter and recited the meter readings. After several minutes of leaning into the dark control panel box the victim requested and received a flash light. A few seconds later the victim received an electric shock and asked for help. The foreman made two rescue attempts. In the first rescue attempt he was knocked backwards by an electric shock after he grabbed the victim around the waist. In the second attempt the foreman reached out, grabbed the victim by the belt, and pulled him to the concrete floor. The foreman could not find a pulse, but began CPR in an effort to revive the victim. The EMS arrived ten minutes later and transported the victim to a nearby hospital where he was pronounced dead.

Shortly after the accident the company investigative team found a detached 220 volt conductor in the panel box. Apparently the victim, while standing on the metal stool, was slightly off balance as he leaned into the dark control box. While attempting to maintain his balance, he supported himself against the inside of the control panel where his right hand made contact with the 220 volt conductor.

CAUSE OF DEATH

The medical record at the hospital listed the cause of death as electrocution. The medical record noted entry wounds on the index finger of the right hand and exit wounds on his right medial wrist.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees should be given appropriate training commensurate with the tasks they are expected to perform.

Discussion: The victim received no training in the maintenance of electrical systems. Although the victim had reset electric relays many times before without incident, he was neither trained nor qualified to repair electrical systems.

Recommendation #2: The employer should develop and implement a comprehensive occupational safety program.

Discussion: The company does not provide training in safe work procedures nor are there rules or written policies governing safe electrical repairs. None of the benefits that a safety program would provide (i.e., training, hazard identification, personal protective equipment, and safe operating procedures) were utilized. Once these procedures are developed the employer should assure that they are implemented and enforced.

FACE 86-26: 50-Year-Old Utility Worker Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project which is focusing primarily upon selected electrical-related and confined space related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On March 24, 1986, a utility worker for a small municipality in Ohio was electrocuted when he elevated his aerial bucket into a 7200 volt power line.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 28, 1986, members of the DSR research team met with the superintendent of the utility company and co-workers of the victim. The accident site was visited and photographs were taken. A surrogate interview was conducted to obtain personal characteristics of the victim.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim worked as a lineman for a utility company that employs nine people. There is no designated safety officer or formal safety program. Insulated rubber electrical gloves (rated to 20,000 volts) are tested on a monthly basis.

SYNOPSIS OF EVENTS

On March 24, 1986, the victim and a co-worker were sent to disconnect the electrical service at a house scheduled to be demolished. After parking the aerial bucket truck beside the pole supplying that service, the victim went up in the insulated aerial bucket and cut the 240 volt line leading to the house. Instead of letting the line fall, he held it in his left hand and began moving the aerial bucket in an effort to drop the line clear of a metal building between the pole and the house. In an apparent attempt to swing over a cable TV line, he elevated the bucket and contacted the 7200 volt line on the crossbar of the pole. The victim completed a path-to-ground through the line that led to the house.

The victim's co-worker (a groundman) realized what had happened, ran to call for an ambulance, and notified the utility company to de-energize the line in accordance with the municipality's established emergency procedures. As the groundman left the scene, two telephone workers arrived. These two workers tried to lower the aerial bucket, but they were not familiar with the controls and therefore were unable to lower it. Then they tried to drive the truck away from the power line; however, the aerial bucket was caught in the high voltage line and they were unable to pull forward more than a few feet.

The utility supervisor arrived within five minutes and sent a utility foreman to cut the power to the line. After he was notified by radio that the power was disconnected, he mounted the truck to lower the bucket. He was unable to lower it at first because the telephone worker had not placed the truck transmission in neutral. After this was corrected, the utility supervisor was able to lower the aerial bucket to the ground (approximately ten minutes after the accident). The victim's polyester clothing was on fire, and a fire extinguisher was used to extinguish the fire in the bucket prior to lifting the worker out.

The victim was conscious after the accident, but was burned severely over 65 percent of his body. He was taken by ambulance ten miles to the local hospital and transferred immediately to the regional burn center.

CAUSE OF DEATH

The victim died one week after the accident from complications of thermal burns resulting from contact with electrical energy.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All workers who work on or around electrical energy must be familiar with the proper procedures to follow in an emergency.

Discussion: The victim's co-worker had been trained not to touch the truck if a power line was contacted, and he reacted appropriately. The supervisor also used caution by having the power line de-energized before mounting the truck. However, the two telephone workers were apparently not aware of the hazard. They were not injured because the insulated aerial bucket contacted the high voltage line. If the power line had contacted the uninsulated boom instead, the truck would have been energized and there could have been two additional fatalities.

Recommendation #2: When working on or around "hot" electrical wires, electrical workers should wear insulated rubber gloves.

Discussion: The victim was wearing leather gloves which the utility company used for lower voltage work (less than 400 volts). These gloves protected him when he cut the 240 volt line, but when he contacted the 7200 volt line the leather gloves were inadequate. He was holding the line leading to the house, which was grounded through the neutral wire, when he contacted the high voltage line. If he had been wearing his insulated rubber gloves (rated to 20,000 volts), there would have been no path-to-ground and he could have avoided injury.

Recommendation #3: The utility company should initiate a safety program that identifies hazards, promotes hazard awareness, addresses specific tasks, and stresses safety training.

Discussion: The utility company has begun sending all electrical workers to the monthly safety meetings of a larger power company. This should be supplemented by local hazard identification and written procedures that minimize or eliminate hazards.

FACE 86-27: Part-time Laborer Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 19, 1986, a part-time laborer assigned to the clean-up department of a manufacturing company was electrocuted when a metal pole he was carrying contacted a 7200 volt power line. A co-worker, apparently trying to rescue the victim, was seriously injured.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 27, 1986, a physician and a safety engineer met with an official of the Industrial Commission of Ohio and a representative of the employer. Co-worker and next-of-kin interviews were precluded in this case.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a manufacturing company that employs approximately 200 people. The personnel manager is assigned responsibility for the company safety program on a collateral-duty basis. Written employee guidance has been developed that includes safety topics of a general nature. The company promotes safety through the use of contests, monetary incentives, and the activities of a safety committee that meets periodically. Additionally, officials of the Industrial Commission of Ohio have served as consultants to the company for safety-related matters during the past several years.

SYNOPSIS OF EVENTS

Two part-time employees (17 and 18 years old), members of the facility clean-up crew, were assigned to remove the accumulation of soot that had built-up inside the smoke stacks of the facility. These smoke stacks were located on the flat roof of the two-story facility. This task is performed semi-annually and had been previously completed by these employees. The two workers were assigned this task by the lead person (supervisor) responsible for the clean-up crew and were given a metal scraper (approximately 49" long with a moon shaped spade on the end) and a steam sprayer to loosen the soot. The two workers had cleaned three smoke stacks that morning and were preparing to clean a fourth one. Apparently in an effort to clean the smoke stacks more thoroughly, the employees decided to add an extension to the scraper. They left the roof and got a nine foot piece of electrical conduit and a coupling from another section of the facility to be used to extend the scraper. The length of the extended scraper was 13 feet.

At approximately 7:30 a.m. the employees returned to the roof to continue cleaning the smoke stacks. The victim apparently was carrying the scraper and the attached extension over his left shoulder, as a soldier would carry a rifle. As the employees walked from the stairs that provided access to the roof towards the smoke stack to be cleaned, the metal pole contacted a 7200 volt power line that crossed the roof of the facility. The power line was approximately 13 feet 3 inches above the walking surface of the roof. The victim provided a path to ground for the current being carried by this conductor. The second employee apparently was injured when he went to the aid of the victim. The circuit protection located on the pole providing electrical service to the facility opened, disconnecting power to the conductor contacted.

The supervisor, who had remained on the lower level, noticed that debris was not falling from the smoke stack. He then went to the roof and found both employees on fire; lying under the overhead power line, one on top of the other. (The time between the accident occurrence and the supervisor going to the roof was estimated by company officials as 30 seconds.) The supervisor could not extinguish the fire. He left the roof to sound the fire alarm and members of the facility fire brigade responded. Using a fire extinguisher these personnel put out the fire and performed first aid on the co-worker who had tried to rescue the victim. The emergency medical service (EMS) was summoned and arrived approximately ten minutes later. The victim was pronounced dead at the scene. The co-worker was severely burned and was transported to a local hospital and then to a burn center. Both of his hands were later amputated and he is currently recovering.

CAUSE OF DEATH

The deputy coroner ruled that electrocution was the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers (regardless of size) should continually evaluate and update the safety program for their facilities. When an accident such as this occurs the employer and the employees should evaluate their safety program and identify areas that need to be improved.

Discussion: A safety program, no matter how comprehensive, can not eliminate all accidents or fatalities. The employer in this case had been working with the Industrial Commission of Ohio for several years and had improved the safety program considerably during that time period. All employers should continually evaluate and update the safety program for their facilities and should take advantage of consultation programs available through many of the states.

The Industrial Commission was contacted after the accident and personnel familiar to the company were able to provide consultative expertise. Based on this cooperative effort, the company has initiated the following actions in response to this incident:

(1) only nonconductive materials will be used on the roof;

(2) general safety and electrical safety training will be increased for all employees;

(3) all repairs or modifications to equipment must be reported to the appropriate crew chief;

(4) part-time employees will be supervised more closely (one full-time employee will be assigned to work with part-time employees).

Recommendation #2: Organizations responsible for enacting regulations that are not retroactive (i.e., that contain grandfather clauses) should consider the costs associated with the potential increase in injuries and/or fatalities that may result from these less stringent requirements.

Discussion: Based on a grandfather clause, regulations applicable for this installation permit power lines to come within eight feet of the roof of this facility; however, the requirement for new construction is 15 feet. Although the power line is 13 feet 3 inches above the roof and in accordance with all regulations, it should be pointed out that compliance with the more stringent regulation may have prevented this fatality. Where grandfather clauses permit a situation (in this case since 1961) that does not assure the same level of safety as afforded by more recently adopted regulations, regulatory organizations should consider the increased costs associated with injuries and/or fatalities that may result. Perhaps a more balanced approach would be to require compliance with the new regulations according to a predetermined schedule. Additionally, signs alerting personnel of these reduced safety conditions should be posted.

Recommendation #3: Employers should prepare job safety analyses for hazardous assignments.

Discussion: Although the employer had prepared job safety analyses for certain tasks performed at the facility, this task was not included. Personal protective equipment (including respiratory protection) should be identified and used. These employees were performing the duties of a chimney sweep and as such should be cognizant of the hazards associated with that activity.

FACE 86-28: **24-Year-Old Manufactured Home Installer Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On May 27, 1986, two workmen were using an electric powered (110V) auger machine to install tie down rods for a manufactured home when the accident occurred. The ground was wet and a continuous grounding system was not provided for the auger machine. A workman provided a path-to-ground when a ground fault condition occurred in the auger machine.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A research industrial hygienist conducted an evaluation of this case, which included: a visit to the accident site, meetings with the compliance officer and the employer, and interviews with a surrogate for the victim and comparison workers. No photographs were taken because the accident site (house foundation) is now concealed by concrete blocks.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The mobile home service and supply company is a relatively small operation, consisting of the owner, a parts manager, two working foremen, and two service men. The company has been in business for approximately 17 years to service and install manufactured homes and to provide a parts supply service. The company has no written safety policies or procedures. Training for new employees is provided on the job by an experienced worker and/or the owner.

SYNOPSIS OF EVENTS

On May 27, 1986, four mobile home service men were installing a new manufactured home. Two workers were inside the home doing finishing work, while the other two workmen were under the home installing tie-down anchors. The workmen under the home were to install nine, 36-inch steel anchor rods. The steel rods are screwed into the ground manually or by using an electric (110V) auger machine. The auger machine is a one-quarter horsepower electric motor with a gear down drive, encased in a metal housing with two handles (one handle with a dead man's switch). The auger machine is usually operated by two men; however, it can be operated by one man.

The electric service had not been hooked up on the new home; therefore, the workmen had to seek a different source of electricity for the auger machine. They received permission from the adjoining property owner to run an extension cord to his property. The electric outlet used was in a tool shed 200 feet from the work site. They used six 50-foot extension cords to reach the outlet. Two cords had ground prongs missing and some of the cords were repaired with electrical tape. The electric outlet used was a

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two prong, 110/120 volt receptacle. An adaptor (which permits a three prong plug to be inserted into a two prong receptacle) was used at the tool shed receptacle. The ground wire of the adaptor was not connected. The extension cords were tied in knots at each connection and these connections placed on concrete blocks. However, the rest of the cord was on wet grass, mud, and wet pea gravel.

The workmen were working under the home on wet pea gravel. They had removed their shirts because of the heat and humidity and were sweating. They had installed seven rods. (It took approximately five minutes to install each rod.) The workmen had inserted half of the eighth rod when the one holding the deadman's switch was shocked and knocked back from the auger machine. The machine fell across the victim. The workman that was knocked back, immediately kicked the auger machine off of the victim; however, he noticed the electric cord was wrapped around the victim's thigh. He yelled for the workmen in the house to disconnect the power, which they did.

Workmen at the site administered CPR, but could not revive the victim. The paramedics and deputy coroner arrived approximately 25 minutes later and pronounced the man dead at the scene.

CAUSE OF DEATH

The coroner's verdict listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The company should develop and implement a written safety program.

Discussion: Worker safety is the primary responsibility of the employer. In order to carry out this responsibility, the employer should: 1) develop a written company safety policy, and 2) develop, document, and enforce the adoption of safe work procedures for all employees.

Recommendation #2: A training program in hazard recognition and control should be initiated for all employees.

Discussion: Although workers may be aware of on-the-job, day-to-day hazards, they sometimes become complacent of such hazards. This complacency, especially when working with electrical energy, can lead to a serious accident. Therefore, it is not only important to train new employees, but to provide refresher training to other employees concerning safe work practices and hazard recognition.

Recommendation #3: A ground-fault circuit interrupter or an assured grounding system should be provided and maintained on electrical equipment (such as the auger machine), as required by OSHA Standard 1926.400(h)(2) and (3).

Discussion: All electrical equipment should be provided with an adequate and approved continuous grounding system to prevent electrical energy going to ground through the equipment and/or user. This is particularly true when the equipment is used in damp or wet areas. This grounding protection is essential for the safety of all employees.

Recommendation #4: All equipment, tools, electrical extension cords, etc. should be inspected and maintained in good repair. Extension cords should be maintained to provide ground continuity. (See OSHA Standard 1926.401(f).)

Discussion: Safe work procedures for employees are interrelated with the use of tools and equipment that are in good condition. The extension cords used in this operation were reported to be in fair to poor condition. Electrical tape was used in several places, and ground prongs were missing from two of the six cords. It is important that extension cords, as well as other equipment used with electrical energy, be properly maintained and replaced when necessary.

FACE 86-29: **29-Year-Old Mechanic Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On May 7, 1986, a 29-year-old class "A" mechanic was electrocuted while assisting the lead mechanic in the maintenance of an electrical distribution system.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On June 25, 1986, the DSR research team (consisting of an industrial hygienist and a safety specialist) met with representatives of the company. The site of this fatality was visited and photographed. Interviews were conducted with surrogates of the fatality victim and co-workers, who perform the same tasks as the victim.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This is a public electrical utility company that has been in operation for 61 years and employs over 3,000 personnel.

The company consists of five divisions with four generating plants and employs a full-time Safety Director. Managers at each division and all supervisory personnel are held accountable for safety. The company has a written safety policy and safety program which establish safety goals.

Management implements and evaluates safety programs routinely and rewards and communicates effective results (i.e., no lost time injuries, good housekeeping, etc.). Safety rules are established, communicated, and enforced by supervisory personnel. Safety committees, which meet monthly to evaluate safety issues, are comprised of supervisory personnel and company hourly employees.

SYNOPSIS OF EVENTS

On Wednesday morning May 7, 1986, a crew consisting of a foreman, lead class "A" mechanic, and another class "A" mechanic (victim) was assigned to perform maintenance at one of the company's substations. The maintenance was to include the replacement of a three-way connector. The grounding of the conductors and corresponding switches and breakers was put in place prior to the maintenance on the three-way connector. The foreman, after having discussed and established working procedures with the maintenance crew, moved approximately 150 feet away from the accident site to perform other activities. While preparing to remove the bolts and plates at the three-way connector the lead mechanic and victim were situated in the bucket of an aerial truck approximately 20 feet off the ground. For reasons unknown and without consulting the foreman, the crew moved a ground wire from the original grounded position (lead wire of the coupling cap to a grounded steel structure) to a secondary grounded position (horizontal conductor secured at the three-way connection point, to the grounded steel structure) (see Figure 1). After repositioning the grounding wire to the secondary position the victim began removal of the bolts from the three-way connector. As the bolts were removed, the horizontal conductor with the grounding wire attached separated from the three-way connector; the victim momentarily contacted the grounded horizontal conductor with his left hand and the energized three-way connector with the right hand. This contact created a path-to-ground and the victim was electrocuted.

The victim slumped to the bottom of the aerial bucket breaking contact with the conductor. On site first aid (CPR) was provided within one minute of the accident and paramedics were at the scene providing advanced cardiac life support within six minutes. The victim died at the hospital approximately sixty-five minutes after the accident as a result of cardiac arrest due to electrocution.

CAUSE OF DEATH

The coroner reported that the cause of death was cardiac arrest due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Standard operating procedures and hazard awareness should be routinely presented and reviewed at safety meetings. Employers should enforce strict adherence to company policy.

Discussion: The crew did not adhere to the safe job operating procedure while providing maintenance to the substation. Repositioning of the ground wire is a violation of the safe job operating procedure which contributed to this fatality.

Recommendation #2: A routinely administered hazard awareness identification program should be established to further educate all employees working with electrical energy.

Discussion: For reasons unknown at this time, a grounding wire was repositioned which resulted in this fatality. A better understanding of electrical energy and hazard awareness may have prevented the crew from repositioning the ground wire which contributed to an employee being electrocuted.

The managerial staff of the employer was provided the following documents and overviews:

- Warning - Confined Space! Article by Richard W. Braddee and Ted A. Pettit. Reprinted from Operations Forum (June 1986), Volume 3: 22-23.

- Request for Assistance in Preventing Deaths and Injuries from Excavation Cave-ins (85-110)

- Request for Assistance in Preventing Occupational Fatalities in Confined Spaces (86-110)

- Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines (85-111)

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- Request for Assistance in Preventing Electrocutions of Workers in Fast Food Restaurants (85-104)

- Request for Assistance in Preventing the Injury of Workers by Robots (85-103)

- Request for Assistance in Preventing Hazards in the Use of Water Spray (FOG) Streams to Prevent or Control Ignition of Flammable Atmospheres (85-112)

- Overview of the National Institute for Occupational Safety and Health (NIOSH)

- Overview of the Division of Safety Research (DSR) .

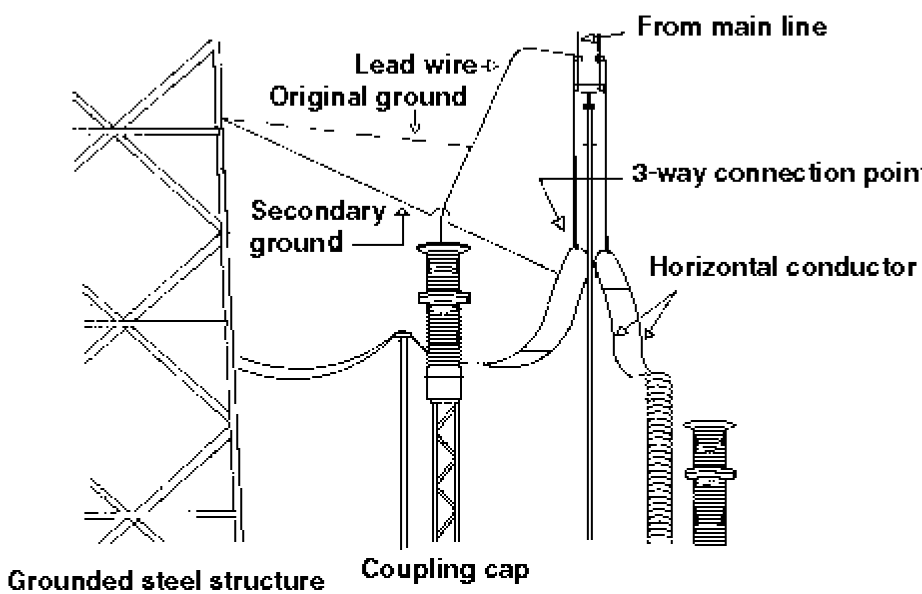

Figure 1.

FACE 86-30: Township Maintenance Worker Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 2, 1986, a township maintenance worker was electrocuted when an aluminum pruning pole he was using during a tree trimming operation contacted an overhead 7200 volt power line.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On June 18, 1986, the DSR research team (consisting of a safety specialist) conducted a site visit, met with employer representatives, interviewed a comparison worker, conducted a next-of-kin interview, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was one of two workers employed by the township's maintenance department. Duties of the workers included tree trimming, snow removal during winter months, and various maintenance tasks throughout the township.

No written safety policy or safety program exists for the township's maintenance department. No safety training is provided by the township.

SYNOPSIS OF EVENTS

Prior to the day of the accident the township maintenance foreman had received a request from a township resident to cut down a dead tree located between the sidewalk and the street curb in the resident's front yard. Upon their arrival at the scene, the foreman asked the area residents to move their vehicles from the work area while the victim fueled the chain saws. The two men then climbed the tree without safety harnesses and began removing the branches from the tree prior to cutting the tree down. A 7200 volt power line ran perpendicularly through the top of the tree, approximately 29 feet above ground level. Three service drop lines ran through the upper portion of the tree to private residences along the street. Both men utilized a wooden broom handle to push the service drop lines away from themselves while cutting the limbs. The victim was approximately 20 feet above ground in the tree, directly above the foreman. When the victim reached this height he began to use a 12 foot aluminum pruning pole with a saw on one end to remove the limbs. The victim was in the process of sawing off one of the larger limbs above him in two foot sections and allowing them to fall to the ground, when one of the sections fell toward him. In an attempt to knock the section of limb away from himself the victim swung the pruning pole at the falling section of limb. The pruning pole contacted the 7200 volt power line. The foreman heard the contact, looked up, and noticed that the victim's legs were smoking.

The foreman began swatting at the pruning pole with his broom handle in an attempt to knock the pruning pole away from the power line. He was unable to break the contact with the power line because his position below the victim did not allow him to strike the pruning pole solidly with the broom handle. The foreman then climbed down the tree. He obtained an aluminum extension ladder from two roofers across the street but, as he attempted to position it on the tree near the victim, he received an electrical shock. The rescue squad and the local utility company were summoned. No further attempts to rescue the victim were made until the utility company de-energized the power line. By this time the victim had been in contact with the power line for 20 to 30 minutes. The victim was removed from the tree and pronounced dead at the scene.

CAUSE OF DEATH

The coroner's office listed electrocution as the official cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should initiate a safety policy that addresses specific tasks performed by the employees, identifies safety hazards, and stresses safety training.

Discussion: The township did not have a safety policy that addressed safety training and procedures specific to tree trimming and other high risk tasks performed by township personnel. Written procedures should detail the tasks to be performed and should identify the safety hazards associated with these tasks. Training should be developed and implemented that addresses these proper work procedures. (Work practices such as working in trees without safety harnesses, men working directly above each other in trees while removing limbs, or maneuvering service drop lines with a broom handle are poor safety practices that greatly increase the risk of serious injury on the job.) The employer should assure that safety policies are enforced. Prior to the performance of a given task the crew foreman should perform a job site survey, which would identify any safety hazards present at a given job site (i.e., overhead power lines), then plan the methods to be used to accomplish the task. (Careful planning in this instance may have led to a safer method of removing the limbs from the tree.) Workers should then be made aware of the hazards they might encounter at a given job site.

Recommendation #2: Employers should provide proper equipment to perform job-related tasks.

Discussion: The township should consider using a non-conductive material such as fiberglass for tool handles when working in the presence of electrical hazards. A non-conductive material would greatly minimize the risk of injury due to contact with electrical power lines.

Recommendation #3: Local government organizations (i.e., municipal authorities, townships, etc.) should assure that personnel are qualified to perform assigned tasks.

Discussion: The workers in this instance were not qualified to perform this task, were not fully aware of the hazards associated with cutting trees down in the vicinity of power lines, and were not aware of procedures to minimize these hazards. The fact that the foreman placed the conductive aluminum ladder on the tree near the victim in a rescue attempt shows that he was not fully aware of the hazards associated with the power line. In this instance the local electric authority should have been contacted to remove the limbs from the tree to a safe point below the power line and the service drop lines. Electric authority personnel are qualified to work in the vicinity of power lines and would be better equipped to remove the tree limbs from around the power lines or the service drop lines. Once these limbs were removed to a safe point below the power lines, the maintenance crew would be able to safely cut down the tree.

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FACE 86-31: **23-Year-Old Groundman Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 30, 1986, at 8:20 a.m. a 23-year-old groundman was electrocuted while making preparations to anchor and plumb a previously set electric utility pole.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case will be included in the FACE Project. On July 17, 1986, a DSR research team met with employer representatives, interviewed comparison workers who perform the same tasks as the victim, interviewed the next-of-kin, conducted a site visit, discussed the incident with the OSHA Compliance Officer, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical contracting corporation that employs 200 people. The corporation has four divisions: 1) Power Line Construction; 2) Electrical Communications/Industrial Wiring; 3) Telephone Services; and 4) General Contracting.

SYNOPSIS OF EVENTS

This employer had been contracted by a local utility company to replace a number of existing wooden electric utility poles. This particular pole, which contributed to the accident, was set approximately four weeks prior to the accident. On the day of the accident, June 30, 1986, a five-man crew was assigned the task to plumb and anchor the previously set new electric utility pole. Electric distribution lines and a transformer were also to be transferred from the old pole to the new pole.

The crew consisting of a foreman, two linemen, and two groundmen arrived at the work site and began preparations to plumb and further anchor the new pole. Before the pole was moved into a plumb position, a lineman attached a temporary insulator on the side at the top of the new pole. A saddle which was attached to the primary line by two squeeze-on clamps was removed. The saddle was used to allow connection of the transformer to the primary line and once removed the two squeeze-on clamps remained on the primary line. The primary line was then positioned on top of the insulator and secured to the insulator with a 1/8" standard aluminum wire. The squeeze-on clamps, approximately six to eight inches apart, were located on either side of the insulator such that the primary line could not slide through the aluminum tie wire.

A groundman attached a chain winch to the guy and anchor, which had been put in place earlier, to move the pole to a plumb position. As this groundman operated the winch, the foreman, who was standing 25-35 feet away from the new pole, would visually check the new pole to determine if it was vertical. As the groundman operated the winch, moving the top of the new pole approximately two-three feet, tension was increased on the primary line tied to the insulator. The increased tension on the primary line caused the aluminum tie wire to break and the primary line moved away from the top of the insulator and down on top of the new pole, energizing it. At the same time the other groundman (victim) was moving a second guy into position to be hoisted to the top of the new pole for attachment. The victim walked between the new and old poles carrying the second guy. As he moved between the poles he passed the guy around the new pole from one hand to the other. The guy contacted the copper butt ground wire running down the side of the new pole, energizing the guy. The groundman holding the guy was electrocuted and the groundman operating the winch was seriously injured.

CAUSE OF DEATH

The county coroner stated the official cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Safe job work procedures should include the identification of all safety hazards prior to the commencement of work assignments.

Discussion: The squeeze-on clamps may have restricted the horizontal movement of the primary line through the aluminum tie, breaking the tie, and allowing the primary line to contact the top of the new pole. Identification and elimination of such hazards may preclude accidents of this type.

Recommendation #2: Squeeze-on clamps should be removed or positioned in a manner not to contact the insulator. The employer should also investigate alternate materials to be used for ties.

Discussion: Increased tension which was placed on the aluminum tie wire causing it to break may have been avoided if the squeeze-on clamps were either removed or positioned in a manner that contact with the insulator was eliminated. The standard 1/8" aluminum tie wire was apparently too weak and not flexible enough to withstand the increased tension applied to it by moving the pole into position. Alternate materials should be investigated by the employer and implemented where applicable.

The corporation vice-president was provided the following:

- Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines (85-111)

- Warning - Confined Space! Article by Richard W. Braddee and Ted A. Pettit. Reprinted from Operations Forum (June 1986), Volume 3: 22-23.

- Overview of the National Institute for Occupational Safety and Health (NIOSH).

FACE 86-32: General Laborer Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 2, 1986, a 17-year-old general laborer at a plant that produces pickles was electrocuted when he contacted a faulty splice on a 440 volt power cord.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 15, 1986, the DSR research team (consisting of a statistician and a safety specialist) conducted a site visit, met with employer representatives, interviewed witnesses and comparison workers, interviewed the next-of-kin, discussed the incident with the OSHA Compliance Officer, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed as a seasonal general laborer at a plant that produces pickles. The plant employs 230 permanent workers. During the growing season as many as 900 people may be employed at the plant.

The safety function at the plant is managed by the operations manager on a collateral-duty basis. An employee work manual is given to all permanent workers. When seasonal help is hired they are read basic safety rules and are trained on the job by another worker. A safety committee comprised of supervisory personnel meets weekly to discuss plant safety and discuss any accidents that may have occurred that week. This has been the second fatality at the plant in its 64 year existence.

SYNOPSIS OF EVENTS

On the day of the incident the victim and another seasonal general laborer were assigned by their crew chief to fill a wooden tank with pickling brine (45% salinity) using a two inch hose. The tank was eight feet high and twelve feet in diameter. One thousand of these tanks are utilized during the processing operation. The tanks are accessed by above ground wooden platforms with approximately three and one-half feet of the tank rising above the floor of the platform.

The co-worker turned on a valve located approximately 20 feet away and the victim proceeded to fill the tank with brine. When the tank had been filled the victim called to the co-worker to turn the valve off. The victim dropped the two inch hose to the platform after the valve had been closed, allowing the brine in the hose to drain out onto the platform. A portable pump and its power cord were on the platform in the vicinity of the tank. The pump was not turned on, but was plugged into a pole-mounted power box approximately 45 feet away. The power cord supplied 440 volts of electricity to the pump. After the victim dropped the two inch hose he stepped away from the tank and onto the 440 volt power cord. The victim immediately shouted and leaned back against the tank remaining in an upright position. The co-worker moved towards the victim, but as he approached the area of the platform saturated with brine he felt electric current running into his foot and leg from the platform boards. The co-worker jumped back and yelled to a second co-worker to turn off the electricity. The second co-worker could not find the switch box so he went to the crew chief and explained what was happening. The crew chief ran to the accident site, observed what was happening, ran across the aisle between the platforms, crossed the next platform, and turned the electricity off. The crew chief then returned to the accident site and along with the second co-worker began to administer CPR to the victim.

A rescue squad was called and arrived at the scene within three minutes. The crew included a medical doctor. CPR was continued for a short period, then the victim was pronounced dead at the scene.

Upon examination a faulty splice was found in the 440 volt power cord of the pump. Two of the leads of the power cord were bare and exposed. These exposed leads allowed the area of the splice to become energized along with the brine saturated portion of the platform. Additionally, the canvas deck shoes and lower portion of the victim's pants were saturated with the brine solution. The 45% salinity of the brine solution increased the conductivity of the entire area due to the conductive traits of the salt.

CAUSE OF DEATH

The coroner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should assure that existing preventive maintenance programs assure that equipment is in safe operating condition.

Discussion: Guidelines for reporting and correcting dangerous or unsafe conditions exist at the plant. Apparently they are not being followed. Periodic inspections should be performed on all plant maintenance and production equipment. These inspections should identify any hazards present and management should take appropriate corrective action. These inspections should be complemented by daily inspections of equipment by qualified personnel before the equipment is put into use. These daily inspections should include the identification of such hazards as cuts or abrasions on conductive cords, equipment cord and plug connections, improper splices, or any other unsafe conditions. Had the preventive maintenance program been utilized at the plant, it is unlikely the faulty splice would have existed. Since the incident all spliced power cords have been replaced with new cords. Additionally, if portable equipment such as the pump is not in use it should be de-energized and its power cord should be wound up and placed on the pump in an orderly fashion.

Recommendation #2: Employers should alert employees of hazards that they may encounter while performing their work tasks and how to control these hazards.

Discussion: The seasonal employees are read basic safety rules when they start work. However, they are not trained in hazard awareness and recognition or how to control these hazards if encountered. Valuable time was lost before de-energization of the pump because the co-worker did not know the location of the power switch and had to summon the crew chief. Persons working with or around electricity should be made aware of the location of switches or breakers that would de-energize their work area.

FACE 86-33: **26-Year-Old Electrician's Helper Electrocuted in South Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 2, 1986, at approximately 5:00 p.m. an electrician's helper was electrocuted while wiring a fluorescent light fixture in a suspended ceiling.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of South Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 18, 1986, the DSR research team (consisting of a research industrial hygienist and an epidemiologist) met with representatives of the company. Interviews were conducted with co-workers who perform the same tasks as the victim. The site of this fatality was not visited. Photographs of the accident site were provided by the employer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This is an electrical contracting company that has been in operation since 1960 and employs approximately 230 personnel. The company has a written safety policy and safety program. The Executive Vice-President is assigned responsibility as the primary safety officer on a collateral-duty basis. Safety rules are established, communicated, and enforced by supervisory personnel. Job supervisors are assigned the primary responsibility to ensure safety at the job site and are provided an operations manual which contains a section on safety. The employer retains a safety consultant who communicates directly with field supervisors on potential hazards. All safety training is provided on the job; otherwise, the company has no formal training program.

SYNOPSIS OF EVENTS

On June 2, 1986, at approximately 5:00 p.m. five electricians and/or electrician's helpers were assigned the task of wiring fluorescent light fixtures in a suspended ceiling of a new wing of a hospital. The panels for the drop ceiling were not in place. Emergency fixtures on a separate circuit were to be wired first and then existing temporary lights were to be de-energized . The crew decided that this process was too slow and, contrary to supervisory directions, proceeded to disconnect the temporary lights and wire the remaining fixtures while some circuits were energized. Co-workers warned the entire crew to test circuits to determine if they were "hot"; however, the victim elected not to use a circuit tester offered to him by a fellow employee. Each member of the crew was to wire the three conductors of a romex cable to the three conductors of the fixture. Members of the crew reported receiving shocks during the installation process.

The victim was standing on a wooden ladder with his body extended above the ceiling grid work which was approximately nine feet above the floor. The victim was wet with perspiration from the warm working conditions. In order to connect the light fixture, he had to lean against the metal grid work while extending his body and arms to reach the conductors to be wired. As he was performing this task, a noise was heard by members of the crew. A co-worker went to the area where the victim was working and saw the victim dangling from the ceiling grid. The co-worker climbed the wooden ladder which the victim had been using and pulled him free of the grid work. The co-worker tried to carry the victim down the ladder; however, both fell to the floor, as they neared the bottom of the ladder.

The co-worker ran into the hospital for help and a doctor and a nurse responded immediately. Cardiopulmonary resuscitation (CPR) was begun and other emergency hospital personnel responded. After an extended effort by medical personnel, the victim was pronounced dead at the scene of the accident.

CAUSE OF DEATH

The medical examiner's certificate of death listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees who work with electrical conductors should de-energize the conductors and take appropriate action to ensure the conductor cannot be accidently re-energized.

Discussion: The crew knew that some circuits were energized. The victim should have tested to determine whether the circuit that he was wiring was "hot" and he could have postponed wiring this fixture until after the emergency lights were wired. Once the circuit was de-energized and locked out/ tagged the wiring could then have been performed safely.

As a result of this incident, the company has had all employees sign a statement that they will not work on energized circuits. Working on energized circuits is contrary to company policy and the company has tried to re-emphasize this policy by using this mechanism.

Recommendation #2: Circuit testing equipment should be provided and used by employees.

Discussion: The victim was not using a circuit testing device at the time of the accident. All employees should be provided proper testing equipment and be trained in its use.

Recommendation #3: Employers should ensure that all employees are aware of workplace hazards and safe operating procedures. This can be accomplished by a company-wide training program.

Discussion: At present the company has neither formal training programs for new employees nor periodic retraining of all employees. Safety training would ensure knowledge of hazards and proper operating procedures.

Recommendation #4: Companies should not let serious accidents or fatalities occur without some effort towards prevention.

Discussion: Companies can often alter the task which was being performed at the time of the accident, inform all employees of what occurred in order to prevent similar accidents, or change company procedures in regards to safety and hazard recognition. This company reinforced company policy by having all employees sign a statement that they would not work on energized circuits. Also, a written tool box explanation on how the fatality occurred and how it could have been prevented was developed and distributed. All company project managers bi-weekly complete a Project Manager Safety Check List for each job site and provide it to the Safety Officer at the project review meetings. This is a change in the company's previous procedure in regards to hazard recognition and compliance with the company's safety program. This forces project manager involvement in workplace safety.

FACE 86-35: 34-Year-Old Maintenance Worker Electrocuted in Ohio

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 29, 1986, a maintenance worker temporarily assigned to the night shift was electrocuted while in the process of replacing a ballast in a fluorescent light fixture.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 21-22, 1986, a safety specialist and a safety engineer met with representatives of the employer and interviewed co-workers and next-of-kin.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a manufacturing company that employs approximately 2000 people. The company operates three shifts five days a week. The company employs a full-time director of safety and security, an assistant director, and a secretary. The safety department staff spends 65 percent of its time on security and environmental issues. The director of safety is in the process of rewriting company safety and security manuals. The frequency and severity rates of the employer are comparable to those rates within the manufacturing industry.

SYNOPSIS OF EVENTS

The 34-year-old victim had been employed as a maintenance worker for 16 years with this employer. He had been assigned to work vacation relief on the third shift. At the time of the incident he was starting the last week of this three week assignment.

As the victim entered the factory at approximately 11:00 p.m. he noticed an overhead fluorescent light was out. Since he was the only maintenance worker on the third shift, it was his responsibility to replace the ballast and fluorescent tubes. This was considered a routine task for the victim. After returning from the maintenance shop with new tubes and a ballast, he obtained a manlift to elevate himself 12 feet above the floor to a height where he could comfortably work on the light fixture. (See figure.) He removed the old tubes, metal shade, and a line fuse from the black wire which he assumed was the hot wire. The victim did not de-energize the conductor to the fluorescent lights. This could have been easily accomplished by disconnecting the twist out outlet box attached to the universal lighting duct or by removing the universal contact which was located beneath the metal fixture and which helps support the light fixture. He then cut all eight wires which were connected to the old ballast and started to strip insulation from the white wire. Apparently while holding the white wire in his left hand, he braced his left index finger against the metal structure supporting the light fixture. Holding the wire strippers in his right hand, the victim began to strip the insulation from the conductor. As he was stripping the insulation his metal wire stripper made contact with the hot conductor at the same time his left hand was braced against the metal structure. The victim received an electrical shock from the 277 volts which serviced the light fixture.

A co-worker heard a noise, turned from her work station, and saw the victim laying face up on the platform of the manlift. She immediately summoned a nearby worker who lowered the platform and moved the victim onto the floor. Workers immediately began CPR and continued until the EMS arrived. The EMS attempted to revive the victim at the site for 30 minutes before transporting him to a local hospital. He was pronounced dead two hours later.

CAUSE OF DEATH

The coroner ruled that electrocution was the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees who work with electrical conductors should de-energize the conductors and take appropriate action to ensure the conductors can not be accidently re-energized.

Discussion: Within 20 feet of the accident site a twist out outlet box was attached to a universal lighting duct. The purpose of the twist out outlet box and the universal lighting duct is to provide 277 volt service to four fluorescent light fixtures in the area. All conductors in the light fixtures would have been de-energized by disconnecting the twist out outlet box. As an added safety precaution, the line fuse located inside the light fixture should be removed as well. In this case the line fuse was removed. Unfortunately the fuse was on the black (neutral) wire and not the white (hot) wire. The victim could have de-energized the light fixture he was working on by disconnecting the universal contact; however, this is more difficult because the universal contact supports the lighting fixture. The universal contact works exactly like the twist out outlet box. Both the twist out outlet box and the universal contact involved in this incident were non-polarized units. One of these units was installed backwards causing reverse polarity in the conductors. By not maintaining polarity, the black wire in the lighting fixture became the neutral and the white wire became hot.

Recommendation #2: Correct electrical polarity should be maintained throughout the electrical service area.

Discussion: The busway within the universal lighting duct is marked + and -. The twist out outlet box should be installed within the universal lighting duct so that polarity is maintained. The twist out outlet box and the universal contact involved in this incident were not polarized. One of these two units was installed backwards which caused reverse polarity. The twist out outlet box involved in this accident had been installed in 1965. Newer outlet boxes are polarized and will maintain polarity in the universal lighting duct. All electrical systems at the manufacturing plant should be evaluated to assure correct polarity is maintained.

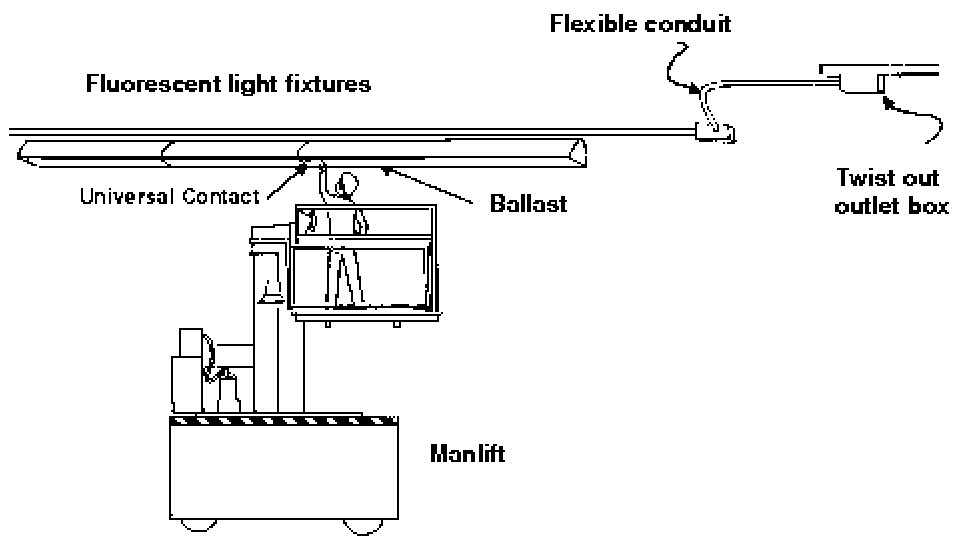

__Figure__. Worker Replacing Ballast from Manlift Platform

FACE 86-36: 22-Year-Old Construction Worker Electrocuted in Kentucky

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 10, 1986, a carpenter was electrocuted when a portable electric saw he was using apparently developed a ground fault.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Kentucky notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 23, 1986, the DSR research team (a safety specialist and a safety engineer) met with employer representatives, conducted a site visit, interviewed comparison workers and a surrogate for the victim, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The general contractor and the construction subcontractor both stated that the victim was an independent contractor and was not an employee. Representatives of the construction subcontractor stated that their company paid the workers' compensation for the victim; however, most employees at this work site were designated independent contractors.

The work site did not have a safety program.

SYNOPSIS OF EVENTS

The victim (a 22-year-old carpenter) was working at a construction site where a 396 unit apartment complex was being built. The victim had agreed to construct the wooden framework for a laundry building located at the site. Electricity to operate portable power tools was supplied to the laundry building from a temporary service pole approximately 50 feet away. This temporary service pole had not been inspected by the city having jurisdiction and did not satisfy the applicable code requirements (not grounded, etc.). Mounted on the temporary pole were a panel box, a ground fault circuit interrupter (GFCI) receptacle installed in a weatherproof box, and a regular receptacle installed in a weatherproof box (or a total of two duplex receptacles). The victim used a homemade extension cord (Type NM, 12/2 wire with a four-gang receptacle and a plastic box) to supply power from the receptacle on the temporary pole to the laundry building. A second extension cord (UL approved) was used to supply power from the homemade extension cord to a portable power saw. The accident site was wet, since it had rained hard the previous night and had sprinkled that morning. It was hot and humid and the victim was sweating.

The victim had cut the tails off of two roof trusses (that portion of the roof truss that overhangs the walls) and was preparing to come down the makeshift ladder (a piece of a floor truss). When he shifted his portable power saw from his right hand to his left hand, he was shocked. The victim fell from the ladder into a puddle of water at the base of the ladder. Apparently, when he contacted the source of electricity, his left hand contracted and he was "locked" to the power saw. This contact with the power saw (the electrical source) continued until a co-worker was able to disconnect the power cord to the saw and the extension cord.

An untrained co-worker tried to give the victim CPR. Approximately five minutes after receiving the call EMS personnel were at the scene and advanced cardiac life support was given. The victim was transported to a local hospital, where he was pronounced dead at 12:38 p.m. The victim had burns on his left hand (the hand gripping the saw) and his left thigh.

CAUSE OF DEATH

Not available at this time.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical equipment that is malfunctioning should be taken out of service immediately and not used until evaluated and approved by qualified electrical repair personnel.

Discussion: The victim reportedly had been receiving shocks throughout the morning. He apparently replaced one of the extension cords he had been using in an effort to eliminate these shocks; however, the source of these shocks (the saw) was not replaced.

Recommendation #2: Equipment should be used only for those applications for which it was designed and approved.

Discussion: Although it does not appear that the homemade extension cord contributed to this accident, it was not approved for this application and should not have been used. The makeshift ladder (i.e., a floor truss) was totally inadequate to be used as a ladder.

Recommendation #3: Electrical service supplied to a construction site should comply with all local regulations and OSHA standards.

Discussion: The temporary pole supplying service to the laundry building was not inspected and wiring methods did not comply with the requirements of applicable regulations. OSHA Standard 1926.400(h)(2) requires that all 120 volt, single-phase, 15-and- 20-ampere receptacle outlets on construction sites, which are not part of the permanent wiring of the building or structure, have approved GFCIs. Mounted on the temporary pole were a panel box, a GFCI receptacle installed in a weatherproof box, and a regular receptacle installed in a weatherproof box (or a total of two duplex receptacles). The GFCI receptacle and the receptacle that the victim was using were tested the day after the accident and both apparently operated properly. Therefore, it can only be conjecture at this time why the GFCI did not adequately protect the victim. The three most obvious reasons for this failure are (1) the GFCI failed to operate properly, (2) the regular receptacle was not protected by the GFCI, or (3) the weatherproof boxes were not sealed adequately.

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FACE 86-39: **Two Workers Electrocuted in Tennessee**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 17, 1986, two workers (a painter and a carpenter) were electrocuted when a scaffold they were moving contacted a high voltage line. The scaffold and the power line were both approximately 25 feet high.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case will be included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On July 30, 1986, a DSR medical officer conducted a site visit and met with representatives of the company which employed the victims. Interviews were conducted with co-workers and the owner of the company employing the victims; no one witnessed the incident. A surrogate interview was conducted to obtain personal characteristics of one of the victims. The accident site was visited with a Tennessee OSHA compliance officer and photographs were taken.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victims worked for a painting contractor, who employs between two and seven workers (depending on available work) as "independent subcontractors." There is no written safety policy and safety meetings are not held. The company's safety program consists of verbal hazard identification and instruction by the company's owner, who personally visits each job site on a regular basis. Several witnesses agreed that the owner/manager had cautioned both men to be careful to avoid the power lines when moving the scaffold.

SYNOPSIS OF EVENTS

On June 17, 1986, four workmen were scraping and painting church windows. Of the 78 windows in the church, only four windows remained to be painted. The temperature at the time of the accident was above 90 degrees Fahrenheit and there was no noticeable wind. The sky was clear and the ground was dry.

The two victims completed their work on the North side and began moving the scaffold around the building, preparing to begin painting windows on the East side. The scaffold consisted of five joined five-foot sections (approximately 25 feet high) on rubber casters. One worker was a painter who had been with the company since November 1985, and the other was a carpenter who was working temporarily for the company while between jobs. The carpenter had worked for the company only eight days, but he did have extensive experience constructing and using scaffolds.

The workers moved the scaffold in an easterly direction (see Figure, Position A), then turned to a southerly direction, circling around a tree which was close to the building. They passed near or under a 12,000 volt line which was approximately 30 feet in elevation (Position B). They continued circling the tree, rotating the scaffold and pushing it towards the East face of the building. The power line changed direction at the pole and the elevation of the line dropped about five feet to approximately 25 feet. The scaffold contacted one phase of the 12,000 volt line (Position C), completing a path to ground (7200 volts phase-to-ground) through the two men and electrocuting them. The ground fault relay of the power company, set at 1750 amps, did not open the circuit breaker. This probably occurred because the casters were made of rubber and the current through the two victims did not exceed 1750 amps. The line was not de-energized until representatives of the power company came and physically removed the jumpers which ran from the North/South lines to the East/West lines.

The victims were in contact with electrical energy for approximately 12 minutes. This prolonged contact caused extensive thermal damage and no resuscitative efforts could be undertaken when the victims were finally removed from contact with the source of electrical energy.

CAUSE OF DEATH

The medical examiner ruled the cause of death for both men to be accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A specific plan of action which ensures safety should be incorporated into job planning when there is a potential risk of contacting electrical energy.

Discussion: The planned move of the scaffold was intrinsically hazardous. While the owner cautioned the men about the high voltage lines, no specific plan to perform the work safely was formulated. Such a plan might have included removing the top section of the scaffold during the move, or trimming tree branches so the scaffold could be kept well away from high voltage lines.

Recommendation #2: When moving a scaffold in the vicinity of electrical lines, an observer without other duties should be available to help maintain a safe distance between the scaffold and the electrical lines.

Discussion: The midday sun may have affected the victims' view when they looked up at the high voltage lines running East/West and they may have assumed that these lines were the same elevation as those running North/South. An independent observer would have been free to choose a different vantage point and aid in maintaining separation between the scaffold and the high voltage lines.

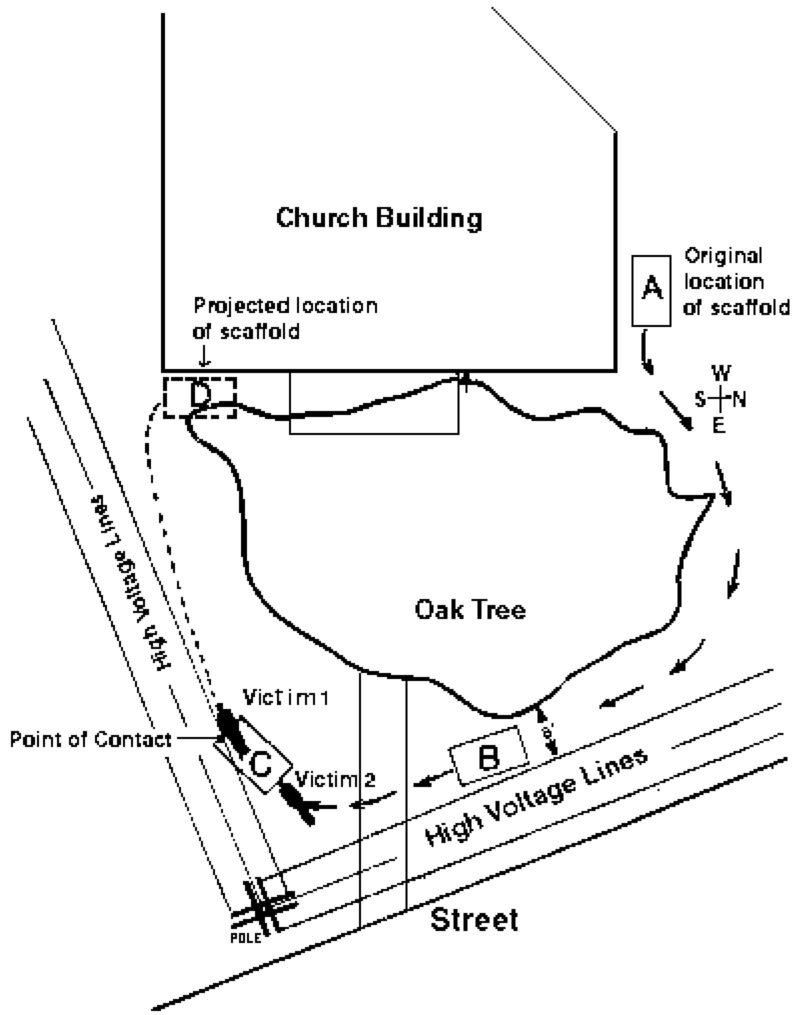
Church Building
Original location of scaffold
A
Projected location of scaffold
D
W
S
N
E
Oak Tree
High Voltage Lines
Victim 1
Point of Contact
C
Victim 2
B
High Voltage Lines
Street
POLE

Figure.

FACE 86-40: **37-Year-Old Lineman Electrocuted in Georgia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 17, 1986, a 37-year-old lineman was electrocuted while reaching overhead with a hot-stick to place a jumper line on one phase of a three-phase 7200 VAC primary line. In his attempt to re-energize the de-energized line it is assumed his hand contacted the barrel of an energized fuse cut-out causing electrocution.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Georgia notified DSR of this fatality and requested technical assistance. This case has been included in the FACE Project. A DSR researcher conducted an evaluation of this case and included interviews with the safety director of the power company, a surrogate for the victim, and comparison workers. Discussions were held with the OSHA Compliance Officer and the attending medical examiner. The medical examiner's autopsy report was obtained. The safety director of the power company and the DSR researcher visited the accident site. Photographs were taken of the accident site and the equipment being used by the victim when the accident occurred.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The rural utility company has been in operation since 1939 and under the same management for all 47 years. The company has a written operations safety manual that is given to all new employees. This manual states that it is "the employees' responsibility to become familiar with all the contents of the manual and to comply with all the rules and regulations while at work with the company." Training of new employees is performed on-the-job by a foreman or experienced employee. The owners and safety personnel appear to be conscientious and willing to provide a safe work environment. All protective equipment is inspected regularly and all insulative rubber gloves are given an electrical test at least every 60 days with faulty gloves being destroyed. The utility company provides hard hats, rubber and leather gloves, rubber blankets, hot sticks, and voltage testing equipment. Employees are responsible for providing safety belts and pole climbing gaffs.

SYNOPSIS OF EVENTS

On the evening of June 17, 1986, eight utility workers were working overtime to repair a 7200 VAC underground distribution line. Before the underground line could be repaired the crew foreman de-energized the line by removing a jumper and opening a fuse cut-out on a pole one mile west of the work site.

After the underground repairs were made, four men were to re-energize the line by replacing the jumper and closing the fuse cut-out. The victim had climbed the pole and attempted to place a jumper on the main line using an eight foot long hot stick. The victim expressed to the workers on the ground that he felt the jumper was too short. When the victim tried to place the jumper on the main line he apparently made incidental contact with the 7200 VAC barrel of the cut-out (see Figure 1).

Even though the victim was unconscious he did not fall off of the pole because he was being supported by a safety belt and steel climbing gaffs which he had embedded into the pole. Workers summoned their foreman who arrived at the accident site approximately two minutes later. He administered CPR to the victim at the top of the pole for approximately eight to ten minutes. Pole top rescue techniques, utilizing a block and tackle (cable and winch), were used to lower the victim to the ground. Emergency medical personnel arrived approximately 20 minutes after the accident occurred and transported the victim to the local hospital. The victim was pronounced dead at the accident site.

At the time of the accident the only protective equipment being worn by the lineman was a pair of non-insulative leather gloves. These leather gloves are to be worn over insulative rubber gloves at all times to protect the rubber gloves. Company regulations require that rubber gloves with leather protectors must be worn by all lineman when climbing or working on any pole to which energized conductors are attached.

CAUSE OF DEATH

The autopsy report listed the cause of death as electrocution due to contact with 7200 VAC. Contact with electrical energy was with the back of the left hand with current passing through his body exiting through the victim's left foot where he was wearing steel climbing gaffs.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should enforce existing regulations concerning the use of safety equipment and safe work practices.

Discussion: An Operations Safety Manual is distributed to all new employees by the rural utility company. Guidelines in this manual should be practiced by employees and enforced by supervisors. This manual states that, "Foremen at all times are responsible for the execution of the work in a safe manner and for the job performance of all employees under their direction."

Recommendation #2: When working near a high voltage line workers should wear all appropriate personal protective equipment.

Discussion: When the accident occurred, the victim was only wearing a pair of leather gloves which are normally worn over rubber gloves to prevent tears and punctures that would weaken the insulative properties of the rubber gloves. The operators safety manual states that "leather protectors shall be worn over rubber gloves at all times" and that "rubber gloves with leather protectors must be worn by all linemen when climbing or working on any pole to which energized conductors are attached."

Recommendation #3: All exposed high voltage conductors should be covered with rubber hoses, boots, or blankets.

Discussion: The victim did not use any insulative barriers to cover the 7200 VAC power line system. When working in close proximity to high voltage powerlines, all exposed conductors in contact distance within a work area must be covered to eliminate the occurrence of an accident.

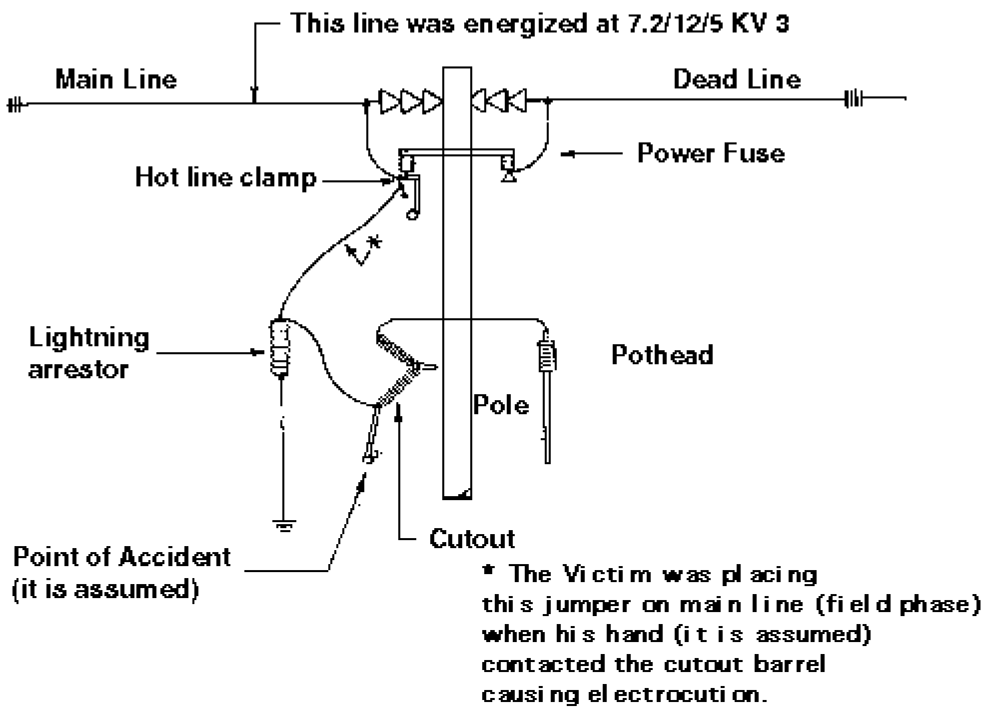

***Figure 1**. Profile of Accident Pole*

FACE 86-41: **52-Year-Old Electrical Technician Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 21, 1986, a 52-year-old electrical technician was electrocuted while testing circuits in a metal cabinet housing power transmission and distribution equipment (see Figure).

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 13, 1986, a DSR research team (consisting of a safety specialist and a research industrial hygienist) conducted a site visit, met with employer and union representatives, interviewed comparison workers and a surrogate for the victim, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a company that designs, manufactures, and markets high voltage power transmission and distribution equipment. This facility, in operation since 1958, employs 700 people.

The safety function is managed by the industrial relations supervisor on a collateral-duty basis. A comprehensive written safety program exists at the company. Most high risk jobs have a written safe job procedure. New employees receive on-the-job training from co-workers and supervisors. The company has a Safety Policy Committee (whose membership consists of management executives), a Union Safety Committee (whose membership consists of employees), safety observers (designated employees in each department), an infirmary which is staffed by an occupational health nurse during the day shift, and a fire brigade. Each of the safety committees meet monthly.

SYNOPSIS OF EVENTS

A small part of the company's business is to repair power transmission and distribution equipment which is housed in metal cabinets. Having completed the repairs on electrical components within one of the metal cabinets the previous Saturday, the repair shop sent the unit to the quality assurance department for a final check. The metal cabinet (6' wide, 5' high, and 5' deep) contained a one KVA transformer, a capacitor, and two 5000 ohm resistors. Electric service (110 volts, 60 Hz, 20 amp) was supplied to the one KVA transformer from a bank of receptacles located on a variable output transformer (rated 0-240 volts) used for testing. The one KVA transformer stepped up voltage to 10 kV. There were no audio or visual indicators that electricity was being supplied from the variable output transformer to the electrical components within the cabinet.

While checking out the unit, the victim determined that the rectifiers in the control circuit were shorted. Both rectifiers were replaced and the victim continued to follow the testing procedure check list. At approximately 1:30 p.m. the victim was at the point in the test where he was to measure the resistance of the two 5000 ohm resistors with an ohmmeter. Apparently he reached into the cabinet with his left hand and attempted to remove one of the resistors. When he touched the resistor his body provided a path to ground and he was electrocuted. The victim fell to the concrete floor.

A nearby co-worker saw a flash, went to the fence enclosed work area, and immediately de-energized the power. Another co-worker called the company nurse. A third co-worker and the company nurse administered CPR until the EMS arrived. The EMS began advanced cardiac life support. The victim was transported to a nearby hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The coroner determined that the cause of death was due to electrocution. The victim had burns on his left forefinger and thumb (entry wound) and a burn on his right thigh (exit wound).

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The testing procedure and the check list for this task should be re-evaluated. All unnecessary exposure to energized equipment should be eliminated or personal protective equipment should be identified.

Discussion: The test procedure should be re-evaluated to identify any unnecessary exposure to energized equipment. Engineering controls should be used whenever possible to protect test personnel from inadvertent contact with energized equipment. One design modification that could be used to eliminate/ minimize exposure to energized equipment would be the use of a dead-man control. During testing and repair, all electrical energy could be supplied to these cabinets through a dead-man control. This design would require the electrical technician to be away from the cabinet, so that he could not contact energized circuitry. Personal protective equipment should be used during those procedures that require test personnel to be in the cabinet while the equipment is energized.

Recommendation #2: Workers should follow the testing procedure check list and safe job procedure for repairing and testing a cabinet containing power transmission and distribution equipment.

Discussion: The testing procedure required the victim to de-energize the circuitry within the cabinet before removing the resistors. The victim did not de-energize the circuits. When he attempted to remove a resistor with his hand, he made contact with 10 kV.

Recommendation #3: The variable output transformer should be redesigned so that it is controlled by one ON/OFF switch.

Discussion: The variable output transformer supplied 110 volts to receptacles located on the side of the variable output transformer and supplied variable voltage (from 0-240 volts) through a rheostat to four contact points located on top of the variable output transformer. Each of the two sources had its own individual ON/OFF switch located on the top of the transformer. Even though the switch controlling the variable voltage portion of the transformer was in the OFF position, the switch controlling the receptacles was in the ON position and energy was supplied to the metal cabinet.

Recommendation #4: The design of power transmission and distribution equipment should incorporate safety considerations to protect workers who maintain, repair, and test these cabinets.

Discussion: The current design of these cabinets does not include (1) a power ON indication for the cabinet, (2) interlock of the access to the cabinet, (3) adequate insulation of the conductors inside the cabinet to safeguard against accidental contact, or (4) appropriate warning signs. Design considerations similar to the above should be incorporated into these cabinets. For instance a power ON indicator could be installed in a conspicuous location, as near as possible to the service entrance of the metal cabinet. The indicator would serve as a reminder that electrical energy is being fed into the cabinet. The victim had repaired many similar pieces of equipment previously and he was considered an experienced electrical technician. The indicator may have alerted him to the fact that the cabinet was energized.

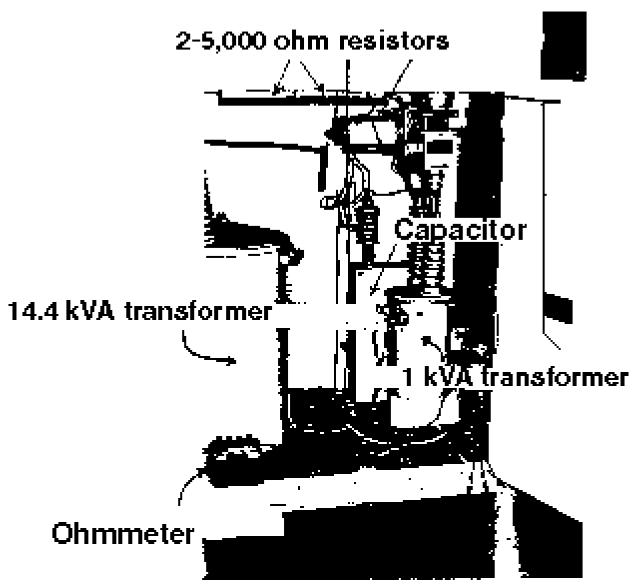

***Figure**. Cabinet Containing Power Transmission and Distribution Equipment Involved in Fatality*

FACE 86-42: **31-Year-Old Groundman Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 4, 1986, at approximately 8:30 p.m. a groundman was electrocuted while performing maintenance on electrical service lines to a residence.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 28, 1986, a DSR research team met with employer representatives, interviewed comparison workers, conducted a next-of-kin interview, conducted a site visit, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a municipal electrical service department and his duties included installation and service to electrical systems throughout the municipality.

A safety program has been developed and implemented. An electrical supervisor is assigned responsibility for the safety program on a collateral-duty basis. Additionally, monthly safety meetings attended by representatives of management and the hourly employees have been instituted as of August 28, 1986.

SYNOPSIS OF EVENTS

On August 4, 1986, a private electrician, who was hired by the owner of a residence to check the residence for electrical problems, had determined that a voltage loss was occurring at the residence. A telephone call was then placed by the owner of the residence to the local municipal electrical service department requesting assistance. A standby crew consisting of a groundman (the victim), who was being considered for a lineman position due to his previous lineman experience with other electrical contractors, and a foreman were dispatched to the residence.

At approximately 8:00 p.m. the standby crew arrived at the residence and determined that the electric service line connectors, which provide the electrical link between the 120/240 volt, three-phase power lines and the electrical lines supplying power to the residence, were corroded and needed cleaning. The aerial truck was then positioned and the bucket raised until it was about 18 to 24 inches away from the power lines, which were approximately 20 feet above the ground. The victim, who was in the bucket, detached the three service lines, cleaned two of the connectors, and re-attached two of the three electrical service lines to the power lines. The foreman, who was on the ground conversing with the electrician, did not witness the accident. Apparently, the victim, who was in the process of cleaning the third service line connector, contacted the energized power line and was electrocuted.

The foreman, after realizing what had happened, lowered the bucket containing the victim and immediately started CPR. An ambulance arrived within 5-10 minutes after the occurrence of the incident and emergency medical service was provided to the victim who was then transported to the local hospital where he was pronounced dead 15 minutes after arrival.

CAUSE OF DEATH

The medical examiner's certificate of death listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Safety rules governing the wearing of personal protective equipment should be enforced.

Discussion: The groundman (victim) was working on energized power lines without wearing insulated rubber gloves which were required by the employer. It should be the responsibility of the employer to enforce all safety rules governing the wearing of personal protective equipment. Prior to the performance of a given task, the crew foreman should perform a job site survey which would include the identification of safety hazards and personal protective equipment to be utilized.

Recommendation #2: Safety equipment (insulated line hose) should be used where applicable.

Discussion: Identification and elimination of all safety hazards should be completed prior to the performance of hazardous tasks. Insulated line hose should have been utilized to cover the energized power lines to prevent incidental contact of the power lines.

The managerial staff of the employer was provided the following documents:

- Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines (85-111)
- Overview of the National Institute for Occupational Safety and Health (NIOSH)
- Overview of the Division of Safety Research (DSR) .

FACE 86-43: **25-Year-Old Restaurant Manager Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 3, 1986, a manager of a restaurant was cleaning the floor of the kitchen, when he came into contact with a refrigerator that had a ground fault and he was electrocuted. The restaurant was closed and the restaurant manager's wife and two-year-old daughter were waiting in the dining area for him to finish.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 26, 1986, a DSR epidemiologist and a safety engineer conducted a site visit, met with the owner of the restaurant, interviewed the next-of kin, interviewed a representative from a control restaurant, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This fatality occurred at a small specialty restaurant that employs fifteen workers. The restaurant is opened for business only on Thursdays, Fridays, and Saturdays and was for sale at the time of the accident. The manager was cleaning the restaurant in preparation of a visit by a prospective buyer.

The employer did not have a formalized safety program.

SYNOPSIS OF EVENTS

On August 3, 1986, a manager of a restaurant was cleaning the floor of the kitchen, when the accident occurred. The restaurant was closed and the restaurant manager's wife and two-year-old daughter were waiting in the dining area for him to finish.

The victim, who was wearing tennis shoes, had put soap and water on the floor and was walking towards the dining area when he slipped and fell. As he fell, he tried to catch himself and he grabbed the handle of a commercial refrigerator nearby. The refrigerator had a ground fault and was not grounded (the cord did not have a ground prong). The ground fault apparently was the result of excessive wear on the insulation of the conductors that supplied electricity to the compressor unit. These conductors were exposed at a cutout hole in the case of the refrigerator, were not protected from abrasion, and were not protected by strain relief.

The victim's wife responded to the noise in the kitchen and tried to separate the victim from the refrigerator. She was shocked, but was able to separate the victim from the refrigerator and drag him into the dining area. She started CPR and contacted the father of the victim (the owner of the restaurant), who called the emergency medical service (EMS). The EMS responded approximately ten minutes after being contacted; however, the time interval between the accident and notification of the EMS could not be determined.

CAUSE OF DEATH

Not available at this time.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All electrical equipment (such as refrigerators) should be designed and maintained to comply with all applicable requirements of the National Electrical Code.

Discussion: The refrigerator involved in this accident was not grounded, had exposed conductors, and did not have strain relief provided for the cord. Additionally, the conductors were not protected from abrasion at the cutout hole. These conditions apparently developed over time and were not recognized as hazardous. The refrigerator was bought used and the owner did not have the owner's manual.

Recommendation #2: Restaurant owners and managers should be encouraged to conduct formalized safety training for all restaurant employees.

Discussion: The hazards to which restaurant employees are exposed are often not recognized by owners and employees because of the similarity to home kitchens and familiarity with many of the tasks performed. However, the severity of these hazards increases because of the increased level of activity and the commercial nature of the operation.

Recommendation #3: All electrical receptacles in kitchen areas of restaurants should be protected by ground fault circuit interrupter breakers or receptacles.

Discussion: NIOSH ALERT (85-104), "Request for Assistance in Preventing Electrocutions of Workers in Fast Food Restaurants" (December, 1984), recommends that GFCIs be installed in the areas where electricity and wetness coexist (i.e., kitchens in restaurants).

FACE 86-45: **29-Year-Old Electrocuted at Ice Cream Plant in Tennessee**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 16, 1986, a 29-year-old maintenance man was in the process of trouble shooting an electrical problem with a popsicle wrapping machine when he was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Tennessee notified DSR concerning this fatality and requested technical assistance. This case has been included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On August 27, 1986, a research industrial hygienist conducted a site visit and met with the production manager and an insurance representative of the company. At the request of the company, co-workers and next-of-kin interviews were precluded.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an ice cream company that employs approximately 110 people. The ice cream plant produces frozen dairy products, i.e., ice cream in various size containers, ice cream cones, ice cream sandwiches, and frozen novelty products. Approximately 60 employees work in the ice cream and frozen novelty production area. New employees are given a plant orientation, which includes a manual on plant procedures and safety requirements. The production manager goes over the manual with the new employee and answers any questions. On-the-job training is provided by a co-worker and supervisor. The production manager is also responsible for overall supervision and training of maintenance personnel. Monthly meetings are held to discuss safety issues with production employees and supervisors.

SYNOPSIS OF EVENTS

On June 16, 1986, the operator of the popsicle wrapping machine notified maintenance that the machine was inoperative. The victim, a 29-year-old maintenance man with six years' experience with the company (four years as a journeyman electrician in maintenance) responded to repair the machine. When he pushed the reset button, the machine started, ran for approximately ten minutes, and then shut down. The victim returned to the maintenance shop and obtained an electrical testing device to test the circuits. He returned with the test device and removed the metal cover from the control box of the machine which housed three reset controls and a fuse. With the cover removed he attempted to restart the machine using the reset buttons; however, he was unsuccessful. The victim was sitting on an elevated metal platform (12 inches high) while working on the machine and the floor was wet.

A few minutes later the machine operator heard a moan and noticed the victim slumped over with his hand on the control box. (Two fingers were inside the control box contacting a 230 volt energized circuit.)

A co-worker went across the room and shut off the main control switch to the machine. The 911 number was called and the EMS arrived in approximately twenty minutes. During the interval between calling for the EMS and their arrival, two co-workers administered CPR. The victim was transported to a local hospital and was pronounced dead-on-arrival.

CAUSE OF DEATH

The cause of death was cardiac arrest as a result of electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A training program in hazard recognition and control should be instituted as part of safety meetings for all employees, especially for employees required to work on or around energized equipment and in wet work areas.

Discussion: Although workers may be aware of on-the-job, day-to-day hazards, they sometimes become complacent of such hazards. This complacency, especially when working with electrical energy, can lead to a serious accident. Therefore, it is not only important to train new employees, but to provide refresher training to other employees concerning safe work practices and hazard recognition.

Recommendation #2: The company should develop and implement a comprehensive occupational safety program, which would include safe methods for trouble-shooting equipment.

Discussion: Worker safety is a primary responsibility of employers. In order to optimally carry out this responsibility, an employer should: 1) develop a company policy which expresses management's commitment to providing safe working conditions, and 2) develop, document, and enforce the adoption of safe work procedures and practices for all employees, especially when working on electrical equipment.

FACE 86-46: 21-Year-Old Groundman Electrocuted in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 9, 1986, a 21-year-old groundman with a line maintenance crew was electrocuted when the boom of an aerial bucket contacted a 7200 volt line. The groundman was in contact with the truck, when a lineman in the aerial bucket inadvertently contacted the power line with the boom.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Tennessee notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 27, 1986, a research industrial hygienist met with the owner of the company and discussed the fatal incident. Co-worker and next-of-kin interviews were precluded as the line maintenance part of the company is no longer in business and the former employees are no longer in the area.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The company was an electrical line maintenance and construction operation with 16 to 18 employees. The victim was a new hire with very little experience. When additional employees were needed for jobs, the employer went through the local union. Training and safety on the job is offered by the State of Tennessee or the local union. Union members attend electrical safety training on a monthly basis. The employer provided no training for employees. No written safety rules were provided, except for those provided by the union or the State of Tennessee.

SYNOPSIS OF EVENTS

On April 9, 1986, two line construction and maintenance crews were in the completion stages of a project which called for replacing 5000 feet of 000 conductor wire and 19 utility poles. The new poles had been installed and the new wire was strung and connected to temporary tie offs. The two crews (10 men) consisted of two foremen, three linemen, two operators, and three groundmen. One crew was in the process of moving the new energized line from the temporary tie off positions to the permanent insulators and removing the old de-energized line when the fatal accident occurred.

The aerial boom truck had been recently moved (under the new line) and the groundman went to get parts from the truck. The groundman proceeded towards the truck and the lineman, who was in the aerial bucket, was raising the aerial bucket to inspect the new connections when the boom (between the insulated section of the boom and the truck) contacted the 7200 volt energized line. At about the same time the groundman opened the steel door of the storage compartment on the truck. When the boom made contact with the energized conductor, a path to ground through the victim's body was created.

The emergency medical squad (EMS) was called and arrived in approximately 30 minutes. The victim was transported to a local hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

Cardiac arrest due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop written safe job procedures that are task specific.

Discussion: The employer had no written safe job procedures. Safe job procedures specific to the task of working on power lines from aerial boom trucks should be developed and detailed procedures should be included that address the various safety hazards associated with these tasks. These procedures should minimally include positioning of the aerial boom truck, placement of line hoses and blankets, and the identification of personal protective equipment to be used. Once these specific procedures have been developed, the employer should assure that they are implemented and enforced by a qualified person at each job site.

FACE 86-47: **54-Year-Old Certified Electrician Dies in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 23, 1986, a partner of an electrical contracting company (a certified electrician) was electrocuted while he repaired airport runway lights. These lights were energized prior to completion of the task.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 28, 1986, the DSR research team (an epidemiologist and a safety engineer) conducted a site visit, met with employer representatives, interviewed a comparison worker, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer was a small electrical contracting company. The victim was one of the partners in the company and was assigned responsibility for all field activities (i.e., the general superintendent). The victim was a certified electrician.

The company does not have a written safety program, but does stress its concern for employee safety in the Employee Information Brochure given to all employees.

SYNOPSIS OF EVENTS

On August 23, 1986, a partner of an electrical contracting company and his son were repairing the runway lights at a small airport when the accident occurred. The runway lighting system was being replaced as part of a renovation project at the airport. This system consisted of runway lights connected in series to a 3000 V (2.2-6.6 amp) source with step-down transformers at each light. The contractor was required to keep the system operational throughout the project. The lights had been out of order since the previous night and this condition required that the airport be closed. At 6:30 p.m. the electrical contractor, his son (an electrician in the company), and the manager of the airport began trouble shooting the runway lights to determine why the lights were inoperative. After identifying several problems with the old system that did not appear to be easily resolved, it was decided to complete the installation of the new system which had been partially installed previously. The contractor disconnected the old lines and installed new lines. After completion of this task the system was energized to determine if it was operating properly. The contractor's son was approximately 1500 feet from the work site in a small building which housed the power switch and the control panel for the runway lights. He was instructed to change the on/off status of the switch when he saw the flashlight blink five or six times. This system had been used without incident that night on four previous occasions.

The manager of the airport was holding a flashlight while the electrical contractor finished taping several connections. As the electrical contractor taped the conductors on the last runway light to be connected, the son turned on the runway lights. The electrical contractor was electrocuted. Apparently the motion of the electrical contractor's arm while taping intermittently blocked the light from the flashlight and the son misinterpreted this as a request to energize the circuit.

The manager of the airport saw the electrical contractor glowing as a result of his contact with the 3000 volt source. He attempted to knock the contractor away from the conductor, but failed. He called for help. Personnel working in a nearby hanger heard his calls and responded. One man ran to the small building housing the electrical panel and opened the breaker approximately 90 seconds after the accident. Another man (who was a trained EMT) went to the accident site and began CPR with the assistance of the manager of the airport. Emergency medical service was summoned. The victim was transported to a nearby hospital where he was pronounced dead.

CAUSE OF DEATH

The coroner's office listed electrocution as the official cause of death. The victim had burns on his left hand between the thumb and the forefinger and on his left foot.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Energization/de-energization of an electrical source must be under the direct control of the personnel working on the system.

Discussion: The blinking light system used to signal to energize/de-energize the system was misinterpreted. For this reason a lockout system is the only procedure that would preclude this incident. It is obvious that the workmen did not want to run back and forth to energize/de-energize the electrical source; however, it must be recognized that although obviously more time consuming, when working with electricity expediency must be secondary to safety. (Electricity is very unforgiving.)

Recommendation #2: Electrical contractors should have a written lockout policy for all jobs and this policy should be enforced.

Discussion: The electrical contractor did not have a written lockout policy and did not use lockout techniques while performing this task. However, the contractor was familiar with lockout requirements, because he was required to comply with those procedures as part of a contract he had with a Fortune 100 company.

FACE 86-49: **National Guardsman Electrocuted in West Virginia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 2, 1986, a National Guardsman was electrocuted when he climbed a tower supporting 46,000 volt transmission lines and contacted a jumper wire. The victim was a member of a special forces group that had been assigned to demolish the tower as part of a training exercise.

CONTACTS/ACTIVITIES

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) contacted the victim's unit and the power company. Both agreed to voluntarily participate as a part of the FACE program. This case has been included in the FACE Project. On August 25, 1986, the DSR research team (consisting of a supervisory safety engineer, an epidemiologist, and two safety specialists) conducted a site visit, met with a representative of the power company, and photographed the accident site. A telephone interview was conducted with the commander of the victim's unit. Comparison worker and next-of-kin interviews are scheduled for a later date.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was a detachment commander in a 75-man company of National Guardmen. The company has a full-time safety officer. Two days each month are set aside for National Guard training. Safety briefings are conducted by the safety officer prior to each training exercise.

SYNOPSIS OF EVENTS

A regional power company requested the National Guard's assistance in demolishing a tower which supported electric power lines at an obsolete switch yard substation. This request was sent to the state headquarters of the National Guard. The Commander decided to honor this request because of the training aspects of the operation.

Two National Guard demolition experts accompanied a power company representative to the site where they photographed the site and made preliminary calculations of demolition requirements. At this time the power company representative told the two demolition experts that the power lines were energized and requested that a power company representative be present any time National Guard personnel visited the job site. The detachment that received the assignment was briefed by the two demolition experts that had conducted the original site visit. It was decided that the demolition work would be completed by the National Guard and that all electrical work would be completed by the power company.

Apparently, the detachment commander decided to visit the work site without permission from his superiors and without notifying the power company. The substation was located in a remote, wooded area. Access to the substation was provided by a dirt road that was almost impassible to automobile traffic. The commander and three detachment members decided to park their vehicle along the main road and to walk to the substation (approximately one and a half miles). Upon arrival at the site the detachment commander decided to climb the tower. As the detachment commander climbed the tower, his hand contacted a jumper wire on a 46,000 volt power line. He received what was to be a fatal shock and fell to the ground.

The victim was conscious and tried to walk to the road, but passed out repeatedly. He was then carried by his co-workers to the vehicle. The victim was transported to the hospital where he was later pronounced dead. Witness statements and National Guard reports indicate that members of the detachment were under the impression that the power lines on the tower were de-energized. There were no signs posted at the substation at the time of the incident to warn of the dangers present. Since the incident the power company has posted danger signs around the perimeter of the substation.

CAUSE OF DEATH

Electrocution

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Workers should be made aware of all hazards at a work site prior to the beginning of any work.

Discussion: When the National Guard decided to undertake this exercise two demolition experts visited the work site with a representative of the power company who briefed them on the status of the power lines in the area. A detachment was then assigned to carry out the demolition exercise. At this point members of the detachment involved with the demolition of the tower should have met with a power company representative and should have been made aware that the power lines were energized. Statements made by National Guardsmen reveal that the majority of the members were under the impression that all the power lines were de-energized, because the tower was obsolete. If these detachment members had been briefed by the power company, this misconception would have been avoided.

Recommendation #2: Employees should strictly adhere to outlined safe work procedures.

Discussion: During the initial briefing between the power company and the National Guard the power company requested that a power company official be present at any time the National Guard visited the job site. Had this request been followed it is unlikely that this fatality would have occurred.

Recommendation #3: Readily climbable towers supporting energized power lines should be equipped with barriers to inhibit climbing by unqualified persons or posted with appropriate warning signs.

Discussion: Section 280 A1b of the National Electrical Safety Code states that "readily climbable supporting structures such as latticed poles or towers shall be equipped with barriers to inhibit climbing by unqualified persons or posted with appropriate warning signs." At the time of the incident the obsolete substation was not in compliance with this section. It was possible to climb any one of the legs supporting the tower and no warning signs were present on the tower. Since the incident, the power company has posted appropriate warning signs on the support legs of the tower.

FACE 86-50: **40-Year-Old Lineman Technician Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 26, 1986, a meter technician who was working overtime as a lineman technician was electrocuted when he contacted an energized conductor. The technician was attempting to repair a fallen power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A safety specialist and a research industrial hygienist from DSR met with company representatives, interviewed witnesses, comparison workers, and a surrogate for the victim, conducted a site visit, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a major electric utility in the southeastern United States and employs 21,000 workers in nine fossil fuel plants, three nuclear plants, and numerous field and administrative offices. In the past six months two employees have been electrocuted and a third worker was fatally injured while operating a fork lift.

The safety program is structured as a line function within each department (i.e., lineman, construction workers, office workers, etc.). Depending on the size of a district, a local safety and training coordinator administers the safety program in one or more districts. Assisting the safety and training coordinators, management and supervisory personnel implement the safety program on a collateral-duty basis. Each department conducts its own safety inspections and audits. Training and safety councils are also structured along departmental lines. The company produces and distributes to each employee a written safety manual. The Chief Executive Officer establishes annual goals for the corporation. Of the 11 goals established for 1986, two are safety related. The two corporate safety goals are: 1) no more than one lost work day injury per 1,000,000 hours of work, and 2) no more than 3.5 vehicular accidents per 1,000,000 miles driven. Another corporate goal is to have no more than 38 outage minutes per customer from transmission line outages.

SYNOPSIS OF EVENTS

The victim (a meter technician) reported to work at 8:00 a.m. on the day of the accident. Job duties for a meter technician consist of the construction, maintenance, and repair of electric meters. The victim performed this job for 20 years, his entire work life. In July, 1982, he attended a seven week basic lineman training course which qualified him as a lineman technician. As such the victim was permitted to climb poles and work with electrical conductors. During his regular shift the victim would work as a meter technician; however, during unplanned outages he worked as a lineman technician restoring electrical service. On the day before the accident, the victim worked more than 14 hours, finishing work at 11:45 p.m. Upon completion of his regular shift the day of the accident, he was asked to work overtime to restore electrical service to a residential customer. The victim had completed two hours of overtime when the accident occurred.

At 5:00 p.m. the victim arrived at the site and discovered a tree limb had fallen across a power line. The limb had detached two conductors (120 V each) and the neutral wire from the utility pole. The three wires were entangled. The neutral wire was severed; the two conductors were energized. After removing the tree limb from the conductors, the victim climbed the pole and attempted to reconnect the neutral and re-attach all three wires to the pole. In order to re-attach the wires to the pole he cut the electrical conductors on the outside of previous splices, attached a rope to the three conductors, fished the rope through a block and tackle, and attached the rope to the bumper of his utility truck. The victim then moved the utility truck until all the slack in the conductors was removed between the two utility poles (a span of approximately 130 feet). The victim then cut several tree limbs near the conductors and reclimbed the utility pole wearing his insulated gloves, hard hat, and safety glasses.

The victim positioned himself slightly above a television cable (approximately 30 inches below the power lines). He then reached to his right and pulled the three conductors toward himself.
While he was pulling the conductors, one of the previous splices ("V" shaped) caught on the cuff of the victim's left glove and pulled the cuff down. The conductor contacted the victim's forearm near his wrist.

The victim fell backwards with his climbing belt holding him upside down at the top of the pole. His left foot was wedged between the telephone and television cables. A nearby resident, who heard the noise, telephoned the Emergency Medical Service (EMS). The EMS was dispatched from a nearby hospital and was at the scene within three minutes (five minutes after the victim made contact with the electrical conductor). EMS personnel climbed the utility pole and determined that the victim did not have a pulse and was not breathing. The electric company's aerial bucket arrived at the accident site within 30 minutes. Company employees removed the victim from the pole. The local medical examiner examined the body and pronounced the victim dead at the scene.

CAUSE OF DEATH

The coroner determined that the cause of death was due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A comprehensive evaluation of the employer's safety program (from corporate level to field level) should be undertaken by an outside organization.

Discussion: This accident represents the second electrocution of a worker within six months and the third employee fatality during that time period involving the same employer. Injuries that are required to be logged on OSHA Form No. 200 appear to be inaccurate and intervention strategies are incomplete. The firm should retain a consultant knowledgeable in utility safety, who can identify strengths and weaknesses of the corporate safety program, and submit recommendations on how to improve the safety program.

Recommendation #2: Employees should request assistance when the task assigned cannot be completed safely alone.

Discussion: The employer's safety manual suggests that workers who find themselves in a task requiring more than one worker should call for assistance. The task the victim was asked to do could not have been done safely by one person.

Recommendation #3: The company should review its internal policies concerning the assignment of overtime.

Discussion: The victim was a distribution meter technician. The only way the victim could receive overtime was to work as a lineman technician. Employees should not be permitted to work overtime and required to perform hazardous tasks (such as those performed by a lineman technician) when these assignments are not part of their normal duties.

Recommendation #4: Employees should be assigned to perform tasks for which they have been adequately trained and are qualified to perform.

Discussion: The victim completed the lineman technician training course; however, he did not use this training on a daily basis. Employees (particularly those working in hazardous occupations) should only be assigned tasks that they have demonstrated that they can perform safely. Training must be followed up with on-the-job supervision and guidance and periodically reinforced.

Recommendation #5: Employers should provide adequate supervision to employees that are not journeyman level.

Discussion: The victim was assigned lineman technician duties on an overtime basis only. This employee could not be as proficient as an employee who performs these duties on a daily basis and should not have been considered capable of independent assignments. This employee should have been assigned tasks that were commensurate with his abilities and should have been adequately supervised.

Recommendation #6: Utility right-of-ways should be routinely inspected and hazardous conditions such as tree growth around power lines should be reported and corrected.

Discussion: The reason that the victim was dispatched to this site was because the power line had been damaged by tree limbs. This would be an obvious source of system damage and utilities should routinely inspect right-of-ways in an effort to minimize this type of damage.

Recommendation #7: All equipment necessary to assure the safety of personnel must be maintained operational at all times.

Discussion: The utility has a two-way radio in each company vehicle. One of the reasons these radios are supplied is to furnish a communications link during emergencies, etc. The radio in the victim's truck was inoperative. This may have contributed to the fatality in two ways: (1) he could not call for the assistance necessary to complete this task safely and (2) emergency response was delayed.

FACE 86-51: 41-Year-Old Truck Driver Electrocuted in Kentucky

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On September 4, 1986, a 41-year-old truck driver was electrocuted while in the process of unloading concrete blocks. He was operating the controls for the truck-mounted crane boom at the time of the accident.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Kentucky notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On September 11, 1986, a safety specialist met with the employer, conducted a site visit, interviewed comparison workers and a surrogate for the victim, photographed the accident site, met with the county coroner, and obtained a copy of the coroner's report.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a company that manufactures precast concrete products (i.e., septic tanks and blocks). The company employs 19 full time people; seven truck drivers and 12 production and clerical personnel. The company has been in existence for 40 years and under the present ownership for 30 years. A safety program exists and a two week on-the-job training period is provided for new employees.

The victim worked as a truck driver delivering concrete products. This job involved driving a flat bed truck with a hydraulic crane mounted on the rear section of the bed to delivery sites and unloading the concrete products. The boom of the crane extends approximately 15 feet. The concrete products are unloaded with a metal fork type unloader attached to a steel cable and winch that is controlled through the crane. The concrete blocks are bundled in different quantities, depending on block size, and placed on wooden pallets to facilitate loading and unloading. The victim had approximately four years' experience with this employer and had made at least two other deliveries to the accident site.

SYNOPSIS OF EVENTS

There is an eye witness to the accident, but the witness was unavailable at the time of the site visit. The accident scenario that follows was developed from interviews conducted with the electric utility engineer that investigated the accident, the owner of the block manufacturing company, the manager of the mobile home sales lot, and inspection of the accident site and truck used to deliver the blocks.

On September 4, 1986, the victim was to deliver an order of concrete blocks to a mobile home sales lot. The victim arrived at the lot and drove the truck to a three-sided, five foot high, wooden storage bin located at the rear of the mobile home sales lot. The storage bin, containing mobile home parts and supplies (i.e., concrete blocks, axles, tires, etc.) had been erected beneath an existing 7.2 kV powerline that is approximately 20 feet above the ground.

The victim then positioned the back of the truck in front of the open end of the storage bin. The victim was standing on the ground between the back of the truck and the opening for the storage bin operating the crane with a hand-held remote controller. One pallet of concrete blocks had been unloaded from the truck and placed on the ground inside and near the opening of the bin. A second pallet of blocks was to be placed on top of the first pallet. Unloading the second pallet required the operator to extend the boom in order to stack the pallets on top of each other. Apparently, the blocks being unloaded obstructed the driver's view and he extended the boom and contacted the powerline. Electrical current from the powerline travelled to ground through the remote hand-held controller and the body of the victim.

The power line had to be de-energized by the local electric utility company before emergency care could be administered to the victim, who was pronounced dead at the accident site.

CAUSE OF DEATH

The coroner's report stated cause of death as electrocution. An autopsy was performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead powerlines.

Discussion: Current OSHA standards 1926.550(a)(15) and 1910.180(J) of the Code of Federal Regulations require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers which cannot be part of the crane. The crane operator/ delivery driver did not comply with these requirements.

Recommendation #2: Employers should periodically conduct training concerning delivery site hazard awareness, including the hazards present around overhead powerlines.

Discussion: The danger of overhead powerlines appears to be obvious; however, contact with powerlines and the subsequent occupational-related fatalities continue. Employers must stress and routinely review the hazards associated with overhead powerlines. Employers must also demonstrate that they are truly concerned about this aspect of job site safety and will not tolerate even one instance of unsafe conduct. In this case the storage bin was located directly beneath a 7.2 kV powerline. An evaluation of the site prior to unloading the blocks would have identified the hazards present and should have precluded the accident.

Recommendation #3: Materials should be stored in areas that do not create additional job hazards.

Discussion: A three-sided, five foot high wooden storage bin had been built directly beneath an existing 7.2 kV powerline. The crane operator/driver, in attempting to unload concrete blocks from the delivery truck into the storage bin, was exposed to an unnecessary hazard due to the storage bin's close proximity to the powerline. Materials should be stored so that access to them does not subject the worker to unnecessary hazards (e.g., overhead powerlines).

FACE 86-53: **52-Year-Old First Class Electrician Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On September 3, 1986, a 52-year-old first class electrician was electrocuted while performing preventive maintenance on a high voltage circuit breaker.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On February 4, 1987, a DSR research team (consisting of a safety engineer and a safety specialist) met with representatives of the company. Photographs of the accident site were obtained and interviews were conducted with a surrogate for the victim and two comparison workers, who perform the same tasks as the victim.

Another electrical-related fatality occurred to another employee of this utility in February, 1987. A separate evaluation of that incident is given in FACE report 87-24-II.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This is a public electrical utility company that employs over 2,200 personnel.

The company establishes and attains safety goals through a written safety policy and written safety program. Employees receive copies of the safety policy and safety program as part of the new employee orientation. Depending on their duties, employees receive both on-the-job and classroom training. A full-time safety staff administers and evaluates the safety program. Safety committees, which consist of supervisory personnel only, meet monthly to discuss and evaluate safety matters.

SYNOPSIS OF EVENTS

On Wednesday morning September 3, 1986, a two-man crew consisting of an Assistant Engineer and a First Class Electrician (the victim), were scheduled to perform preventive maintenance on a high voltage (34.5 kV) oil circuit breaker (OCB). As part of the preventive maintenance, the insulation values of the OCB bushings were to be tested.

The crew arrived at the substation where they parked the test van adjacent to the OCB scheduled for testing. Prior to the start of testing, the assistant engineer telephoned the load dispatcher and asked for permission to work on the breaker. After receiving instructions from the load dispatcher, the assistant engineer directed the victim to move the test van so they could test the bushings. In the meantime, the assistant engineer proceeded to the bus side of the OCB and pulled down (opened) the handle of the gang-operated disconnects for the OCB. The assistant engineer visually checked the disconnect blades to ensure they had opened. Satisfied that the disconnect blades were opened, he placed a hold card on the handle. The assistant engineer then tested the first bushing on the OCB. After finishing the test on the first bushing the assistant engineer informed the victim, who was still in the van, he was ready to test the second bushing. The victim came out of the van and switched the test lead from the first bushing to the second bushing. After completion of this test, the assistant engineer informed the victim he was ready to test the third bushing. The victim removed the lead from the second bushing and as he touched the lead to the third bushing, which was energized, he provided a path to ground and was electrocuted.

Investigation of the accident revealed that one of the disconnect blades remained closed after the handle for the gang-operated disconnects had been pulled down (opened). An equipment failure (i.e., a broken porcelain insulator skirt at the base of the cap) allowed the cap to remain stationary while the rest of the mechanism rotated when the handle was pulled downward. This action permitted the disconnect blade to remain in the closed position allowing current to flow through the third bushing.

CAUSE OF DEATH

The coroner's report indicates the cause of death as electrical burns.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The safe job working procedure should be revised to include additional steps to further verify the status of this equipment.

Discussion: The closed disconnect blade was the result of an equipment malfunction and oversight by an employee. During routine maintenance, other disconnects should be visually examined for signs which indicate similar malfunctions. The implementation of additional steps in the safe job working procedure (i.e., testing the bushings with a "noisy tester" or statoscope) prior to performance of maintenance would indicate to the employee the presence or non-presence of electrical energy in the bushings. Additionally, a procedure for grounding the system prior to testing the bushings should be developed and implemented. This last recommendation is currently being developed by the utility for incorporation into the safe job working procedure.

Recommendation #2: Training should address both safe job procedures and hazard recognition.

Discussion: A disconnect blade remained in the closed position creating a dangerous situation and ultimately causing the death of a worker. A visual check of the disconnect failed to identify the closed disconnect blade. The handle for the gang-operated disconnects is located approximately 18 feet below and 5 feet to the side of the disconnects. The assistant engineer made the visual check from the ground where the handle was located. This remote location and other equipment in the area may have obstructed his vision. Visual verification of disconnect opening should be performed in a manner that considers location, background obstructions, and angles of sight.

Recommendation #3: Include selected employee representatives in the monthly safety meetings.

Discussion: Employee representatives from different departments can be a valuable asset to the safety program and all levels of personnel should be represented at periodic safety meetings. Safety-related problems should be communicated to personnel responsible to take corrective action.

FACE 86-55: **Lead Line Mechanic Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 11, 1986, a 39-year-old lead line mechanic was electrocuted while he replaced a fuse holder.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. A DSR safety engineer and a research industrial hygienist conducted this evaluation, which included interviews with the safety director of the power company, two comparison workers, and a witness to the incident. Discussions were held with the OSHA compliance officer and the accident site was visited. Photographs were taken of the accident site and the equipment being used by the victim when the incident occurred. A surrogate for the victim agreed to participate, but declined to do so at this time. The compliance officer's report, the autopsy report, and the report filed by the responding emergency medical service have been requested.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The utility company has been in operation since 1904 and currently employs over 5000 employees. A written safety manual is given to each new employee. This manual includes requirements concerning the use of personal protective equipment. Additionally, the company enforces these requirements. The company requires all lineman technicians to complete an initial training course and annually gives refresher training concerning such topics as pole top rescue. All employees are trained in CPR. The training facility for the company was very well equipped and emphasized hands-on training.

SYNOPSIS OF EVENTS

On Sunday, August 10, 1986, a lead line mechanic (the victim) and a groundman were contacted at home and requested to work overtime to repair damage to the electrical distribution system that was caused by a storm earlier that day. The lead line mechanic and the groundman started working at 10:00 p.m. and had completed two tasks assigned to them by 3:00 a.m. The victim and the groundman had moved to a third location and were attempting to restore power to a residential area when the accident occurred.

The lead line mechanic was working in a two-man aerial bucket without any personal protective equipment (i.e., non-conductive hard hat, insulated rubber gloves, lanyard, etc.). The workers initially identified the problem at this third location as a blown fuse. However, when the victim elevated the aerial bucket he found that the fuse holder was also damaged. The lead line mechanic removed the fuse, disconnected the energized tap (top), disconnected the de-energized tap (bottom), and removed the fuse holder. When the victim disconnected the taps, he bent them back towards the end that remained connected. He then lowered the aerial bucket and was given a replacement fuse holder by the groundman, who was standing on the platform over the cab of the truck. He then elevated the aerial bucket and installed the replacement fuse holder. After installing the fuse holder, he began to reconnect the taps starting with the de-energized tap. As he pulled the de-energized tap toward the bottom of the fuse holder with his bare hand, his head contacted the energized tap and he was electrocuted.

Because he did not have his lanyard attached the victim fell into the aerial bucket. The groundman lowered the aerial bucket and tried unsuccessfully to remove the victim. He then called for assistance on the radio in the truck. The emergency medical service responded within approximately five minutes. The two EMS personnel and the groundman tried once again unsuccessfully to remove the victim from the aerial bucket. CPR was attempted inside the aerial bucket, but it is questionable how effective this effort was. Approximately 20 minutes after the incident a fourth person arrived at the scene and the victim was removed from the aerial bucket. He was then transported to a local hospital where he was pronounced dead.

CAUSE OF DEATH

Not available when this report was prepared.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: When working near a high voltage line workers should wear all appropriate personal protective equipment.

Discussion: When the accident occurred, the victim was not wearing any personal protective equipment required by the company. Employees must wear personal protective equipment when working in the vicinity of energized conductors/equipment.

Recommendation #2: Employers must enforce company requirements concerning the use of personal protective equipment.

Discussion: Utility companies must constantly enforce company requirements concerning the use of personal protective equipment. This utility has disciplined employees for not using personal protective equipment on several occasions, including one incident that involved the victim.

Recommendation #3: The lighting system that provides illumination to the work area should be re-evaluated.

Discussion: This fatality occurred at 3:00 a.m. It had been raining and all lights in the neighborhood were out because of the storm damage. The only illumination to the work area at the top of the pole was from a spot light mounted on the cab of the truck. This light was directed through the steel mesh platform located over the truck cab and according to the groundman was inadequate. DSR engineering personnel should evaluate lighting systems used on aerial buckets to determine optimal design configurations.

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FACE 87-02: 36-Year-Old Laborer Electrocuted In North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 7, 1986, a house moving company was in the process of moving a house down a street. The victim was standing on the roof of the house, lifting up wires so that the wires would clear the top of the house. The laborer inadvertently contacted an energized 7200 volt power line and was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case has been included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On October 29, 1986, the DSR research team coordinator conducted a site visit, collected incident data, photographed the site, interviewed comparison workers, and discussed the incident with the state compliance officer and the employer representative.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was one of seven employed by a house moving company. The company had no written safety program. Safety training consisted of only telling the workers to be careful. The owner stated that all power lines were treated as if they were energized; however, there was only one pair of insulated gloves available for use in the company.

SYNOPSIS OF EVENTS

On October 7, 1986, a house mounted on large truck dollies was being moved down a highway to a new location. The victim and another co-worker were standing on the roof of the house to ensure that the house could clear all overhead lines. At the time of the accident, the house was passing under three overhead lines: a cable TV line (18 feet above the road); an energized 220 volt, insulated line (22 feet above the road); and an energized 7200 volt, uninsulated line (31 foot above the road). (See Figure 1.) The peak of the roof was 28 feet above the road surface. The power company was preparing to de-energize a 220 volt, uninsulated line at the next intersection. The power company was not de-energizing low voltage (220 volts or less), insulated lines and did not de-energize the 7200 volt line at the time of the incident. Representatives of the power company told the workers which lines were energized and the workers acknowledged that they were aware of the energized lines. The co-worker was wearing rubber gloves, but the victim was not wearing any personal protective equipment. The house moving company had borrowed a hot stick from the telephone company, but were not using it at the time of the incident. This was the sixth house moved down this roadway during this particular house moving job. The five previous houses were moved without incident utilizing the same procedure. According to representatives of the power company, the 7200 volt line was energized on all five previous occasions.

After the 220 volt line had cleared the roof, the victim grabbed the cable TV line with both hands and stood up to walk the line over the top of the house. While doing this, the back of his neck came into contact with the 7200 volt line and he was electrocuted. The victim and the cable TV line provided a path to ground for the 220 volt line. The co-worker did not come into contact with the line.

After contact, the victim fell from the roof of the house to the roadway. Police personnel, who were at the scene directing traffic, provided initial cardiopulmonary resuscitation (CPR) until the emergency medical service (EMS) squad arrived to provide advanced cardiac life support. Attempts to resuscitate the victim were unsuccessful. The victim was then transported to a local hospital where he was pronounced dead.

CAUSE OF DEATH

No autopsy was performed. Cause of death was listed as electrocution. Burn marks were on the back of the victim's neck and palms of both hands.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees working with energized conductors should wear required personal protective equipment.

Discussion: OSHA standards require employees to wear protective equipment when working around electrical hazards (1910.132). These standards identify specific types of insulated protective equipment to be worn by workers (1910.137). Protective equipment includes insulating gloves, blankets, hoods, line hose, and sleeves. There were only one pair of rubber gloves available from the company and the co-worker was wearing them.

Recommendation #2: All electrical lines should have been de-energized.

Discussion: All electrical lines should have been de-energized by the power company prior to the house being moved under the lines. The power company was on the scene de-energizing some of the lines, but not all of them. The victim would not have been electrocuted had this 7200 volt line been de-energized.

Recommendation #3: The employer should develop a safety program designed to recognize and correct hazards.

Discussion: The company does not provide training in safe work procedures nor are there any safety rules or written policies. None of the benefits that a safety program would provide (i.e., training, hazard identification, personal protective equipment, and safe operating procedures) were utilized.

Recommendation #4: Fall protection should be provided for employees while working on the roof of the house being moved.

Discussion: OSHA standards require employees to be protected from falls while working on elevated surfaces (1910.28). Employees working on the roof of the house should be protected by a safety belt attached to a lifeline which is secured to the house.

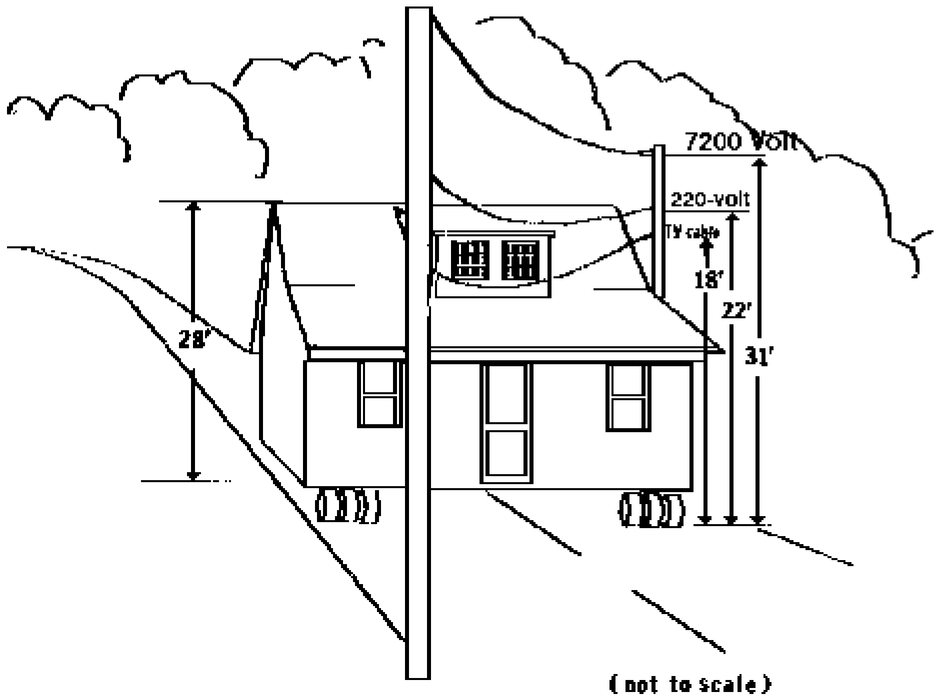

Figure 1.

FACE 87-03: Mechanic Electrocuted in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 28, 1986, a mechanic for a wrecker service was electrocuted when a 2-way radio antenna he was holding contacted a 7200 volt overhead power line. A driver for the wrecker service, who was assisting him, received minor injuries.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case will be included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On November 6, 1986, a member of the DSR research team met with the Tennessee OSHA compliance officer for this case and the owner/manager of the company. Interviews were conducted with co-workers and a surrogate for the victim. The site of the fatality was visited and photographed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was a mechanic for a company which operates a wrecker service. Additionally, the company repairs and sells used cars. The wreckers are used frequently to repossess cars sold and financed by the company.

The company has no written safety policy or safety program. Any safety training is provided "on the job."

SYNOPSIS OF EVENTS

On June 28, 1986, the victim (a mechanic) and his co-worker (a wrecker driver) were asked to remove a 25 foot 2-way radio antenna from the mobile home site which had previously served as the company office. The weather was hot and humid, but the ground was dry.

The antenna was taken down from the electric pole immediately adjacent to the mobile home and laid upon the ground. The two men then began raising the antenna in order to place it on a pickup truck parked nearby. The victim was stabilizing the base of the antenna on the ground as his co-worker raised the antenna. The top of the antenna contacted a nearby high voltage line which was approximately 19 feet above ground. The victim, wearing leather shoes, received a fatal injury. His co-worker, wearing rubber-soled tennis shoes, was temporarily "knocked out" by the current and received a minor laceration under his right eye.

The victim's step-son, who was watching, took the pickup truck and drove approximately 100 yards to the new office location and asked the secretary to call the emergency medical service. The ambulance arrived five to ten minutes after the accident and provided basic life support measures. The resuscitation efforts were unsuccessful and the victim was pronounced dead in a local emergency room.

CAUSE OF DEATH

The coroner's report listed the cause of death as electrocution. Exit burns were noted on the victim's right foot, but no entrance burns were observed. No autopsy was performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Metal antennas should be located well away from electrical lines.

Discussion: This antenna should not have been mounted on the pole which provided electrical service to the mobile home. The proximity to nearby high voltage lines made this location inherently dangerous.

Recommendation #2: Employers should only assign personnel tasks that they are qualified to perform.

Discussion: Apparently no one recognized the hazards involved with the task being performed. Aside from the inherent danger described above, the injured co-worker stated that he did not know the overhead power lines were uninsulated. The lack of hazard awareness was an obvious contributor to this fatality.

FACE 87-04: Apprentice Sheetmetal Worker Electrocuted in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On September 10, 1986, a sheetmetal apprentice was electrocuted while guiding a "powered scaffold" being unloaded from the flatbed of a truck, using the crane mounted on the truck. The hoist cable of the crane was energized when it contacted an overhead, 6500 volt (phase to ground) power line. A co-worker, also standing on the ground and guiding the scaffold, received minor electrical burns.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration (OSHA) for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case will be included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On November 4, 1986, a member of the DSR research team met with the company owner/manager and a representative of Tennessee OSHA. Photographs of the truck crane involved in the accident were taken, as were photographs of a "power lift" similar to the one being unloaded when the accident occurred. The overhead power line had been replaced with an underground cable shortly after the accident.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim worked as an apprentice sheetmetal worker for a company which fabricates and installs awnings and canopies, primarily as overhead covers at gasoline pumps. The company does have a written safety program, but does not have safety meetings or specific safety training.

SYNOPSIS OF EVENTS

The weather on the day of the accident was clear. Earlier in the day the victim had washed a truck in front of the company shop (the accident site) and the ground was still damp.

A powered scaffold, in need of repair, was being unloaded outside the shop door when the accident occurred. The outriggers of the truck were down. The crane operator ("C" on sketch) and another employee ("D" on sketch) were standing on the truck bed; the victim ("A" on sketch) and his co-worker ("B" on sketch) were standing on the ground guiding the power lift which was being unloaded. The ground where the victim stood was still damp from the runoff which resulted from washing the truck. The ground where his co-worker stood was at a slightly higher elevation and was dry.

A fifth employee ("E" on sketch) walking towards the truck, with a better view of the situation, warned them that they were too close to the overhead power line. Suddenly, a "ball of fire" appeared to engulf

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the hoist cable. The victim and his co-worker were held by the current for a few seconds; then both were released and fell to the ground as the hoist cable and power line separated.

Both the victim and his injured co-worker were conscious shortly after the accident. The victim, who had a pulse and was breathing, complained of difficulty swallowing. The ambulance arrived in approximately 10 minutes and was at the scene approximately 15 minutes. Details of medical care given at the scene are not available, but paramedics stated that the victim "crashed" while enroute to the hospital and could not be resuscitated. He was pronounced dead in the emergency room.

The injured co-worker received only minor electrical burns of his hands and feet. He was not hospitalized and reported to work the next day.

CAUSE OF DEATH

The death certificate listed the immediate cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead powerlines.

Discussion: OSHA standard 1910.180(j)(1)(i) requires that a minimum clearance of ten feet be maintained between parts of truck cranes or loads and energized electrical power lines rated 50,000 volts or less, unless insulating barriers are erected. The truck was placed between the power lines and the company building, which were approximately 25 feet apart. The lift was then unloaded on the power line side of the truck (see sketch), which made compliance with the OSHA standard virtually impossible.

Recommendation #2: Hazard awareness regarding overhead powerlines should be stressed and management's commitment to safety emphasized.

Discussion: The danger of overhead powerlines appears to be obvious; indeed, the truck had a large sign mounted on the side which included the following phrases: "DANGER", "ELECTROCUTION HAZARD - THIS MACHINE IS NOT INSULATED", and "YOU MUST MAINTAIN A CLEARANCE OF AT LEAST 10 FEET BETWEEN ANY PART Of THE MACHINE OR ITS LOAD AND ANY ELECTRICAL LINE OR APPARATUS CARRYING UP TO 50,000 VOLTS, ..." The fact that this accident still occurred suggests that active, rather than passive, communication of hazard awareness and safe operating procedures is necessary. Management's commitment to safety should be communicated by disciplinary action when safety standards are disregarded.

Recommendation #3: Every worksite should be evaluated and a procedure developed to eliminate or minimize hazards.

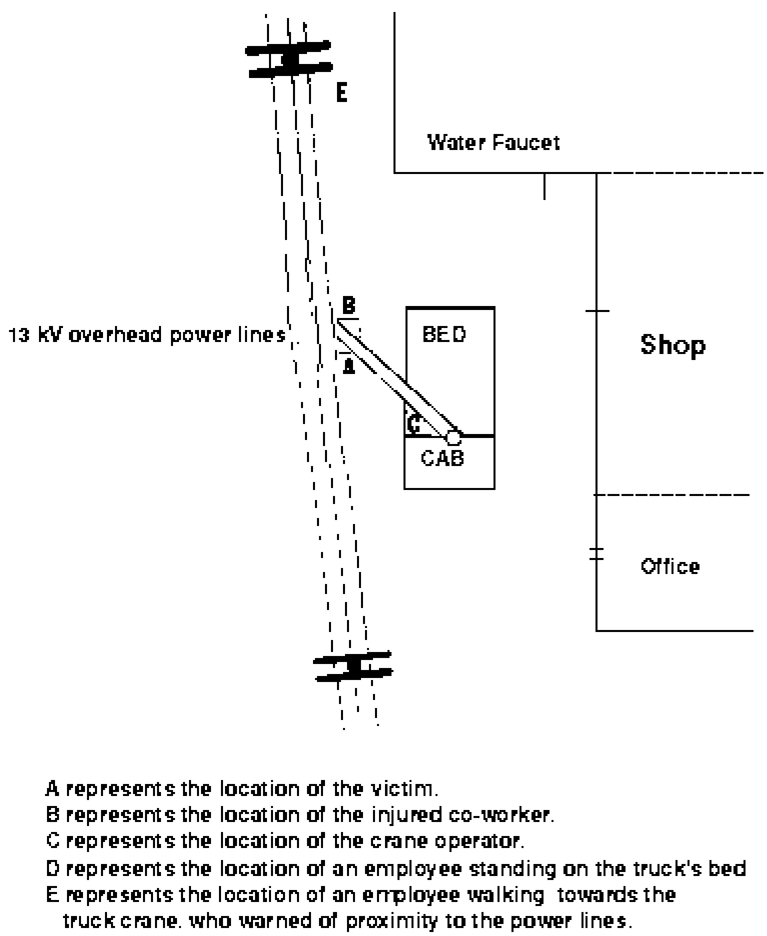
Discussion: Management arranged to have the overhead power lines at the company's shop removed and replaced with a buried cable. However, overhead power lines will continue to create hazardous situations at the company's installation sites; procedures to accomplish the work safely will have to be considered for each individual site.

Recommendation #4: When changes in personnel are made, the implications for safety should be considered.

Discussion: A few weeks prior to the accident the company supervisor was dismissed. The owner/manager, who was functioning as a supervisor, was not present when the accident occurred. Removal of key personnel can potentially impact the safe performance of work.

Recommendation #5: A safety observer with no other duties should monitor the work when there is even the remotest chance of contact with overhead power lines.

Discussion: While there seems to have been no attempt made to maintain the required clearance, one may question whether the distance between a vertical hoist cable and horizontal power line can always be determined accurately from the operator's position. The fact that another employee ("E" on sketch) warned of proximity to the power line immediately before the accident suggests that a safety observer could have helped prevent this fatality.



Sketch. *Plan View of the Accident Scene*

FACE 87-07: **34-Year-Old Machine Operator Electrocuted in Ohio**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 1, 1986, a machine operator was electrocuted when he inadvertently contacted an energized conductor located in a motor control panel box that had the cover plate removed.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 5, 1986, a DSR research safety specialist conducted a site visit, met with employer representatives, interviewed comparison workers, photographed the accident site, and discussed the incident with a representative of the Industrial Commission of Ohio.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small division of a manufacturing company that has been in operation for 50 years and employs over 20,000 workers. The division itself employs 34 personnel and is responsible for packaging and shipment of fiberglass products. A safety program has been developed and implemented. Safety committees, comprised of management and hourly employees, meet quarterly to review safety items. Safety rules are also posted and distributed to all employees.

SYNOPSIS OF EVENTS

On November 1, 1986, the victim and a co-worker were instructed to cut bulk rolls of fiberglass into narrower widths, a job they had performed on previous occasions. The workers were to use a fiberglass cutting machine (a gang slitter) powered by a 1/2 horsepower, 220 volt, three-phase electric motor. The control box for the motor was attached to a corner leg of the slitter machine, approximately two feet above the floor, facing away from the machine. A reset button, part of the control box, was used to reset the breaker for the gang slitter motor. The equipment had not operated properly on the previous shift. The motor had tripped the breaker several times and, for reasons unknown at this time, the cover plate enclosing the control box had been removed and never replaced, thus exposing the energized conductors in the control box.

At approximately 9:15 a.m. the two workers were monitoring the operation of the gang slitter. The co-worker was located at the corner of the machine where the bulk roll of fiberglass was mounted. The other worker (the victim) was standing diagonally across from the co-worker at the corner where the smaller widths of fiberglass were being re-rolled. The victim was holding onto the frame of the gang slitter when his upper right leg contacted an energized conductor in the control box. The victim's body provided a path to ground for the electrical current. After approximately 30-40 seconds of being in contact with the energized conductor, the victim fell back away from the machine breaking contact with the conductor.

The co-worker ran to the foreman's office and summoned help. Paramedics were on the scene providing advanced cardiac life support approximately six minutes after being notified. The victim was pronounced dead on arrival at the hospital emergency room, 46 minutes after the event occurred.

CAUSE OF DEATH

The deputy coroner established the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should review operating procedures involving electrical panel boxes to assure that these procedures are safe and being followed.

Discussion: Cover plates on panel boxes are provided to prevent accidental contact with energized conductors. The removal and replacement of cover plates should be done by authorized personnel only. Safe job procedures should address the maintenance and repair of electrical panel boxes and management should enforce strict adherence to these procedures. These procedures should minimally include rules governing lockout/tagging of electrical equipment or circuits. Equipment or circuits that are de-energized should be rendered inoperative and be locked out and tagged at all points where such equipment or circuits can be energized. Controls that are to remain deactivated during the course of work on equipment or circuits should also be locked and tagged. Equipment or circuits being maintained or repaired should be clearly identified and employees should be trained not to use any equipment until it has been tested and placed back in service.

Recommendation #2: The motor control panel box should be relocated. Adequate work areas should be maintained during repair and maintenance of electrical equipment.

Discussion: When normally enclosed live parts are exposed for inspection or servicing an adequate work area should be maintained. Control panel boxes should be located where they are easily accessible for maintenance and for operation by the machine operator. Motor control panel boxes should not be located in congested areas such as an aisle or a work area.

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FACE 87-08: **Laborer Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 14, 1986, a 20-year-old laborer was electrocuted when the 21 foot aluminum flagpole he was installing came into contact with an overhead electric power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 19, 1986, a DSR research team (an epidemiologist and a research industrial hygienist) conducted a site visit, met with the owner of the company, interviewed two comparison workers and a surrogate for the victim, and photographed the accident site.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer was a small exhibition service company which set up, decorated, and tore down sites for fairs and trade shows. The fatality occurred during set-up for a fair at the state fairgrounds.

The employer did not have a formalized written safety program; however, weekly meetings with employees covered how tasks were to be performed at each site and safety bulletins were distributed with each employee's paycheck.

SYNOPSIS OF EVENTS

On October 14, 1986, a laborer (the victim) and a co-worker were erecting flagpoles on a fence which surrounded the state fairgrounds. Standard operating procedures required that the poles be carried parallel to the ground from the truck to the site where the flagpole was to be installed.

After installing several flagpoles, one of the 21 foot aluminum flagpoles was removed from the truck by the co-worker. The victim then carried the flagpole towards the site where it was to be erected in a vertical position, perpendicular to the ground. The flagpole came into contact with a 7,200 volt overhead powerline which was 20 feet 11 inches above the ground. The line was 9 feet 6 inches from where the flagpole was to be installed. The victim was instantly thrown back away from the power line. The victim was not wearing any personal protective equipment at the time of the incident.

A co-worker at the site started cardiopulmonary resuscitation (CPR). An emergency medical service (EMS) was notified. EMS personnel arrived at the site approximately five minutes after notification. The victim was transported to a nearby hospital where he was pronounced dead.

CAUSE OF DEATH

The medical examiner's office listed electrocution as the official cause of death. The victim had burns on both feet.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical hazards should be identified and procedures to avoid electrical contact should be communicated and practiced.

Discussion: At the time of the accident, the victim was not following the specified instructions for carrying a flagpole. The employer verbally requested employees who were erecting flagpoles to carry them parallel to the ground until they were at the point where the flagpole was to be installed. Since this incident the employer has circulated a safety bulletin to all employers which identifies safety hazards at that job site.

Recommendation #2: Maintain a clearance between work sites and powerlines.

Discussion: Utility companies normally specify the amount of clearance required between powerlines and other structures to decrease the likelihood of contact with the line. In this case, the 9 foot 6 inch distance between the powerline and the fence where the flagpole was to be erected was not adequate. The powerlines are being placed underground at the state fairgrounds in order to prevent inadvertent contact in this high use area.

FACE 87-09: **Laborer Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 22, 1986, a laborer was electrocuted when he contacted a 13 kV, underground power line while digging with a pneumatic clay spade.

CONTACTS/ACTIVITIES

Officials of the Maryland Occupational Safety and Health (MOSH) Administration notified the Division of Safety Research of this fatality and requested technical assistance. This case has been included in the FACE Project. NIOSH research personnel have conducted a site visit, met with owner and employer representatives, interviewed two comparison employees, and photographed the site.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small company that specializes in the construction of caissons. Caissons are defined as shafts drilled into the ground, which are encased with a metal shell and then filled with concrete. The caisson is used at sites where the soil has low bearing capacity and it is necessary to transmit the loads to a firmer strata. NOTE: The caissons referred to throughout this report were called caissons by the construction workers and would be termed open-end caissons by foundation engineers; however, these shafts do not satisfy the definition of a caisson as delineated in 29 CFR 1926.804(b) because these chambers are not air- and water-tight.

The employer has a written safety program and policy; however, these do not appear to be implemented on a daily basis.

SYNOPSIS OF EVENTS

The employer of the victim was a subcontractor on a construction job that required the repair of the foundation of a tunnel between two buildings. The tunnel had been built on uncontrolled, ruble fill (i.e., waste concrete, scrap steel, debris, and backfill) and was settling. Caissons that extended below the tunnel foundation were to be constructed, the tunnel foundation was to be supported from below, and the caissons were to be filled with concrete. Initially an auger was used to excavate the caissons; however, after drilling approximately two feet deep the workers hit materials that required them to excavate the remainder of the caissons by hand. Each hole was lined with steel casing, 30 inches in diameter. One worker (a bottom man) would loosen the material at the bottom of the hole with a pneumatic clay spade and then load this material into a bucket, which was raised to the surface and emptied by a co-worker (a top man). The crew had been excavating by hand for several weeks and the shaft where the victim was working was approximately 26 feet deep.

At approximately 3:00 p.m. on October 22, 1986, a caisson laborer (the victim) was digging in one of the shafts with a pneumatic clay spade when he contacted a 13 kV, underground electrical power line.

Co-workers heard noises coming from the hole. The steel casing in the hole began vibrating and fire came out of the top of the hole. Five minutes after this initial contact, co-workers notified emergency medical personnel and the local electrical utility. Rescue could not be initiated until the power was disconnected, which was approximately 20 minutes after the incident occurred. Emergency medical personnel could not enter the caisson for five or ten minutes after the power was disconnected because of the heat generated as a result of the contact with the electric power line. The body was removed from the caisson at 3:51 p.m.

CAUSE OF DEATH

The medical examiner determined the cause of death as electrocution. The victim's body was burned almost beyond recognition. An autopsy was not performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All underground utilities should be identified prior to the start of drilling or excavating.

Discussion: According to interviews with the principals involved, the owner apparently provided the general contractor a set of plans for another facility (similar to, but not identical to, the accident site). The contractor and subcontractor relied on these drawings and did not contact underground utility identification services before drilling.

Recommendation #2: Owners and designers must provide accurate plans to contractors and subcontractors.

Discussion: The plans provided to the contractor apparently did not accurately locate the underground power line. This occurred even though the owner had contracted with an engineering design firm to develop the project design and monitor this effort. Plans of a similar facility were provided so that construction could be started quickly. Scheduling, productivity, or cost effectiveness should not be permitted to adversely impact the safety of workers.

Recommendation #3: Underground electrical power lines should be identified through the use of warning tape or other appropriate means.

Discussion: The power line was buried beneath 26 feet of backfill that included concrete, scrap steel, etc. The victim did not recognize that he was digging into an electrical power line. The buried electrical power lines should have been identifiable by a change in the consistency of the backfill (i.e., sand, crushed stone, or earth) and should have been marked by warning tape.

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Recommendation #4: The employer should develop a comprehensive safety program that clearly documents procedures for safe entry into confined spaces.

Discussion: The shaft that the victim was in at the time of the accident was a confined space and as such all applicable requirements concerning confined spaces should be followed. All employees who work in or around confined spaces should be aware of potential hazards, possible emergencies, and specific procedures to be followed prior to entering a confined space. These procedures should include, but not be limited to the following:

1. Air quality testing to determine adequate 0_2 level.

2. Ventilation of the confined space to remove air contaminants.

3. Monitoring of the space to determine that a safe oxygen level is maintained.

4. Employee training in confined space entry, testing, and use of personal protective equipment (respirators, clothing, etc.).

5. A standby person outside the space for communication and visual monitoring.

6. Emergency rescue procedures.

Even though normal oxygen levels were obviously present in the shaft at the time of the accident, entry into confined spaces should not be attempted until atmospheric testing of the confined space insures that the atmosphere is safe. This testing requirement applies to all confined spaces, including those under construction. Testing must be done by a qualified person prior to entry.

Recommendation #5: Employees working in a confined space, particularly one that severely restricts rescue efforts, should wear a lifeline at all times.

Discussion: The victim was not wearing a lifeline at the time of the accident. Although the use of a lifeline probably would not have altered the fatal outcome of this event, a lifeline could be a life saving device under certain circumstances and should be used at all times.

Recommendation #6: Pneumatic tools should be secured to the hose by some positive means.

Discussion: The use of pneumatic tools in a confined space could result in a severe injury, if the hose, while still under pressure, were to become disconnected from the tool. Pneumatic tools should be secured to the hose by some positive means to prevent the tool from becoming accidently disconnected (29 CFR 1926.302). This will prevent the hoses from whipping around violently, if they were to become disconnected.

FACE 87-10: **Pump Operator/Truck Driver Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 27, 1986, a pump operator/truck driver was electrocuted when the boom on the concrete pump he was operating contacted a 7600 volt power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 20, 1986, a safety engineer conducted a site visit, photographed the accident site, interviewed a company representative and a comparison worker, and interviewed a surrogate for the victim.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a family-owned and operated business that employs 30 workers. The company constructs concrete footers and foundations for light construction (i.e., single family residences) and has several trucks used for long distance hauling.

The company does not have a written safety program and depends on its small size to communicate safety issues and concerns. This is the first fatality experienced by the employer. Until this incident the employer had an improving safety record based upon declining worker's compensation rates.

SYNOPSIS OF EVENTS

On Monday, October 27, 1986, a pump operator/truck driver (the victim) was dispatched to a development of single family residences to pour the foundation of a residence being constructed. The victim had been on this job site the previous Friday and had poured the footers for the residence. Many of the job sites where this company works have underground electrical service; however, the owner of the company stated that he reminded the victim, prior to leaving for the job site, that this site had overhead power lines and that he should exercise caution. The truck was 28 feet long and had a concrete pump mounted to the bed. A four inch steel reinforced, rubber hose was mounted on the boom. The back section of the boom could extend 24 feet and the entire boom can extend 72 feet (upwards or forwards). When the victim arrived at the job site he pulled his truck into the front yard of the residence with the cab closest to the house. Apparently he parked the truck in the same location on the previous Friday (approximately 10 to 15 feet from the house). He then began to set up the concrete pump. The victim lowered the outriggers on the truck and rotated the pump perpendicular to the bed of the truck. He then elevated the boom and the rubber hose so that he could reach the foundation that was to be poured. Although no one actually witnessed the incident, the consensus of those interviewed was that the victim was using the pendant controller to elevate the boom and was standing on the passenger side of the truck approximately eight feet away from the rear of the truck. The pendant controller had a 50 foot cable attached to it that permitted the operator to move around freely. According to the manufacturer of the pump, the pendant controller was electrically insulated from the pump. The truck had signs stating that operation of the equipment within ten feet of high voltage lines was unlawful.

The rubber hose mounted on the boom apparently contacted the overhead power line (approximately 33 feet above the ground). A witness who arrived at the scene shortly after the incident stated that the boom was approximately six inches away from the power line when he arrived. The victim was lying on the ground approximately seven and a half feet from the truck. The rubber hose mounted to the boom appeared to have a burn mark where the hose apparently contacted the power line. The cable to the pendant controller had several places where the insulation appeared to be melted; however, the pump and controller reportedly were operational after the accident.

Workers in a nearby residence heard the noise resulting from the contact and went to the aid of the victim. Two workers performed cardiopulmonary resuscitation (CPR) on the victim. Both workers were trained in CPR and one of these workers was a member of a rescue squad. The emergency medical service was notified and arrived at the scene approximately ten minutes later. The victim was transported to a nearby hospital and was pronounced dead on arrival.

CAUSE OF DEATH

The coroner determined the cause of death to be accidental electrocution. An autopsy was not performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA standard 1926.550(a)(15) requires that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers. Additionally, 29 CFR 1926.550(a)(15)(IV) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means. The pump operator/truck driver in this case did not satisfy these requirements.

Recommendation #2: All boomed vehicles capable of contacting overhead power lines should be electrically insulated.

Discussion: The owner of the company stated that the victim had been made aware of the overhead power lines and there were signs on the truck stating that it was unlawful to operate the equipment within ten feet of high voltage power lines. Those personnel interviewed all stated that the victim was a good worker and was a safe worker. The victim had been on this work site previously without incident. Even with these safeguards and other considerations the fatal accident occurred. It is apparent that the regulations concerning cranes and overhead power lines are adequate when followed; however, boomed equipment should be provided with electrical insulation so that a momentary error in judgment does not result in the loss of life.

Recommendation #3: The employer should emphasize safety concerns to all employees.

Discussion: The employer does not have a written safety program and relies upon the small size of the company and its informal organization to assure employee safety. A more formal approach to safety should be initiated. Although a written safety program may not be necessary, a written policy stating management's commitment to work place safety should be developed. All employees should know that workplace safety is of the utmost importance, even when it may adversely impact production, efficiency, or scheduling. A more formal system of tailgate meetings, etc. could be used to address specific safety considerations.

FACE 87-11: **Laborer Electrocuted in Ohio**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 4, 1986, an 18-year-old laborer in an oil recycling plant was electrocuted when he contacted a pump casing that was energized due to faulty wiring.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 13, 1986, a DSR researcher (a safety specialist) conducted a site visit, met with representatives of the company and officials of the industrial Commission of Ohio, photographed the accident site, and conducted interviews with comparison workers.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed at a chemical service plant that recycled industrial and synthetic oils. The company has been in operation since 1980 and employs 17 workers. In 1983 the company was moved into the present facility because of expanding operations. Used oil is treated at 200º F to remove all oxidized by-products and is then filtered and analyzed to determine what additives are required so that the recycled oil meets appropriate standards. Chemicals are then added and the filtering and analysis process is repeated.

The company has no written safety policy or safety program. The safety function at the plant is managed by the President on a collateral-duty basis. The job supervisor and the plant manager are responsible for safety at the facility. All new employees undergo a three month probationary period during which time they receive on-the-job training. At the time of the incident several new workers were being trained so that a second production shift could be added at the plant.

SYNOPSIS OF EVENTS

On the day of the incident the victim began his shift at 4:30 p.m. His first assignment was to change the filter elements on a filtering tank. The task required approximately one-half hour for completion. The victim and a co-worker were then to pump the oil from a filtering tank into a kettle where it could be analyzed to determine what additives were needed for the oil to meet customer specifications.

The victim and co-worker used a standard 7.5 horsepower, portable bane pump and a two inch, steel-reinforced hose to accomplish this task. (Due to the type of substances being pumped, the pumps need to be rebuilt approximately every six months.) Shortly after the pumping process had begun, the co-worker saw the victim standing with one hand on the pump and "shaking." The co-worker stated that the victim was "shaking" for five to seven seconds. As the co-worker approached the victim, the victim fell away from the pump. The co-worker momentarily attempted to administer CPR to the victim, then ran to the office area of the plant and summoned a fellow worker. Both men tried to revive the victim until the rescue squad arrived approximately five minutes after the co-worker noticed that the victim had contacted the energized pump. After defibrillation was attempted at the scene, the victim was transported to a hospital where he was pronounced dead.

Upon examination of the pump, it was found that the portable pump frame was not grounded and the insulation on one of the conductors entering the motor connection box had been damaged, allowing a live conductor to become exposed. The live conductor energized the metal pump frame. The victim provided a path to ground and was electrocuted when he contacted the pump frame. No strain relief device was present where the power cable entered the motor connection box. Without the strain relief device any force exerted on the power cable could have contributed to the damaged conductor insulation.

The electrical installation in the plant is known as a three-wire, three-phase Delta system. This system differs from other three-phase installations in that it lacks a grounded neutral (white conductor) as part of its circuit. Circuits in these installations can operate without a grounded neutral because an electrical potential difference exists phase to phase.

The plant ground system in this case was provided by electrical conduit which was connected to the structural steel of the building and the water pipes (i.e., to ground). Resistance measurements and a visual inspection by a professional engineering firm determined the ground system to be continuous with grounding values that were acceptable per the National Electrical Code (NEC). However, a grounding conductor (equipment ground or protective ground) connecting the non-current carrying metal parts of the pump to the ground system was not present on the pump. The purpose of the grounding conductor is to protect people from electrical shock by carrying the fault current to ground. The absence of the grounding conductor allowed the pump frame to become energized when the damaged conductor contacted the motor connection box.

CAUSE OF DEATH

Although the coroner's office labeled the incident as apparent electrocution, no official ruling has been given at the time.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical equipment (such as portable pumps) should be designed and maintained to comply with applicable requirements of the National Electrical Code (NEC).

Discussion: The frame of the portable pump involved in this incident was not connected to a grounding conductor and did not have strain relief provided for the power cable at the motor connection box. All plugs and power cables connected to the portable pumps were changed to a four-wire, grounded system. The fourth wire was connected to the pump frame, thus assuring adequate grounds for the portable pumps. Additionally, all electrical receptacles used with the pumps have been changed from three-pole to four-pole receptacles. The fourth pole has been grounded to the conduit system. These modifications bring the pumps into compliance with article 250-45 of the National Electrical Code (NEC).

Recommendation #2: The employer should develop and implement formal safety training.

Discussion: The employer should develop and implement a formal safety program that specifies work procedures for the various tasks a worker might be required to perform while on the job. Employees should receive safety training that would allow them to recognize and control safety hazards. Management of the plant and consultants from the Industrial Commission of Ohio are working together to accomplish these goals.

Recommendation #3: The employer should develop and implement a comprehensive preventive maintenance program for electrical equipment.

Discussion: Although the portable pumps are rebuilt approximately every six months, more frequent inspections of electrical equipment by qualified personnel should be performed to assure worker safety. Any hazards discovered should be promptly corrected. Additionally, daily inspections should be performed by users of the equipment. These daily inspections should minimally identify such hazards as damaged plugs or receptacles, damaged insulation on conductors, missing guardplates, poor or loose connections, etc. Management of the plant is working together with consultants from the Industrial Commission of Ohio to establish a preventive maintenance program at the plant.

FACE 87-12: Four Members of a Maintenance Crew Electrocuted in California at a Major Naval Installation

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 31, 1986, four members of a maintenance crew at a major naval installation were electrocuted and one crew member was critically injured when a scaffold they were moving contacted a 12,000 volt power line. The men were using the 30-foot high scaffold while painting a three story building.

CONTACTS/ACTIVITIES

The National Institute for Occupational Safety and Health provided assistance to the Naval Public Works Center concerning this fatality. This case has been included in the FACE Project. On November 17, 1986, the DSR research team (consisting of two safety specialists) conducted a site visit, met with representatives of the base safety and compensation offices, interviewed comparison workers, interviewed surrogates for the victims, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The maintenance crew of the major installation consists of 1100 workers, who are assigned to work in one of the five zones of the naval installation. The victims were painters in the 400 man crew of zone three.

The safety function at the naval base is managed by the safety office on a full-time basis. A written safety policy and a comprehensive safety program exist at the base. The safety office publishes safety bulletins to be used by supervisors for their bi-monthly workplace safety meetings.

Workers are required to sign statements as evidence that they have attended these safety meetings. A safety committee of supervisors meets monthly to discuss safety issues. First line supervisors receive eight hours of annual supervisor training. Hazard recognition is stressed at these training sessions. The safety officer personally conducts training in respiratory protection, back injury prevention, handling of hazardous materials, and confined space entry.

SYNOPSIS OF EVENTS

The crew (a crew chief and four painters) was painting a three story structure that housed offices for base personnel. The crew was using tubular welded frame scaffolding, approximately 4 feet wide by 8 feet long. The scaffold was five tiers high (approximately 28.5 feet) and was mounted on five-inch rubber-clad, aluminum wheels. The crew had completed painting the left side of the office building and was preparing to paint the front of the building. Although time was allocated on the work order to dismantle and rebuild the scaffold, the crew began to push the five-tier high scaffold to the front of the structure.

A three-phase 12,000 volt power line was located 27.5 feet above the ground and 17.5 feet away from the left front corner of the building (See Figure).

A second scaffold was located at the left front corner of the structure. This three-tier high scaffold was also constructed from tubular welded frame scaffolding. However, the base dimensions were increased an additional three feet because the outriggers were extended. The crew had to maneuver the five-tier scaffold between the extended outriggers of the second scaffold and the 12,000 volt power line to reach the front of the building. Naval personnel estimated that less than four feet of clearance existed between the 12,000 volt power line and the five-tier scaffolding.

As the crew was maneuvering the five-tier scaffold around the extended outriggers of the second scaffold, the five-tier scaffold contacted the 12,000 volt power line. The four painters remained in contact with the scaffold while the crew chief received a severe electrical shock and was knocked backwards away from the scaffold. As naval personnel and civilians tried to approach the victims they received electrical shocks through their feet from the current running through the scaffolding to ground. The crew chief was able to grasp a board held by a rescuer and was pulled to safety. He was flown by helicopter to a local hospital where he was listed in critical condition. Rescuers tried to separate the victims from the scaffold, but were unable to do so until the power lines were de-energized.

CAUSE OF DEATH

The cause of the four deaths was listed as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Supervisory personnel trained in hazard recognition should make a job site survey prior to the start of work at a site.

Discussion: Hazard recognition is stressed during yearly first line supervisor training sessions. The first line supervisor in this case (the crew chief) should have made a job site inspection to identify potential safety hazards. Once a safety hazard (in this case the power line) is identified, measures can be taken to control it.

Recommendation #2: Supervisors should utilize all allocated time to safely accomplish job assignments.

Discussion: Sufficient time to dismantle and re-assemble the scaffolding for moves was allocated on the work order. Had the scaffolding been even partially dismantled prior to the move, it would have made the scaffold much more maneuverable and would have eliminated the potential hazard presented by the power line.

Recommendation #3: Safe working distances should be maintained between scaffolding and power lines.

Discussion: California OSHA regulations require that six feet of clearance be maintained between power lines and scaffolding. Although California OSHA does not have jurisdiction in the case, it is smart and safe work practice to maintain at least a six foot distance as clearance. Additionally, when scaffolding is being moved in the vicinity of power lines a person should be appointed to constantly monitor the clearance between the power lines and the scaffolding.

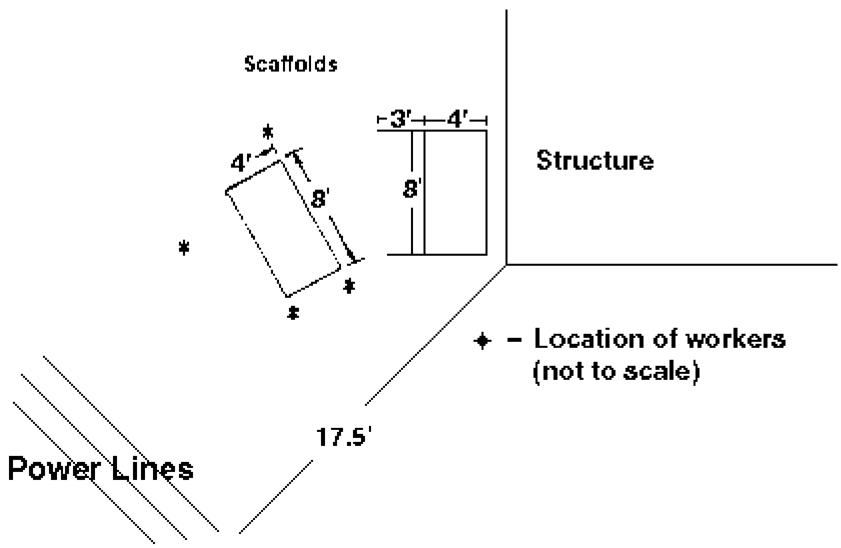

Figure. *Top View of Accident Site*

FACE 87-13: Laborer Electrocuted in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 23, 1986, a laborer was helping unload sewer pipe from a flatbed truck. He was electrocuted when the boom cable of a truck-mounted crane contacted an overhead high voltage line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case will be included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On December 2, 1986, a member of the DSR research team met with the company's safety officer and job superintendent. The accident site was visited and photographed. Interviews were conducted with co-workers and the victim's supervisor.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was a laborer for a large construction company involved in sewer construction. Safety meetings are held weekly on the job site. The company safety officer spends approximately ninety per cent of his time on health and safety and visits each job site every two weeks. Training is provided "on the job."

SYNOPSIS OF EVENTS

A flatbed truck loaded with sewer pipe (24 inches in diameter and 20 feet long) was parked along a two-lane road. A second truck, equipped with an extensible, hydraulic, boomed crane, was backed up to the rear of the truck loaded with sewer pipe. The victim's job was to help position the sewer pipes on the ground and unhook the wire rope choker from the pipes after the crane operator lowered them to the ground. Two co-workers remained on the truck to connect the choker to each end of the pipes being unloaded by the crane. The pipes were being placed end to end along the roadside as they were unloaded. Two pipes had already been unloaded and a third was being unloaded when the accident occurred.

After the third sewer pipe was lowered to the ground, the victim was positioning the pipe by grasping the pipe and wire rope choker and pulling. At the same time, the boom cable contacted an overhead power line and a blue flame was seen arcing between the pipe the victim was holding and pipes previously unloaded. The victim slumped over the end of the pipe and collapsed.

Two co-workers began cardiopulmonary resuscitation (CPR) and a third ran to call for help. The Emergency Medical Service (EMS) personnel arrived approximately eight to ten minutes after the accident and began advanced cardiac life support. However, the victim could not be resuscitated.

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CAUSE OF DEATH

The medical examiner listed the cause of death as accidental electrocution. No autopsy was performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA standard 1926.550(a)(15)(i) requires that a minimum clearance of ten feet be maintained between parts of truck cranes or loads and energized electrical power lines rated 50 kV or less, unless the lines were deenergized and visibly grounded or insulating barriers are erected.

Recommendation #2: While working near a high voltage line, if visibility could be obstructed, an observer should be used to help the operator maintain the required clearance, as required by OSHA Standard 1926.550(a)(15)(iv).

Discussion: Tree branches may have obstructed the operator's view of the overhead power lines. An independent observer might have aided in maintaining the required separation.

Recommendation #3: Hydraulic, extensible booms may require special care when operating near high voltage lines.

Discussion: Prior to the accident, the operator extended the hydraulic boom in order to unload the pipes furthest from him. Since the boom was lengthened, the maximum vertical reach of the boom was greater than in previous lifts, a change the operator may have failed to consider.

Recommendation #4: Engineers who plan construction projects and establish contract requirements should incorporate safety into their planning.

Discussion: The construction company was required by the city to leave at least one lane of the two lane road open to traffic. This necessitated modifying their work practices to use a truck crane to unload the sewer pipe, instead of using a forklift. When safety and convenience conflict, safety should receive priority.

FACE 87-14: Stagehand Electrocuted in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 26, 1986, a stagehand was electrocuted when he contacted an exposed electrical wire protruding from an uncovered junction box.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case will be included in the Fatal Accident Circumstances and Epidemiology (FACE) Project. On November 28, 1986, a member of the DSR research team met with the Tennessee OSHA compliance officer for this case. The accident site was visited and photographed. Interviews were conducted with co-workers, a surrogate for the victim, and with the president of the local stagehands' union.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was an independent contractor who was a member of the local stagehands' union. The union schedules work and distributes wages when concert groups perform in a local sports and entertainment center, but is not considered an employer. While safety is discussed at union meetings, there is no formal safety program. All training is provided "on the job."

SYNOPSIS OF EVENTS

On October 26, 1986, the victim was working above the ceiling of the entertainment center, preparing for an upcoming concert. He was lying on a metal catwalk, reaching out to replace a ceiling tile near the catwalk.

As the victim worked, he contacted a bare electrical wire (277 volts) which was protruding from an electrical junction box located on one side of the catwalk. The wire had previously supplied electricity to a nearby mercury vapor light. Apparently, when the light was disconnected, the cover plate of the junction box was not replaced and an energized conductor was protruding.

After contacting the energized conductor, the victim cried out and collapsed. Two co-workers ran to his assistance and began cardiopulmonary resuscitation (CPR) in less than one minute. The local ambulance service was called and paramedics responded in less than five minutes. However, the victim had to be carried down from the narrow catwalk located above the ceiling before defibrillation and other advanced cardiac life support (ACLS) measures could be applied. The total time which elapsed between the accident and defibrillation was greater than ten minutes and the victim could not be resuscitated. He was pronounced dead in a local emergency room.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution. Electrical burns were noted on the victim's chest.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The electrical system above the ceiling of the entertainment center should be inspected periodically.

Discussion: Many examples of substandard electrical conditions were noted after the accident occurred, including broken conduit and uncovered junction boxes. While most of these have now been repaired, the wiring above the ceiling is subject to frequent modification and abuse and an ongoing inspection program will be necessary to maintain safety standards.

Recommendation #2: The stagehands should be trained in electrical safety.

Discussion: The stagehands should be trained to recognize and report unsafe electrical conditions (junction boxes without covers, etc.), as well as to avoid abusing the electrical system (there was evidence that someone had been walking on the electrical conduit).

FACE 87-15: **19-Year-Old Laborer Electrocuted in Kentucky**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances And Epidemiology (FACE) Project, which in focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 27, 1986, a 19-year-old laborer was electrocuted while painting a concrete silo.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Kentucky notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE project. On December 9, 1986, the DSR research team (a safety engineer and a statistician) visited and photographed the accident site. Interviews were conducted with the owner of the company, two comparison workers, a representative of the farm where the incident occurred, and a surrogate for the victim. The coroner was contacted and the autopsy report was reviewed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small concrete restoration company which employed seven workers at the time of the incident. Because this work is seasonal the number of employees fluctuates accordingly.

The company does not have a safety program other than what is required to meet contractual obligations when bidding on contracts. Although this safety program is rather good on paper, it does not appear to be implemented on a daily basis.

SYNOPSIS OF EVENTS

On August 27, 1987, the owner of a concrete restoration company and six employees were painting a concrete silo (65 feet high, 16 feet in diameter) that they had repaired as part of the same contract. The victim and a co-worker were painting from scaffolding along the side of the silo. The workers were approximately 23 feet above the ground and were not using any personal protective equipment. The scaffolding was erected to the top of the silo. The workers were using eight foot aluminum poles (that could be extended to 16 feet) with paint rollers attached on one end to paint the silo. The presence of the scaffolding above the employees required them to paint through the openings of the support lumbers of the scaffolding. A 7200 volt power line was located six to eight feet behind the workers and approximately 23 feet above the ground. (See figure.)

The victim was painting a screen that covered several vent holes. This required him to stretch in order to reach the screen with his paint roller. Apparently while the victim was bringing his roller and the pole back to the scaffold to put paint on the roller, he contacted the electrical line with the aluminum pole.

The victim collapsed and the co-worker laid him on the aluminum walk boards. The owner, who was suspended from a boatswain's chair, swung over to the scaffold and performed cardiopulmonary resuscitation (CPR) on the victim until emergency medical service (EMS) personnel responded approximately 20 minutes after the victim contacted the power line. Advanced cardiac life support was administered by responding EMS personnel; however, this was begun only after the victim was removed from the scaffolding. The victim was pronounced dead on arrival at a nearby hospital.

CAUSE OF DEATH

The coroner determined the cause of death to be electrocution (high voltage). Electrical burns were noted on the victim's right side.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should not erect scaffolds within ten feet of electrical power lines. Electrically conductive tools should not be used where they may come into contact with electrical power lines.

Discussion: Although there are no Federal regulations concerning working a specified distance from energized power lines, several states have requirements concerning this activity. Additionally, employees should not be allowed to use electrically conductive tools when working in the vicinity of electrical power lines. Erection of the scaffolding and the use of the aluminum pole within six to eight feet of the power line is inherently dangerous and should not be permitted. The aluminum poles had warning signs concerning their use around electrical lines; however, these warnings were not heeded.

Recommendation #2: Employers should thoroughly evaluate the safety concerns of their employees and take any necessary corrective action.

Discussion: Prior to the accident, employees notified the owner of the company that they were receiving shocks while working on the silo. The owner investigated the situation and determined that the shocks were resulting from voltages induced on the silo by the nearby power lines. This explanation is plausible given the voltage and proximity of the power line. Employers should thoroughly evaluate the safety concerns of their equipment. Many states provide free safety consultation to employers and utilities often provide advice concerning electrical matters. Either of these organizations may have been able to adequately explain this phenomenon and may have identified the even more serious hazard presented by the proximity of the power line to the silo.

Recommendation #3: Autopsy reports and other technical reports resulting from an incident of this kind should be explained by qualified personnel in the medical examiner's office to lay people who are provided copies.

Discussion: Many witnesses interviewed were confused concerning the events surrounding this incident. This confusion was exacerbated by the clinical terminology used in the autopsy report and a misunderstanding of the details of that report. The only electrical burns identified were on the victim's right side. These burns resulted from arcing between the victim's body and the aluminum pole and could only result if high voltage was present. A scorch mark was noted on the victim's right shoe; however, there were no electrical burns on his feet, hands, or head. All other marks identified in the autopsy report refer to marks that would normally result from the medical treatment provided to the victim and do not have any role in the events surrounding the actual contact with electricity.

Recommendation #4: Guardrails should be installed on the level of scaffolding where employees are working.

Discussion: OSHA regulation 1910.28(d)(7), Tubular welded frame scaffolds requires that guardrails be installed on the level of the scaffolding where employees are working. The employees were working with scaffolding above them and were using the structural supports as guardrails. Guardrails that comply with the above referenced standard should have been installed.

Recommendation #5: Employers that provide their own electrical distribution system should periodically have those systems evaluated by personnel qualified to determine if these systems were installed and are being maintained in accordance with all applicable safety requirements.

Discussion: The farm owner (i.e., the owner of the electrical lines) purchases electricity from the utility and is responsible for distribution throughout the farm. A private electrician is contracted to perform maintenance and repairs on the electrical system; however, it appears that this arrangement does not provide an adequate level of safety for systems similar to the one involved in this incident. The line was located six to eight feet from the silo and almost directly above three small buildings that house pumps and other equipment associated with the silo. Employers that provide their own electrical distribution systems should periodically have those systems evaluated by qualified personnel to determine if these system are being installed and maintained in accordance with all applicable safety requirements.

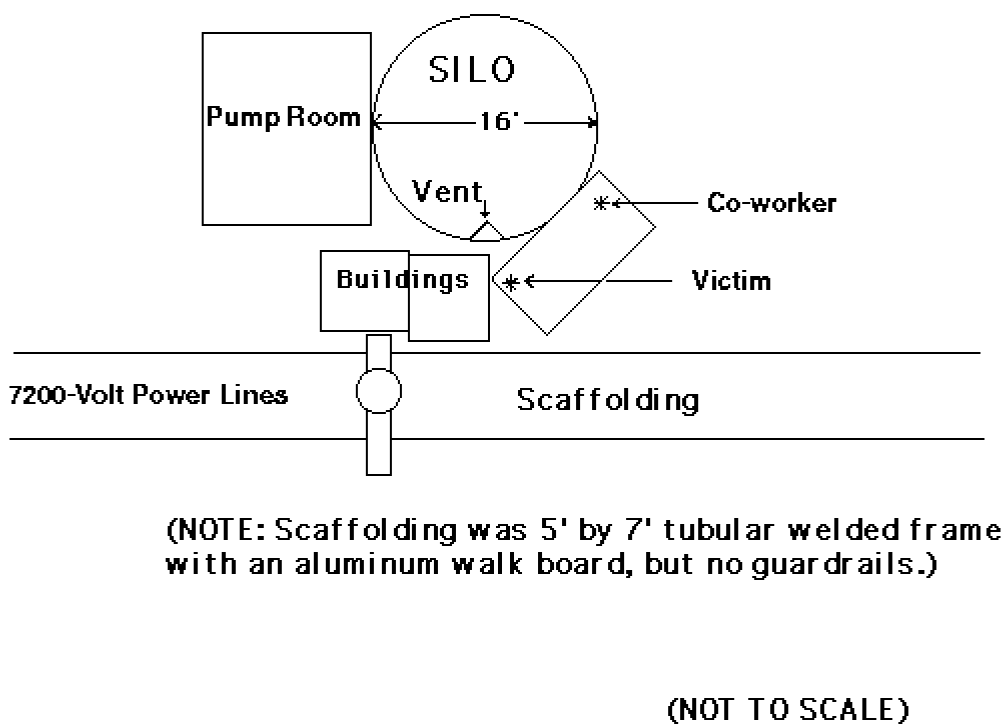

***Figure**. Top View of Fatality Site*

FACE 87-16: **31-Year-Old Fire Chief Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 15, 1986, the chief of a volunteer fire department was electrocuted while attempting to extricate an injured person from a vehicle involved in an accident. He was holding a winch cable which contacted downed, energized power lines.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. Two research industrial hygienists from DSR met with the fire chief, interviewed comparison workers and a surrogate for the victim, conducted a site visit, and photographed the accident site.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a volunteer fire department with a staff of two full-time paid, two part-time paid, and 40 volunteer firemen. Although the victim was on volunteer status for this fire department, he was also a full-time paid fireman for a nearby city fire department.

The volunteer fire department does not have a written safety program; however, a fire department handbook which is given to all department personnel does outline required personal protective equipment for firemen responding to an emergency. New department members serve a six month probationary period during which time they must complete a 52-hour fireman training course. In addition, the department presents three-hours of training each week that department members are encouraged to attend. A major part of the training involves emergency response drills, the proper use of personal protective equipment, rescue techniques, and on-the-job employee safety. The fire chief was responsible for the management of this on-going training program.

SYNOPSIS OF EVENTS

On November 15, 1986, at 7:20 p.m. the chief of a volunteer fire department (the victim) and several other firemen responded to a power line transformer fire. At 7:22 p.m. while still at the site of the transformer fire, the fire department received another emergency call concerning an automobile accident. A vehicle had gone off the road and struck a utility pole carrying a 7200 volt, three-phase power line. The force of the collision broke the pole off at ground level which caused one conductor to fall to the ground and two other conductors to sag until they were approximately three to five feet above the ground. An injured passenger remained pinned inside the vehicle. The ground was wet as it had rained previously that day. The chief of the fire department (who was on volunteer status) and another volunteer fireman arrived at the accident site. They were joined by the engine company and rescue unit from the fire department and

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an ambulance; a total of eight fire department and rescue personnel. All fire department personnel except the fire chief, who had assumed the role of fire ground commander, and two other firemen were wearing turnout gear which included leather gloves and rubber boots.

The vehicle involved in the accident was on its side approximately two feet from the downed conductors. The conductors were between the overturned vehicle and the road where the rescue vehicle was parked. Fire department personnel were warned that the power lines were down and to be careful. A power company employee was notified of the transformer fire and was enroute to de-energize the power line. In an effort to stabilize the accident vehicle and prevent it from turning over, a steel cable attached to a winch mounted on the rescue vehicle was extended to a length of 47 feet, passed between the conductor on the ground and the sagging conductors, and was attached to the luggage rack of the accident vehicle. The fire chief, six firemen, an emergency medical technician (EMT) employed by an ambulance company, and a bystander were all holding on to the steel cable. Five firemen let go of the cable after having been told to "stand back." The luggage rack then pulled loose and the rack and cable contacted the energized lines. The fire chief and the bystander were both electrocuted. It is estimated that the fire chief was in contact with the electrified steel cable for approximately 30 to 45 seconds. One fireman who was not wearing turnout gear and the ambulance company EMT did not let go of the cable before it became energized. They were injured, receiving severe electrical burns. Those firemen not holding the cable when it became energized felt a slight electrical shock from the ground.

The fireman were all EMT qualified and responded immediately. The fire chief, the bystander, and the injured fireman and ambulance company EMT were freed from the electrified steel cable with the use of a fiberglass pole. Cardiopulmonary resuscitation (CPR) was initiated within seconds and the injured fireman was revived after experiencing full cardiac arrest. Resuscitation efforts failed to revive the fire chief who was rushed to a nearby hospital where he was pronounced dead by the attending physician.

CAUSE OF DEATH

The medical examiner determined that the cause of death was due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical sources that pose an imminent danger to rescue personnel should be de-energized prior to any initial rescue attempt.

Discussion: Attempting to extricate an injured person from a vehicle amid an electrical hazard of this magnitude only further endangered rescue personnel and the person originally involved in the automobile accident.

Recommendation #2: Fire department standard operating procedures should require the wearing of personal protective equipment for all fire department rescue personnel responding to the scene of an emergency.

Discussion: Standard operating procedures in the fire department handbook address "wearing protective gear on the fire scene" and states that "All firemen riding a fire apparatus shall wear protective gear when responding to an emergency..." The requirement should be expanded to include the mandatory wearing

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of personal protective equipment such as helmets, gloves, rubber boots, etc. of all rescue personnel including the fire ground commander when responding to any emergency.

Recommendation #3: Only authorized rescue personnel should assist in rescue procedures.

Discussion: Unauthorized persons such as bystanders and passersby should be restricted from entering into the immediate accident area where trained rescue and emergency personnel are present, and under no circumstances should unauthorized persons be allowed to participate in rescue operations where imminent dangers exist. Such well-intended volunteer help is often poorly, if not totally, untrained in rescue techniques. The presence of bystanders often hinders the efficiency of trained rescue personnel and poses an unnecessary hazard to rescuers and to the bystanders themselves.

Recommendation #4: Firemen should be trained in recognition and appreciation of hazards, preventive measures for personal safety during rescue operations, and safe rescue techniques.

Discussion: Although firemen are trained in various firefighting techniques, it would appear additional training is needed in hazard recognition, particularly electrical hazards. This training should include recognition, awareness, safe rescue procedures, and an appreciation of electrical hazards, along with necessary preventive measures to avoid future accidents of this nature. Rescue personnel assumed an extreme and unnecessary risk by threading a steel cable between downed, energized power lines and attaching the cable to the luggage rack in order to stabilize the accident vehicle. The very idea was ill-conceived. Its realization posed an imminent danger with fatal results. Another method to prevent the vehicle from overturning should have been considered under these circumstances and future training of emergency service personnel should address the utilization of safer rescue techniques.

Recommendation #5: Personnel assigned responsibility to coordinate activities at an accident site (i.e., fire ground commander) should not become involved in the rescue effort, if an adequate number of personnel are available.

Discussion: It would appear that a sufficient number of personnel were available at the accident site to preclude the need for the fire chief to be involved in the "hands-on" rescue. His involvement in the rescue may have diminished his ability to recognize the seriousness of the hazard and to take corrective action.

FACE 87-18: **Worker Electrocuted in South Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On October 21, 1986, a worker was electrocuted while steam cleaning a rubber mill. The rubber mill had an on/off switch which was not watertight. Steam entered the switch and energized the outer surface of the switch and the rubber mill. The victim was holding the steam cleaner's wand in his hand and standing in water when the wand contacted the electrically energized rubber mill. The victim's body provided a path to ground and he was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of South Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On December 12, 1986, a DSR research team conducted an evaluation of this accident. The investigation began with an interview of the collateral-duty safety director for the company. FACE survey instruments were completed for the victim and two comparison workers. Discussions were also held with the OSHA Compliance Officer. The safety director of the company and the DSR research team visited the accident site. Photographs were taken of the accident site and the equipment being used by the victim at the time of the accident.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The company has been in operation since 1949, but has been under the present ownership for only one year. The company has a written corporate safety policy that is communicated during new employee orientation and is on file for reference by employees. This manual states that the "Supervisor is responsible for the safety and loss control of his/her employees" and "Each employee is responsible for his/her own safety, the safety of others working with him/her and for the proper care of equipment and quality of the product." The manual further states that employees shall "Shut down your machine before cleaning, adjusting, or repairing, and lock and tag the machine." The company has a lockout and tagout procedure, but it does not mention steam cleaning. Training of new employees is performed on-the-job by a foreman or experienced employee. The company requires respirators for employees who are exposed to toxic dusts and vapors and supplies hearing protection to workers who are exposed to noise levels over 90 dba. Periodic auditory and respiratory examinations are given to employees.

SYNOPSIS OF EVENTS

At approximately 2:30 a.m., Tuesday, October 21, 1986, a laborer was steam cleaning a rubber mill machine. A rubber mill is a machine which uses large rollers driven by electric motors to convert bulk rubber materials into flat strips that can be formed into tires. The rubber mill is powered by 440 volts supplied through a nearby breaker panel, and is also equipped with an on/off switch mounted on the rubber mill. The steam cleaning machine is a portable device consisting of a motor, a heater, a water tank, and a pump mounted on a metal frame with rubber wheels. A wand on the steam cleaning machine, which is held by the operator, is used to direct pressurized steam for the cleaning operation. Although the steam cleaner is a portable device, designed to plug directly into an appropriate power source, the male electrical plug on the steam cleaner was not compatible with an existing female receptacle located within reach of its power cord. Therefore, the steam cleaner was wired directly into one of several nearby breaker panels. Preliminary investigations by OSHA and company management indicated that the steam cleaning machine had been properly wired into the breaker panel and the method of supplying power to the machine was not implicated as a contributing factor to the accident.

While the victim was cleaning the rubber mill, steam entered the switch and condensed forming water, which partially filled the on/off switch. This water short circuited the switch and energized the frame of the rubber mill. The on/off switch, which was not designed for wet or damp locations, was incapable of preventing the steam and/or water from reaching electrical components inside the on/off switch. As the victim continued cleaning the rubber mill, he apparently contacted the energized rubber mill with the wand of the steam cleaner. Since the wand on the steam cleaner was made of conductive metal components, contacting the energized rubber mill with the wand provided a path for current to pass through the victim's body to ground. Although the on/off switch was in the off position during the steam cleaning operation, power to the on/off switch was not de-energized at the breaker panel. Thus, the on/off switch box and the rubber mill became energized as it filled with steam during the cleaning of the rubber mill. The victim was standing in water and was not wearing insulated gloves or boots when the accident occurred. This was the first time the victim had operated the steam cleaning machine.

The foreman discovered the victim lying on the floor with the steam cleaning wand in his hands. The foreman removed the wand from the victim's hands, yelled for help from co-workers and went to summon the emergency medical service. When the foreman returned, co-workers were administering cardiopulmonary resuscitation (CPR). Co-workers administered CPR for fifteen minutes until the emergency medical squad arrived. The victim was pronounced dead at a local hospital two hours later.

CAUSE OF DEATH

The death certificate lists the cause of death as electrocution. The victim had electrical burns on his right wrist and on the naval area of the stomach.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should ensure that employees have been instructed on the operation and safe work practices for all machinery and equipment they are required to operate.

Discussion: This was the first time the employee had used the steam cleaning equipment. Employees must be made aware of and follow safe job procedures as defined in the company's safe job manual. It is the responsibility of the employer to instruct employees in safe work practices associated with using steam cleaners around electrical equipment.

Recommendation #2: A procedure for ensuring that the rubber mill will be locked-out and tagged-out at the breaker panel should be instituted.

Discussion: Locking-out the breaker panel would have de-energized the electrical components inside the on/off switch. The machinery or equipment being cleaned should also have been locked-out and tagged-out to prevent electrical shock or inadvertent start-up of the rubber mill during steam cleaning.

Recommendation #3: If steam cleaning of the rubber mill and other equipment is to continue, this equipment should be modified to meet all requirements of the National Electrical Code that apply to the use of electrical equipment in damp or wet locations.

Discussion: Since the on/off switch was not suitable for wet or damp locations, steam and/or water was able to enter the switch and energize the frame of the rubber mill during the steam cleaning operation. An on/off switch suitable for use in wet environments would reduce the possibility of water entering the box and providing an electrical path to the outside of the box.

Recommendation #4: The hand-held wand on the steam cleaner should be insulated or made of non-conductive materials.

Discussion: The hand-held wand was constructed of conductive material which allowed current to flow down the wand and through the victim. An insulated or non-conductive wand should be provided to reduce the risk of electrical shock to workers.

Recommendation #5: Specific safe procedures for steam cleaning operations should be developed and the steam cleaning machine should be clearly marked to warn that fatal injury can result if the equipment is used to clean equipment which has not been electrically de-energized.

Discussion: This was the first time that the rubber mill had ever been steam cleaned. It appears that the injured employee was unaware that water can introduce paths to ground from energized electrical components.

FACE 87-19: **20-Year-Old Bricklayer Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 24, 1986, employees were working from a tubular welded frame scaffold to construct a brick wall. A ten foot section of wire reinforcement being moved by a co-worker contacted a 7620 volt power line and the scaffold. When this occurred, a bricklayer, who was in contact with the metal railing of the scaffold, was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On January 13, 1987, the DSR research team coordinator conducted a site visit, collected incident data, photographed the site, interviewed comparison workers, and discussed the incident with the state compliance officer and the employer representative.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small masonry company which employed 50 workers at the time of the incident. Because the work is seasonal the number of employees fluctuates accordingly.

The company does not have a formal safety program and does not have any safety rules which address working on scaffolds.

SYNOPSIS OF EVENTS

On November 24, 1986, seven employees of a masonry company were working from a tubular welded frame scaffold to build a brick wall for a building under construction. The scaffold was 9 sections long; one section wide; and 4 sections high (approximately 63 feet x 5 feet x 24 feet). The scaffold planking was constructed of wood. A work platform was attached to the front of the scaffold facing the brick wall. This platform was 2 feet wide and ran the length of the scaffold. The platform was 22 feet above the ground. The bricklayers worked while standing on this platform and received their stock from the main part of the scaffold. The scaffold was located between a 7620 volt power line and the building under construction (see Figure 1). The horizontal distance from the power line to the edge of the scaffold was 21 inches. The height of the power line from ground level was 27 ½ feet.

At the time of the accident, a laborer was walking along the top section of the scaffold carrying a piece of wire reinforcement (10 feet long and 8 inches wide). The wire reinforcement touched the 7620 volt line. The laborer, who was wearing leather gloves at the time, received a shock and dropped the wire reinforcement. The reinforcement fell across the 7620 volt line and the metal rail of the scaffold, energizing the entire scaffold. A bricklayer (the victim) was standing on the work platform, but was in contact with the main scaffold. This contact provided a path to ground and the bricklayer was electrocuted. Burn marks on the victim's hands and left leg above the knee indicate that he was touching the frame of the main scaffold with his hands while his knee touched the frame of the work platform section. The wire reinforcement eventually fell from the 7620 volt line, de-energizing the scaffold.

Emergency medical service (EMS) personnel arrived in approximately ten minutes and administered advance cardiac life support. Attempts to resuscitate the victim were unsuccessful. The victim was pronounced dead on arrival at a nearby hospital. None of the other workers on the scaffold received injuries.

CAUSE OF DEATH

Cause of death was listed as electrocution. Burn marks were on the victim's hands and left leg above the knee.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should not erect scaffolds within ten feet of energized electrical power lines.

Discussion: Although there are no Federal regulations concerning working a specified distance from energized power lines, several states have requirements concerning this activity. Erection of the scaffold within 21 inches of the power line was inherently dangerous and should not have been permitted.

Recommendation #2: The electrical power lines should have been de-energized.

Discussion: The brick wall being constructed was nine feet, six inches horizontally from the power lines. According to the power company, this met their minimum requirement concerning distance between the power lines and buildings. Unfortunately, when the scaffold was constructed in this area, a safe distance from the power lines could not be maintained. The power lines should have been de-energized. In this instance, the lines serviced only one existing building, and there would have been minimal disruption of service.

Recommendation #3: The employer should develop a safety program designed to recognize and correct hazards.

Discussion: The company does not provide training in safe work procedures and does not have any safety rules which address working on scaffolds. The tasks performed by workers while on the scaffolds should be evaluated, hazards identified, and these hazards should be addressed by a safety program.

Recommendation #4: Hazard awareness regarding overhead powerlines should be stressed and routinely reviewed so that all employees working near overhead power lines are aware of these energized sources.

Discussion: The danger of overhead powerlines appears to be obvious; however, contact with powerlines and the subsequent occupationally-related fatalities continue. Employers must stress and routinely review the hazards associated with overhead powerlines. The workers were not aware of the hazards associated with working near energized powerlines. Prior to the incident, an electrician told the workers on the scaffold that the 7620 volt line "might be hot." In an apparent attempt to see if he indeed would get shocked, an 18-year-old worker reached from the scaffold and touched the 7620 volt line. Fortunately for him, he was standing on the wood planks of the scaffold and did not provide a path to ground.

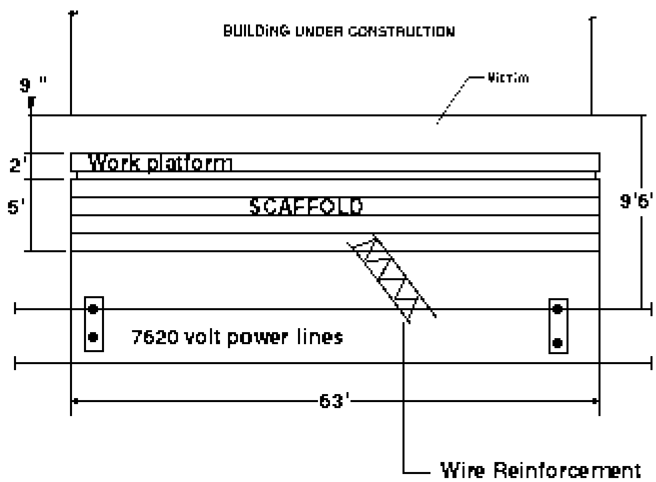

Figure 1. *Top View of Fatality Site*

FACE 87-21: **Injection Mold "Set-Up" Man Electrocuted in Tennessee**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 12, 1986, a "set-up" man was electrocuted when he simultaneously contacted an injection molding machine which was grounded and a grinding machine with a ground fault.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. This case has been included in the FACE Project. On January 26, 1987, a member of the DSR research team met with company management personnel. The accident site was visited and photographed. Interviews were conducted with two comparison workers and a surrogate for the victim.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was an injection mold "set-up" man for a plastics manufacturing company. The company manufactures plastic components (i.e., plastic lawnmower wheels) for other companies. There are no safety meetings and no designated safety officer. While there is a written safety manual, it appears to be used infrequently. All training is "on the job."

SYNOPSIS OF EVENTS

The victim, a co-worker, and a supervisor were working to "set-up" an injection molding machine. The plastic parts being manufactured were defective and the victim opened a door to the molding machine to remove and examine one of the plastic parts. As he closed the door with his left hand, he supported himself with his right hand by holding the metal handle of the nearby portable grinding machine, which was used in recycling scrap plastic. An energized wire to a safety interlock (a switch designed to stop the grinder when the top cover was opened) apparently was contacting the metal case of the switch, electrically energizing the switch and the metal case of the grinder at 270 volts. The victim's body provided a path to ground from the energized grinder to the grounded injection molding machine. Due to involuntary muscular contraction ("can't let go" phenomenon), the victim could not let go of either handle. His co-worker noticed that "something was wrong" and grabbed the victim from behind. He received an electrical shock, but was not injured. The supervisor then went to the electrical panel (a few feet away) and de-energized both machines.

The victim collapsed and an attempt at cardiopulmonary resuscitation (CPR) was made by co-workers. The plant is located in a rural setting and the emergency medical service (EMS) did not arrive for approximately 16 minutes. Ambulance personnel stated that no one was performing CPR when they arrived, no one at the scene was certified in CPR, and apparently only mouth-to-mouth efforts (without chest compressions) had been attempted. The victim was blue in color, had no pulse or respiratory effort, and had a "flat" (no electrical activity) electrocardiogram. It was felt that the victim was beyond help at this point and no further resuscitation efforts were made.

CAUSE OF DEATH

The medical examiner found no burns on the victim's body. He ruled the cause of death to be "accidental electrocution," since the victim had no history of heart disease and a co-worker who tried to aid him was "shocked." No autopsy was performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All electrical systems should be inspected periodically by qualified electricians and undergo routine preventive maintenance as prescribed by the equipment manufacturer.

Discussion: The plant engineer stated that the plug of the grinder was loose in the receptacle and that there was evidence of "arcing" on the back of the receptacle. The receptacles were ceramic and had been in service for many years. Apparently, a continuous path to ground was not provided for the grinder, in accordance with Section 250-51 of the 1987 edition of the National Electrical Code (due to poor mechanical contact at the receptacle). Receptacles should be routinely tested with a receptacle tension tester to ensure that good mechanical contact is made; the resistance to ground of all grounded equipment should be verified periodically. Electricians were brought in from outside the plant to locate and repair the electrical problem after the accident occurred. Qualified electricians should also provide routine preventive maintenance for all electrical equipment.

Recommendation #2: Safety should be a design consideration in all electrical installations.

Discussion: The safety interlock, a design modification, was electrically energized at 270 volts. This voltage is greater than necessary; using a transformer to step down the voltage to the safety interlock would provide for a safer installation. Electrical equipment design modifications should only be done by qualified personnel.

Recommendation #3: The handles of all metal enclosures housing electrical equipment should be non-conductive (insulated).

Discussion: After the accident, the company installed insulation on the metal handles of some electrical equipment. Non-conductive (insulated) handles are not currently required by the National Electrical Code; however, many low voltage electrocutions occur when the victim "can't let go" after grasping an energized metal handle. While non-conductive (insulated) handles should not be considered a substitute for effective grounding, it would increase the overall safety of the equipment. This recommendation will be submitted to the National Electrical Code Committee for consideration.

Recommendation #4: The company should develop a planned response to emergencies.

Discussion: The plant personnel who attempted CPR apparently did not have current certification. Provision should be made to ensure that all work shifts have qualified individuals with current CPR certification available. Employers in rural areas may want to discuss the feasibility of obtaining an automatic defibrillator with their plant physician or medical consultant. Prolonged EMS response times to rural locations (greater than eight to ten minutes) make successful resuscitation of a cardiac arrest victim unlikely.

FACE 87-22: Laborer Electrocuted in Ohio

INTRODUCTION

The National institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 14, 1986, a laborer was electrocuted while attempting to repair and install a faulty, eight foot long fluorescent light fixture.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On January 21, 1987, a DSR safety specialist conducted a site visit, met with employer representatives, and interviewed comparison workers. The incident was discussed with members of the Industrial Commission of Ohio and the county coroner's office. The Industrial Commission of Ohio provided photographic documentation of the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed in a facility that housed two completely independent shops that have operated under the same management for 28 years. The victim was one of three men employed at a custom mold making shop that produced steel molds for thermoplastic material. The adjoining shop utilized these molds to produce thermoplastic products.

No written safety policy or safety program existed at either operation. The president of the operations managed the safety function on a collateral-duty basis. The victim was a mold maker apprentice enrolled in a four-year apprenticeship program governed by the State of Ohio. This training program consisted of 8000 hours of on-the-job training and four hours of schooling, one day a week. The victim had just begun his third year in the program.

SYNOPSIS OF EVENTS

On the day of the incident, production at the facility was slow. The foreman instructed a group of men to install a used eight foot fluorescent light fixture on the facility ceiling above two metal lathes. The light fixture was to be suspended approximately two feet below the 14 foot ceiling with two sections of furnace chain. The workers were going to cut the chains to the proper length once the fixture was permanently installed. The excess chain was draped, over the pipes of the sprinkler system, which were located below the ceiling. A co-worker lifted one end of the fixture while standing on a forklift platform and the victim lifted the other end of the fixture into place while standing on a two and a half foot tall metal stool. After the light fixture was secured, it was plugged into a 110 volt receptacle on the ceiling. The facility had a two-wire electrical system that provided no grounding protection for the receptacle. Additionally, the ground prong on the light cord had been removed. When the light fixture was energized, an orange glow was visible at the ends of the fluorescent bulbs. The workers noticed the orange glow, unplugged the fixture, and lowered it to check the wiring for a short.

The workers did not summon the employee that normally performed electrical work for both shops, because they did not feel that a serious problem existed. The fixture was raised back to the ceiling and plugged in again. The same orange glow appeared. This procedure was repeated several times. The men decided to check the light one final time. The light was unplugged, lowered, and laid upside down. Then, using an extension cord, the fixture was plugged into a 110 volt receptacle in an adjacent room. The bulbs lit properly. Without unplugging the fixture the victim turned the fixture over, held it under his arm, and began to climb the stool. Co-workers heard a scream and saw the victim fall to the floor. The co-worker, who had his arms resting on the pipes of the sprinkler system, was knocked backward by the electric current that traveled up the lengths of chain and through the pipes.

Cardiopulmonary resuscitation (CPR) was begun immediately by the co-workers. The rescue squad was summoned and arrived within ten minutes. After advanced cardiac life support procedures were performed at the scene, the victim was transported to a local hospital where he was later pronounced dead.

Investigations conducted by the Industrial Commission of Ohio, Division of Safety and Hygiene, and NIOSH discovered factors that may have contributed to the severity of this incident. A short existed in the internal wiring of the light fixture (possibly a bare conductor in contact with the fixture frame). Reverse polarity existed in the receptacle into which the fixture was plugged at the time of the incident. Jolting the light fixture by laying it upside down cleared the short and allowed the bulbs to light properly. When the victim held the light fixture under his arm and began to climb the stool (again jolting the fixture) the short reappeared, energizing the light fixture, and causing the victim's electrocution.

CAUSE OF DEATH

The coroner's office determined the cause of death to be electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Industrial electrical systems should be periodically inspected and upgraded to comply with applicable sections of the National Electrical Code.

Discussion: The electrical system in this facility did not adhere to several articles of the National Electrical Code (i.e., Article 100, reverse polarity; Article 250-24(b), ungrounded systems; Article 250-81, bonding jumpers; Article 252-92(a), grounding electrode systems; Article 410-180, grounding of light fixtures in ungrounded systems). The electrical system of this facility should be inspected and upgraded to comply with all applicable sections of the National Electrical Code. This would greatly reduce the risk of serious injury due to electrical energy.

Recommendation #2: A comprehensive safety program outlining proper safe work procedures for tasks being performed by workers should be developed and implemented.

Discussion: A comprehensive safety program that would clearly outline proper procedures and techniques to be used in the performance of tasks should be developed. The workers should then be instructed in the proper procedures and techniques to perform their everyday duties. Once this safety program is developed, management should ensure that it is implemented.

Recommendation #3: Employees should receive training in hazard awareness and recognition.

Discussion: Employees should be made aware of any existing hazards that they may encounter during the performance of their duties. Additionally, employees should be trained to recognize and report to the proper people any hazard that might present itself in the workplace. In this instance, once it was determined that a problem existed with the light fixture the person at the facility responsible for electrical maintenance should have been immediately summoned before any additional work was performed on the light fixture.

Recommendation #4: Proper work platforms should be provided and used for elevated work surfaces.

Discussion: Working off of the forklift platform is an unsafe work practice. Ladders and approved work platforms with hand rails and other safety features should be used when working above floor level. When the co-worker was knocked backward by the electric current, he could easily have fallen off the platform and a serious injury could have resulted.

FACE 87-24: **Lineman Apprentice Electrocuted in Indiana**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On January 6, 1987, a lineman apprentice was electrocuted while attaching the wooden cross arm on a new utility pole. The new pole was being erected next to a shorter pole it was to replace. The electric power lines supported by the old pole were energized with 12 kV of electricity. The victim contacted an energized conductor on the pole being replaced and his body provided a path to ground.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On February 4, 1987, a DSR research team conducted a field evaluation of this accident. The field investigation was preceded by telephone discussions of the accident with the safety director for the utility company. FACE survey instruments were completed for the victim and two comparison workers. The conditions (events leading up to the accident) were reviewed with the safety director. The old pole has been removed, but photographs taken of the site at the time of the accident were available and were reviewed.

BACKGROUND/OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

This is an investor-owned electrical utility company that employs over 2,200 personnel.

Safety goals are established by written safety policy and safety programs. A full-time safety staff administers and evaluates the safety program . Safety committees, meeting monthly and comprised of supervisory personnel only, discuss and evaluate safety matters. Employees are trained on the job and in the classroom, depending on their duties, and employees receive written safety rules, as part of a new employee orientation.

SYNOPSIS OF EVENTS

At approximately 2:00 p.m., Tuesday, January 6, 1987, a lineman apprentice (the victim) was attaching a wooden cross arm on a new utility pole. The day was very windy with gusts up to 40 miles per hour (mph). The pole was being erected to provide additional electrical service to an industrial customer of the utility company. Uninterrupted electrical service to the customer was being provided at the time of the accident by lines on a shorter pole adjacent to the new pole. The victim had climbed the new pole and had completed making cross arm attachments on the side of the pole away from the energized lines.

An experienced lineman on the ground was supervising installation of the new pole. Before work continued on the side of the pole closest to the energized conductors, the lineman and the victim apparently discussed whether insulating devices (lineguards, rubber line hoses, etc.) should be placed on the energized lines; however, it was decided that the insulating devices would not be necessary and they were not used. Company regulations require the use of insulating devices when working less than four feet from uninsulated energized conductors. The victim moved around the pole to finish attaching the cross arm. His back contacted the energized lines and he was electrocuted.

Exit wounds were observed on the victim's feet. The distance between the face of the new pole and the existing power line was 42 inches.

CAUSE OF DEATH

The coroner's report indicates the cause of death as electrical burns.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Insulating devices (lineguards, rubber line hoses, etc.) should be used in accordance with company policy.

Discussion: The nearest energized power line was 42 inches away from the face of the new pole. The victim had to work on the crossarm which was even closer to this line. This did not provide an adequate work area. Company policy requires that insulating devices be installed when working less than four feet away from energized power lines. If insulating devices had been used the worker would have been protected.

Recommendation #2: All personnel should be held accountable for on-the-job safety.

Discussion: Safety concerns (i.e., placement of protective devices, etc.) should be a factor in the performance evaluations of all personnel. The use of insulating devices and other personal protective equipment can easily be seen during job site inspections and all personnel should be made aware they are being evaluated on these factors. Supervisory personnel should take the lead in assuring that work site safety is maintained.

Recommendation #3: Training provided to linemen concerning the use of insulating devices should be re-evaluated.

Discussion: The company's training concerning its required use of insulating devices and other personal protective equipment should be re-evaluated to assure that linemen understand the reasons for using insulating devices and when insulating devices and other personal protective equipment should be used. The wind appears to have been a factor in this incident. Training should address the adverse impact that inclement weather conditions may have on job performance and identify procedures that can be used to minimize hazards resulting from these conditions.

Recommendation #4: The use of insulated boots or dielectrically tested overshoes with insulator devices on the side supports should be evaluated and adopted, if appropriate, for linemen and other personnel working around energized conductors.

Discussion: The worker's body provided a path to ground through his feet. Several utilities require their employees to wear insulating boots or dielectrically tested overshoes with insulator devices on the side supports when working on energized conductors on a pole. The employer should evaluate use of this personal protective equipment to determine if they could provide adequate protection to personnel working around energized conductors.

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FACE 87-28: **Two Painters Electrocuted in Ohio**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On November 17, 1986, two painters were electrocuted while painting a twenty foot metal light pole. The two men were using a 36 foot aluminum extension ladder. One painter was standing on the ladder painting the pole. The second painter was on the ground steadying the ladder. The ladder slipped away from the light pole and the painter on the ladder contacted a 12,460 volt power line causing the electrocution of the two painters.

CONTACTS/ACTIVITIES

Officials of the Industrial Commission of Ohio notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On February 18, 1987, the DSR research team met with representatives of the Industrial Commission of Ohio and employer representatives. Photo documentation of the accident site was provided by the Industrial Commission of Ohio.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victims were employed by a firm that provides commercial painting services. The firm consisted of three painters and the owner. The firm had no written safety policy or safety program. The owner of the firm would outline the work procedures to be followed by the painters on the job site prior to the start of each job.

SYNOPSIS OF EVENTS

The firm had been contracted to paint the interior of a restaurant and six light poles around the perimeter of the restaurant's parking lot. The light poles were inverted-L shaped and were 20 feet in height. The crossbars on the tops of the poles were approximately six feet in length.

On the day of the accident the owner and one painter were working inside the restaurant while the two victims were outside painting the light poles. The victims were painting the fifth light pole, using an airless spray gun to paint the pole and a 36 foot aluminum extension ladder to reach the top of the pole. A 12,460 volt power line was located approximately 21 feet above the ground (twelve inches above the crossarm, and twenty inches to the outside of the vertical support). The actual length to which the ladder had been extended at the time of the accident is unknown, but it at least extended beyond the crossbar. One victim was standing on the ladder painting the crossbar at the top of the light pole. The second victim was standing on the ground steadying the ladder. The owner, who had been checking on the progress of the two workers painting the light poles, heard a scream as he was walking back to the restaurant. The owner turned and saw the painter and the ladder falling to the ground. The worker who had been steadying the ladder was lying on the ground. The fire department rescue squad and the emergency medical service were summoned.

The fire department rescue squad arrived first and administered cardiopulmonary resuscitation (CPR) to both victims. Upon arrival, the emergency rescue squad performed advanced cardiac life support (ACLS) procedures, which were unsuccessful. The two men were pronounced dead at the scene. There were no eye witnesses to the accident, but it is assumed that the ladder slid horizontally along the crossbar and the victim on the ladder contacted the power line. An entrance wound was present on the back of the right forearm of the victim who had been working on the ladder. The current passed through the victim and the ladder to ground. The current also passed through the second victim (holding the ladder) to ground. There were two factors present that may have contributed to this accident. First, the ladder was placed on uneven ground and wooden blocks were placed under one leg of the ladder in an effort to provide an even surface. It is possible the blocks may have slid out from under the ladder. Secondly, the top rung of the ladder was damaged. The victim may have leaned on this damaged rung and lost his balance, causing the ladder to slide along the crossbar.

CAUSE OF DEATH

The cause of death of the two men was listed as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Ladders used near energized power lines should be made of non-conductive materials.

Discussion: OSHA Standard 1926.951(c) states that "conductive ladders shall not be used near energized lines..." The aluminum ladder used in this incident was conductive. If a ladder made of non-conductive material had been used in this case, the double fatality might have been prevented.

Recommendation #2: Ladders should be properly maintained in accordance with applicable standards.

Discussion: The damaged top rung on the ladder in this case may have contributed to the accident by causing the victim to lose his balance. When a ladder is found to be defective it should be removed from service or properly repaired. OSHA regulation 1926.450(2) states that "The use of ladders with broken or missing rungs...is prohibited."

Recommendation #3: Ladders should be placed on level ground and adequately supported to prevent movement.

Discussion: In this instance the ladder was placed on an uneven surface. Wooden blocks were placed under one side of the ladder to level the ground surface. This is a poor safety practice. The ladder may have fallen because these blocks moved. Ladders should be placed on even surfaces and adequately supported in order to attain maximum stability. Additionally, the ladder should have been tied to the light pole to prevent the top of the ladder from sliding off of the pole.

Recommendation #4: A safe working distance must be maintained between power lines and equipment or structures that require periodic maintenance or access.

Discussion: Energized power lines in proximity to a work area constitute a safety hazard. Extra caution must be exercised when working near energized power lines. A distance of six feet between power lines and ladders, tools, or scaffolds should be maintained at all times. At least one state (California) requires that a six foot minimum clearance be maintained. The power line in this instance was within two feet of the light pole. Proximity of the pole to the power line should not constitute a hazard during maintenance operations. To allow the pole to remain within two feet of the power line would jeopardize the future safety of maintenance personnel. The light pole or the power line should be moved.

Recommendation #5: All personnel should be trained to recognize safety hazards associated with the tasks they are assigned to perform.

Discussion: Training should be provided to all personnel that would enable them to identify safety hazards associated with the tasks they are assigned to perform (i.e., energized power lines, etc.). Measures could then be taken to control these hazards and assure worker safety. The fact that this condition was allowed to continue even after the owner checked the area demonstrates that none of the persons involved recognized the serious hazards that were present.

FACE 87-29: **Lathe Operator Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On February 6, 1987, a lathe operator was electrocuted when he contacted the energized frame of a computerized lathe.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project.

On March 4, 1987, a DSR research team (a research industrial hygienist and a safety engineer) met with the compliance officer (who had conducted the investigation for the State) and a company representative. Comparison workers were interviewed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is a division of a major corporation that manufactures turbo chargers for diesel engines. At the facility where the fatality occurred there are approximately 300 employees, consisting mainly of machinists with some assembly, maintenance, and office personnel. The employer has a written safety program and policy. The personnel manager is responsible for facility safety on a collateral-duty basis. (Approximately 10% of the manager's time is allocated to safety management.) The organization employs a plant safety officer at corporate headquarters. New employees are given a handbook which addresses general employee safety and company safety rules and regulations and receive basic plant safety orientation from the plant safety officer. New employees also receive on-the-job training from supervisors and co-workers for specialized procedures required in certain manufacturing processes. Machinists complete a comprehensive training program on design, maintenance, and operation of the various machines in the production area. A safety committee consisting of the plant safety officer, a plant management employee, and worker representatives meet monthly in order to address safety problems and to reinforce the safety policy.

SYNOPSIS OF EVENTS

In March of 1985 the corporation transferred an additional manufacturing process to the existing production area of the plant. In order to accommodate for the proposed increase in the plant electrical load, an electrical contractor was hired to install an additional 480Y/277 volt transformer at the power supply center inside the production area and a three-phase wiring system, also inside the production area. The wiring system was routed from the transformer through a metal busway (approximately 450 feet long) attached to the ceiling, 27 feet above the plant floor. In August, 1986, new lathe and mill machines were installed by a machine contractor representing the machine manufacturer. The machine contractor made electrical connections from each new machine to the individual switch boxes on the busway. On September 13, 1986, the electrical addition was completed and the busway system was energized. During the installation of the additional electrical system and machines, three grounding deficiencies occurred:

1. The electrical contractor failed to connect the "Z bar" or grounding conductor located inside the transformer cabinet to the grounding conductor in the busway which served the machines in the new production area of the plant.

2. The electrical contractor failed to connect the grounding conductor on the new transformer to building steel or to a grounded circuit conductor on the supply side of the electrical service disconnect.

3. The machine contractor connected the grounding conductor from the computerized lathe involved in this incident to the insulated neutral lug inside the switch box.

Any <u>one</u> of these grounding deficiencies interrupted the continuous ground for the lathe and the first two deficiencies interrupted the continuous ground for any of the other electrical equipment connected to this circuit. After installation, the machine contractor functionally checked the lathe and turned it over to the employer who began production in October, 1986. Until the time of the accident the employer was not aware that the grounding for this circuit was inadequate. There was nothing unusual about the electrical operation of any equipment connected to this circuit (according to machine operators, management, and other witnesses) and there were no reported incidents involving electrical shock from any of the new machinery. Some time prior to the accident (unbeknown to the employer until after the accident) a capacitor in the ungrounded lathe (between the frame ground and the lathe servo power supply) failed, energizing the frame of the lathe with 220 volts of electricity.

On February 6, 1987, at about 5:00 p.m. a computerized lathe operator (the victim) reported to work and continued the lathe operation being performed by the first shift lathe operator. The operation consisted of turning aluminum sand castings on two computerized lathes. The lathes faced each other with a four foot work space between them. The concrete floor between the lathes was covered with a 1/2 inch rubber mat. A pressurized 3/4 inch metal air line (at ground potential) ran vertically between the two lathes approximately eight inches from the inadequately grounded lathe. Although there were no eye witnesses, it is presumed that the victim's hand made contact with the grounded metal air supply line while his other hand was in contact with the energized lathe frame. A few minutes later the victim's supervisor was walking by when he noticed the victim lying face down between the two lathes. His right arm was touching the metal drip pan of the defective lathe beside the air pressure supply line. The supervisor received a slight electrical shock when he contacted the victim's arm; so he grabbed the victim by the feet and pulled him away from the lathe.

Plant employees called the local emergency medical service rescue squad (EMS) and initiated cardiopulmonary resuscitation (CPR) on the victim until the arrival of EMS personnel, approximately eight minutes later. EMS personnel performed advanced cardiac life support (ACLS) measures, including defibrillation, at the scene. The victim was rushed to a local hospital where he was pronounced dead by the attending physician at approximately 6:00 p.m.

CAUSE OF DEATH

The medical examiner determined the cause of death to be cardiac arrest due to electrocution. Electrical burns were noted on the left side of the victim's face.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should ensure that electrical systems and each piece of equipment with an electrical connection within those systems have a permanent and continuous path to ground.

Discussion: Although the new electrical system and machines were installed by certified electricians from the electrical contractor and machine contractor, the employer should verify that each piece of electrical equipment has a proper equipment ground and that a continuous grounding path is maintained throughout the electrical system as required by 29 CFR 1910.304(f)(3) and (4) and the National Electric Code (NEC) 250-51. This could be accomplished by the employer implementing their own machine and electrical system ground maintenance program or through a program conducted by a qualified, independent electrical contractor.

Recommendation #2: State or local government agencies should implement and enforce an electrical inspection program to verify compliance with the National Electric Code or equivalent local regulations.

Discussion: Appropriate state or local governmental agencies should enforce electrical standards and prohibit the energizing of any newly constructed or modified electrical system until that system has been determined to comply with all applicable electrical standards (through an electrical inspection by authorized and qualified personnel). The modifications to the electrical system that ultimately resulted in this fatality were not inspected because this was not considered a new installation.

Recommendation #3: The computerized industrial lathe and other similar computerized machinery should be re-evaluated to identify possible electrical safety design modifications or the implementation of administrative controls for electrical safety.

Discussion: The computerized lathe in this incident was programmed to de-energize itself if the capacitor failed; however, this was dependent upon the presence of an adequate electrical ground. Because there was no continuous path to ground present when the capacitor failed, the frame of the lathe was energized and the lathe continued to operate. This present design should be re-evaluated to assure that any necessary design changes are retrofitted to prevent a reoccurrence of this type of accident.

Minimally the manufacturer should: 1) Emphasize to purchasing companies the importance of providing and maintaining a continuous electrical ground for any type of industrial machine. This could be accomplished through bold printed warnings in equipment operation manuals, warning tags attached to the power supply cord, etc.; 2) Verify that an adequate electrical ground is provided at the power source serving the machine and notify the purchasing company of any ground deficiencies encountered (if the machine manufacturer or representative of the machine manufacturer is also contracted to install the machine(s) as in this incident).

Recommendation #4: The electrical disconnecting means for each piece of equipment should be clearly and unmistakenly identified.

Discussion: Each machine in the production area has an individual over-current protection device inside a manual disconnect switch box attached to the busway approximately 27 feet above the plant floor. Several switch boxes were inadequately labeled and clustered so closely together that it was not apparent as to which machines they served. Each switch box should identify the machine it controls and should be located so that electrical current to any machine can be quickly and easily disconnected in the event of an emergency (in accordance with 29 CFR 1910.303(f) and NEC 110-22).

FACE 87-31: 28-Year-Old Electronic Technician Dies from Electrical Burns in Georgia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 18, 1986, a 28-year-old electronic technician died from electrical and thermal burns resulting from a flashover explosion in a 20 kV switch compartment.

CONTACTS/ACTIVITIES

Officials of the Georgia Department of Human Resources notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On March 4, 1987, the DSR research team coordinator conducted a site visit, collected incident data, interviewed a comparison worker and a surrogate for the victim, and discussed the incident with employer representatives.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a large municipal transportation company which employed 3000 workers at the time of the incident. The company has an extensive safety program with a full-time safety manager and a safety board made up of representatives from each of the company's operating divisions. Safety committees have been established in each division and they conduct monthly safety discussions. Classroom safety training is provided to employees. The victim (who worked for the company less than one year) received 41.5 hours of Maintenance-of-Way Electronic Technician Training. This training addressed the theory of operation for traction power substations and gap breakers and included safety considerations.

SYNOPSIS OF EVENTS

On August 18, 1986, a team of five technicians was performing preventative maintenance on the AC-switch gear in a rail car maintenance shop. The lead technician placed the equipment in a maintenance mode by opening the primary switch (20 kV interrupter switch) to the power company which disconnected power to the AC-switch gear. The team members then simultaneously performed maintenance on various equipment. An electronic technician (the victim) was assigned the task of cleaning the lower compartment of the primary switch. The switch consists of a cabinet containing two compartments, each with its own door. The upper compartment contains three knife switches used to disengage the incoming power. The knife switches are gang operated by a lever mounted on the upper compartment. The lower compartment (the only area that should have been cleaned) contains circuitry for transferring power to other areas of the maintenance shop. This compartment is de-energized when the three knife switches are opened. The victim was working alone at the time of the incident.

Apparently, after opening the three switches in the upper compartment, the victim proceeded to clean the upper compartment area by spraying cleaning fluid from an aerosol spray can onto the circuitry. When the aerosol spray contacted the line side of the switch it provided a conductive plasma for the electric current. The current passed through the spray and the victim's right hand, across his chest, and exited from his left upper arm which was apparently in contact with the center switch blade. This is supported by evidence of darkening of his right thumb, a melted spray can finger actuator, and an exit wound on the inside of his left upper am. Particles removed from one open switch blade were identified as human skin by a testing laboratory. At the time of the incident, the electric current, which exceeded 3,000 amperes of phase current and 1200 amperes of neutral current as registered on power company equipment prior to the breakers tripping, caused a flash of light and loud explosion. The other technicians found the victim leaning into the upper switch compartment with his clothes on fire.

One technician used a fire extinguisher to extinguish the fire on the victim. Another technician used the plastic hose of a vacuum cleaner to pull the victim from the switch compartment. The emergency medical service (EMS) personnel responded within 5 minutes and treated the victim at the scene. The victim was transported to a nearby hospital where he died 24 hours later.

CAUSE OF DEATH

Cause of death was listed as sequela of electrical burns.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Maintenance should not be performed on energized equipment unless adequate personal protective equipment and devices are used.

Discussion: In this incident, the victim was performing inspection and cleaning maintenance on an open electrical switch which had the line side energized at 20,000 volts. Maintenance work should not be performed on high voltage equipment unless it is personally verified as de-energized and grounded. This recommendation is presently being followed by the company.

Recommendation #2: The compartment door to the primary disconnect for the power company feeder lines should be secured against unauthorized entry.

Discussion: The upper compartment door of the interrupter switch was open. Even though the victim should not have been cleaning compartments in the upper area, it was readily accessible. Securing this door would eliminate inadvertent access.

Recommendation #3: A check list should be followed to verify de-energization prior to maintenance being performed on the high voltage equipment.

Discussion: A check list should be developed that identifies the steps to be taken prior to maintenance being performed on the equipment. This verification will help eliminate maintenance being performed on energized equipment such as happened in this incident. This recommendation is presently being followed by the company.

Recommendation #4: No aerosol spray cans should be permitted to be in any high voltage rooms, such as traction power substations, gap breaker substations, auxiliary power substations, etc.

Discussion: The aerosol spray from the spray can initiated an electrical arc in the switch compartment. This recommendation is presently being followed by the company.

Recommendation #5: Existing company safety rules should be re-emphasized through training of workers in the performance of their assigned duties and the associated hazards.

Discussion: The victim violated two company safety rules. One rule stated that "when performing maintenance on equipment of 2500 or more volts, the equipment should be de-energized and grounded and work should be performed between grounds." Since the victim was working inside the primary interrupter switch compartment, he was not working between grounds.

The second rule stated "for equipment normally energized between 2500 and 50,000 volts, a distance of 3 feet should be maintained when working about the equipment. The victim was within this minimum distance requirement when he was working inside the primary interrupter switch compartment.

These rules and others will be re-emphasized by the company during foremen monthly meetings and the Safety Rule of the Day/Week Program.

FACE 87-32: **27-Year-Old Painter Electrocuted in Georgia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 21, 1986, a 27-year-old painter was electrocuted when the aluminum ladder he was moving contacted a 7200 volt power line.

CONTACTS/ACTIVITIES

Officials of the Georgia Department of Human Resources notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On March 5, 1987, the DSR research team coordinator conducted a site visit, collected incident data, photographed the site, interviewed comparison workers and a surrogate for the victim, and discussed the incident with the Federal OSHA compliance officer and the employer representative.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small painting contractor which employs 7 workers. The company has no written safety program. Safety training consists of only telling the workers to "be careful.."

SYNOPSIS OF EVENTS

On July 21, 1986, the victim was standing on a 24 foot, fully extended, aluminum extension ladder while painting a gutter on an apartment building. The gutter was located 18 feet above the ground and 8 feet 6 inches horizontally from a 7200 volt power line. The power line was parallel to the gutter and was 19 feet 6 inches above the ground. The victim was working alone at the time of the incident. The normal procedure for painting the gutter would be to paint a certain area of the gutter, then descend the ladder; move the ladder to a new location on the gutter; ascend the ladder; and continue painting.

It is assumed the victim was moving the ladder to another location on the gutter when the ladder came in contact with the 7200 volt line. The ladder and the body of the victim provided a path to ground and the victim was electrocuted. The victim had burns on both hands and the ladder was scorched 19 feet 6 inches from the end of the ladder that the victim was holding.

The victim fell (breaking contact with the energized conductor) and was found on the ground under the power line. Emergency medical service (EMS) personnel responded (time interval between incident occurring and arrival is unknown) and administered advance cardiac life support (ACLS) procedures. Attempts to resuscitate the victim were unsuccessful. The victim was pronounced dead on arrival at a nearby hospital.

CAUSE OF DEATH

Cause of death was listed as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Ladders used near energized power lines should be made of non-conductive materials.

Discussion: OSHA Standard 1926.450(a)(11) states that "portable metal ladders shall not be used for electrical work or where they may contact electrical conductors. " The aluminum ladder used in this incident was conductive. If a ladder made of non-conductive material had been used in this case, the fatality might have been prevented.

Recommendation #2: To assure proper protection for anyone working near the electrical power lines, arrangements should be made with the power company to de-energize the lines or at a minimum to cover the lines with insulating line hoses or blankets.

Discussion: The power lines are located 8 feet 6 inches horizontally from the gutter on the building. Unfortunately, when a ladder is being used in this area, a safe distance from the power lines cannot be maintained. The power lines should have been de-energized or protected with insulating equipment.

Recommendation #3: The employer should develop a safety program designed to recognize and correct hazards.

Discussion: OSHA Standard 1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." The company does not provide training in safe work procedures and does not have any safety rules. The tasks performed by workers should be evaluated, hazards identified, and these hazards should be addressed by a safety program.

Recommendation #4: Hazard awareness regarding overhead power lines should be stressed and routinely reviewed so that all employees working near overhead power lines are aware of these energized sources.

Discussion: The danger of overhead power lines appears to be obvious; however, contact with power lines and the subsequent occupationally-related fatalities continue. Employers must stress and routinely review the hazards associated with overhead power lines. In this incident, it can be assumed the worker was not aware of the hazards associated with working near energized power lines.

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FACE 87-34: 19-Year-Old Electrician's Apprentice Electrocuted In Georgia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On March 17, 1986, a 19-year-old electrician's apprentice was electrocuted when he contacted live conductors while disassembling an energized switch box in an office building.

CONTACTS/ACTIVITIES

Officials of the Georgia Department of Human Resources notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On March 3, 1987, the DSR research team coordinator conducted a site visit, collected incident data, interviewed comparison workers and a surrogate for the victim, and discussed the incident with the Federal OSHA compliance officer and the employer representative.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small electrical contractor which employes 106 workers. The company has written safety rules that are communicated to the employees both in writing and verbally. Safety training consists of on-the-job training and safety meetings. A foreman is assigned safety responsibilities on a collateral-duty basis.

SYNOPSIS OF EVENTS

On March 17, 1986, an electrician's apprentice (the victim) and a journeyman electrician were installing two new switch boxes on the walls of a room being renovated in an office building. The circuits in the room where the new switch boxes were being installed were de-energized with the exception of the circuit to an existing metal switch box suspended by conduit from the ceiling. Prior to installing the new boxes, the journeyman electrician momentarily left the room and told the victim that "they would figure out how to wire the boxes" when he returned. The victim was expected to wait for the return of the journeyman electrician prior to performing any work; however, while the victim was alone, he elected to disassemble the energized switch box suspended from the ceiling. The box was adjacent to one of the walls and located 39½" from the floor. Due to the relocation of walls during the renovation, this suspended switch box was to be replaced by a new box. The suspended switch box was energized by a 277 volt circuit from the adjacent room. A metal sheathed cable provided electricity to this switch box; however, this cable was outside of the conduit and entered the switch box through the side of the box. Apparently, the victim thought the suspended box was de-energized since it was in the same room as the new boxes being installed.

The victim reached into the suspended box and, using wire cutters, cut the conductors from each of the four terminal connections in the box. There was no evidence of arcing or sparking. Then with his left hand the victim pulled the metal sheathed conductor out of the switch box which he was holding in his right hand. Apparently, the bare conductors contacted the box and/or his left hand. The victim provided a path to ground and was electrocuted. Burn marks found on the victim's right hand were consistent with the shape of the box.

The victim was found 14 feet from the switch box. Emergency medical service (EMS) personnel responded (time interval between incident occurring and arrival is unknown) and administered advance cardiac life support (ACLS) procedures. Attempts to resuscitate the victim were unsuccessful. The victim was pronounced dead on arrival at a nearby hospital.

CAUSE OF DEATH

Cause of death was listed as cardio-respiratory arrest due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical circuits should not be repaired, moved or otherwise accessed unless de-energized and de-energization personally verified.

Discussion: Apparently, the victim assumed the power to the suspended switch box was disconnected and did not present a hazard. Personnel working around sources of electricity should personally verify that all power is disconnected. This verification should minimally consist of disconnecting the circuit at the distribution panel (i.e., circuit breaker, fuse, etc.) and testing the circuit to assure de-energization.

Recommendation #2: Electric circuits should be properly labelled at the distribution panel and any circuits disconnected at the panel should be either locked out or tagged out.

Discussion: All the circuits in the room in which work was being performed should have been de-energized and the circuit breakers at the panel should have been either locked out or tagged out. In addition, the circuits at the distribution panel should have been checked for proper labelling. This would have eliminated any confusion as to which circuits in the room were actually de-energized prior to the installation of the new switch boxes.

Recommendation #3: Hazard awareness should be stressed at safety meetings.

Discussion: The company had written safety rules, conducted safety meetings, and provided on-the-job training for apprentices which consisted of working with a certified electrician. In this incident, the victim was only employed with this company for one month, but he had worked with a certified electrician for three years prior to working for this company. Even though the victim should not have been working on the energized switch box, it is apparent he was not aware of the hazard. Had he checked to see if the circuit to the switch box was de-energized prior to disassembling the switch box, the incident would not have occurred.

FACE 87-35: Lineman Electrocuted in Maryland

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On January 16, 1987, a journeyman lineman with 31 years' experience was electrocuted when he contacted a 34.5 kV power source while replacing a switch jumper.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On March 19, 1987, the DSR research team met with employer representatives, interviewed a comparison worker, and discussed the incident with the OSHA compliance officer. Photographic documentation of the accident site was provided by the employer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by an integrated electrical contracting company that performed residential and commercial wiring and underground low voltage work for the public utility company. The company employed 100 full-time workers. Additional people were hired from the local union roster as the work load demanded. The company did not have its own safety program or written safety policy. The local union provided all members with written safety rules and yearly training. The company provided on-the-job training and the supervisor was responsible for safety at the job site.

SYNOPSIS OF EVENTS

A local chemical plant had an infrared study performed on three of its distribution substations. The results of this study indicated "hot spots" (bad connections) that needed repaired or replaced. The electrical contractor was hired by the chemical plant to perform this work. The day before the accident the crew assigned to perform this task was briefed on the infrared study by chemical plant representatives. Two areas were identified as urgent; these areas involved the switch jumper wires for three parallel power lines on two of the substations. The parallel lines were 33 inches apart and there were three switch jumper wires at each substation. It was decided that the switch jumper wires which were attached from each parallel line to its switch hardware, would be replaced.

On the morning of the accident a journeyman lineman (the victim), an apprentice lineman (his stepson), and another worker were replacing the jumper wires at the first substation. The victim and his stepson raised themselves in the two-man aerial bucket. The disconnect switches located on the substation were opened but the victim did not place grounds on either side of the switches or cover the line (live) side of the switch with insulated line blankets as the safety rules required. The voltage on these lines was 2400 volts. The victim climbed out of the aerial bucket and laid down on the substation structure to perform the work while his stepson handed him the materials he needed from the aerial bucket.

After lunch the crew began preparing to change the switch jumper wires on the 34.5 kV lines at the second substation. The victim was told by his supervisor to ground the lines and test them with a light-emitting diode-type tester before beginning work on the jumper wires. Witnesses stated that the victim refused to use the tester or to connect the grounds and that the victim mentioned several times during the morning that he was in a hurry and had to leave work early. The disconnect switches located on the substation were opened and the victim raised himself and his stepson in the aerial bucket up to the first line and replaced the jumper wire. The victim then positioned the aerial bucket underneath the first and second lines which were 33 inches apart. The victim decided to change the second jumper wire while standing on the substation structure. The stepson stated the victim pulled himself from the bucket onto the substation structure and was cleaning the switch with a wire brush when a flash occurred. (The wire brush could not be found after the accident.) The victim then fell approximately 25 feet to the ground.

The victim, who was conscious, was flown by life flight helicopter to a nearby hospital where he died four hours later. He received electrical entry wounds on his left elbow and forearm and exit wounds to his right knee and both feet.

CAUSE OF DEATH

At the time of the investigation the medical examiner's report was not available.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees must follow safe work procedures.

Discussion: The victim chose not to follow safe work procedures even after being told to do so by supervisory personnel. Employees must understand that safe work procedures must be followed at all times.

Recommendation #2: Employers should assure adherence to established safe work practices.

Discussion: The local union distributed written safety rules to all of its members. These rules were to be the minimum safety requirements on all jobs unless the customer's safety rules were more comprehensive. Though the employer in this instance accepted these written union safety rules as company policy, they were not enforced by the supervisor. When the victim refused to ground and test the lines before he began the repair work at the second substation or when his earlier unsafe work practices were observed, corrective supervisory action should have been taken immediately; however, the victim was allowed to proceed with his unsafe work habits. Had the victim been made to work safely, the accident might have been prevented.

Recommendation #3: The employer should develop and implement comprehensive safety rules and training to assure that its workers are afforded the safest possible work environment .

Discussion: The employer should develop comprehensive written safety rules and training to assure that employees follow safe work procedures while performing their assigned tasks. The employer should establish a safety program and assure strict adherence to this program once it is established.

FACE 87-36: 41-Year-Old Truck Driver Electrocuted After Unloading Bricks in Maryland

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On March 16, 1987, a 41-year-old truck driver for a manufacturer of masonry products was electrocuted when a truck-mounted crane he was operating contacted a 7600 volt power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On April 9, 1987, a safety engineer conducted a site visit, met with employer representatives, interviewed comparison workers, EMS personnel, and police, and visited the accident site. Photographs of the accident site were provided by the Maryland Occupational Safety and Health Administration.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer manufactures and distributes masonry products. The company consists of two facilities with a total of 96 employees.

The company has a written safety program that includes safety committees, inspections, and training. Safety committee members are responsible to implement many aspects of the safety program. A rather extensive on-the-job training program has been implemented for truck drivers and manufacturing employees. The operations manager is assigned safety responsibilities on a collateral-duty basis; however, he has received no safety training.

SYNOPSIS OF EVENTS

On March 16, 1987, a truck driver (the victim) was to deliver three pallets (i.e., cubes) of bricks to a new residential development and then deliver the remainder of the truck's load to another site. The truck driver had previously made a delivery to the first site without incident; however, during the previous delivery he had pulled the truck off the dirt road to the side of the house and had stacked the masonry products to the rear of the house. On the day of the accident the victim parked the truck at an angle, blocking the dirt road. The truck driver stacked the bricks to the side of the house in the yard. A 7600 volt power line ran parallel to the dirt road on the side of the road farthest away from the house. The ground was wet on the day of the accident.

The victim had off loaded the three cubes of bricks and was apparently returning the truck mounted crane to the transport position when the crane contacted the 7600 volt power line, approximately 26 feet 9 inches above the ground. The truck driver was standing at the rear of the truck, operating the crane with a pendant controller. The pendant controller, being held by the driver, provided a path to ground through the victim's body and he was electrocuted.

After an indefinite period of time (estimated by police as 2 to 3 minutes), a workman in the residence noticed that the victim had been injured and notified emergency medical service (EMS) personnel, who were on the site three minutes after being notified. When EMS personnel arrived on the scene, the victim was in contact with the energized pendant controller and on fire. EMS personnel extinguished the fire by throwing dirt on the victim. After the victim was separated from the energized circuit, EMS personnel were unable to revive the victim and he was pronounced dead on the scene.

CAUSE OF DEATH

The cause of death was electrocution. The autopsy report has not been completed to date.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: Current OSHA standards 1910.180(j) and 1926.550 (a)(15) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers which cannot be part of the crane. The truck driver did not comply with these requirements.

Recommendation #2: All boomed vehicles capable of contacting overhead power lines should be electrically insulated.

Discussion: It is apparent that current regulations concerning cranes and overhead power lines are adequate when followed; however, boomed equipment should be electrically insulated so that a momentary error in judgment does not result in the loss of life. One aspect of electrical insulation includes the pendant controller. The pendant controller in this case was electrically conductive and provided a path for the electrical current to go to ground through the body of the victim. Non-conductive controllers (i.e., fiber optic designs, etc.) would eliminate the pendant controller as the path to ground and could reduce the number of fatalities which result when boomed vehicles contact energized power lines. Since this incident, the employer has purchased fiber optic pendant controllers for all of their delivery trucks.

Recommendation #3: Employers should periodically conduct and document training concerning delivery site hazard awareness, including the hazards present around overhead power lines.

Discussion: The employer relies very heavily upon on-the-job training. Some of the problems with on-the-job training are that you cannot be sure of what was discussed and if all hazards have been addressed. If on-the-job training is to be relied upon, guidance concerning the contents of this training should be developed and provided to those employees responsible to conduct on-the-job training. On-the-job training should be periodically supplemented with other forms of training. Employers must stress and routinely review the hazards associated with overhead power lines. Employers must also demonstrate that they are truly concerned about this aspect of job site safety and will not tolerate unsafe conduct.

Recommendation #4: The employer or the truck driver should evaluate all worksites to identify the presence of any hazardous situations (i.e., overhead power lines).

Discussion: All worksites (facilities of the employer and delivery sites) should be evaluated to identify the presence of any hazardous situations (i.e., overhead power lines). The employer's facility that was visited had overhead power lines present in areas where delivery trucks routinely operated. Although the employer has a prohibition against raising truck mounted cranes in the loading area, removal of the power lines should be evaluated. Removal of the power lines will eliminate the possibility of the occurrence of similar incidents if employer guidance is not followed.

FACE 87-37: **Truck Driver Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On February 12, 1987, a truck driver was electrocuted when the bed of a dump truck he was operating contacted a 7200 volt power line. A path to ground was provided by the truck driver when he stepped out of the truck.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project; however, because the company was dissolved immediately after the incident no epidemiologic evaluation was conducted. A DSR safety specialist discussed the incident with the OSHA compliance officer. Photographs were provided by the owner of the power line.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was the only driver for a trucking firm that provided hauling services. The firm had no written safety policy or safety program and no safety training was provided to the driver. The State of North Carolina does not require truck drivers to operate a truck as a condition for licensing and does not require specialized training for truck drivers, but does require that drivers have a chauffeur's license.

SYNOPSIS OF EVENTS

On the day of the incident the driver was spreading gravel in the driveway of a private residence with an 18 wheel cab-over type tractor trailer with a 32 foot 8 inch long aluminum hydraulic lift bed. Several loads of gravel had been spread at this site throughout the day.

At dusk the driver informed the owner of the residence that he was about to spread the last load of the day since it was getting dark. The driver returned to the truck and raised the truck bed to dump the gravel. The driver then pulled the truck forward while at the same time lowering the bed. The bottom phase, which was 24 feet above ground, of a three-phase 7200 volt distribution system that ran perpendicular to the road caught under a tie-down railing that ran around the front and sides of the truck (see Figure 1). This contact energized the truck. The owner of the residence stated that the tires on the truck began to explode. It is assumed that the driver exited the cab of the truck to see what was wrong and as his foot touched the ground he provided a "path to ground" from the electrically energized truck and was electrocuted.

The victim was pronounced dead at the scene by the coroner.

CAUSE OF DEATH

The medical examiner ruled electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop safe work procedures that address tasks performed by employees, identify safety hazards, and stress safety training.

Discussion: The employer did not have established safe work procedures that were specific to the tasks performed by the driver, i.e., spreading gravel in residential areas. Procedures should be developed and implemented that detail the tasks to be performed and should identify the safety hazards associated with these tasks. The employer should assure that the safety procedures are followed.

Recommendation #2: Workers should perform a job site survey prior to the performance of a given task.

Discussion: Overhead power lines are an ever-present hazard in residential areas. NIOSH research indicates that one hundred thirty-five occupational fatalities occurred from 1980 to 1984 that were dumptruck related. Of these, approximately seven percent were electrocutions due to the bed of a dumptruck contacting overhead power lines (NIOSH unpublished data, 1987). Prior to the performance of a given task workers should perform a job site survey, which would identify any safety hazards present at a given job site. Workers would then be aware of the hazards they might encounter at a given job site. Additionally, in this instance the gravel was being dumped at dusk which would have made the power line very difficult if not impossible to see. If proper vision cannot be maintained by the driver in the truck someone should be posted outside the truck to be on the lookout for hazards.

Recommendation #3: Truck drivers should be required to operate a truck as a condition for licensing and should receive specialized training concerning the hazards associated with operating a truck.

Discussion: The State of North Carolina does not require truck drivers to receive any specialized training prior to driving tractor trailer trucks. A driver need only to apply for and receive a chauffeur's license to be considered qualified to drive these vehicles. Prospective drivers should receive training in both the operation of and the hazards associated with the operation of tractor trailer trucks and should be required to demonstrate their proficiency in operating these vehicles before being issued a license.

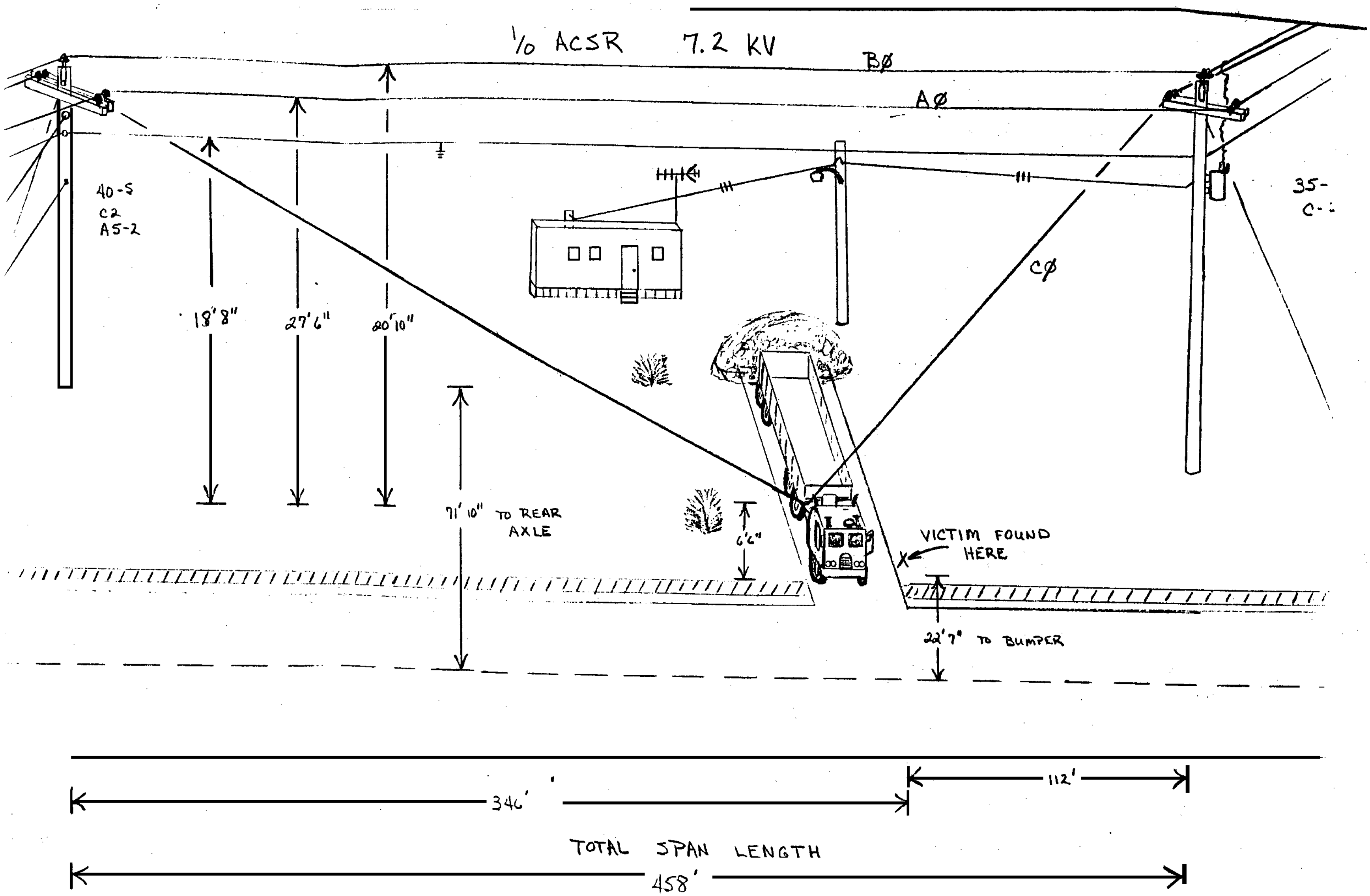

Figure 1. *Furnished by the Electrical Membership Corporation that owns the power lines.*

FACE 87-38: **Lineman Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 16, 1987, a "Class A" lineman was electrocuted when the boom of a "digger derrick truck" contacted a 7200 volt power line while he was leaning against the truck.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 5, 1987, the DSR research team conducted a site visit, met with employer representatives, interviewed comparison workers, discussed the incident with the OSHA Compliance Officer, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by an electrical contractor that specializes in power line construction and maintenance. At the time of the accident the company was performing contract work for the local power company. The contractor employs a total of 450 workers; 160 employees work out of the branch office where the victim worked. Although the workers follow the safety rules and procedures of the power company, the contractor has a comprehensive safety program. Construction personnel receive periodic structured classroom and structured on-the-job training. The contractor requires construction personnel to be certified in cardiopulmonary resuscitation (CPR). Safety meetings are conducted each day by the "Class A" linemen at each jobsite prior to the start of work. If inclement weather cancels work for a day, employees are required to attend safety meetings at the branch office. The employer has a documented preventive maintenance program for its bucket trucks and digger derrick trucks. Protective sleeves and gloves are removed from service on a monthly basis and dielectrically tested. The contractor has established a quarterly safety incentive program that rewards workers who have injury-free work records.

SYNOPSIS OF EVENTS

The local power company was relocating its rural transmission and distribution lines to make them more accessible for service. On the day of the accident, work was scheduled at the intersection of two country roads (one road surface was dirt, the other blacktop) that were perpendicular to each other. The power lines along these roads were also perpendicular although the power line along the dirt road was located in a field approximately 100 yards from the side of the road. The crew was to begin setting new poles at the intersection, then continue setting poles along the dirt road so that the power line in the field could be moved closer to the road for easier access.

The crew consisted of two "Class A" linemen and a "Class C" lineman. One of the "Class A" linemen (the victim) was designated as crew chief and was responsible for the work being accomplished and for jobsite safety. The men were to use a digger derrick truck to dig the holes and to lift the poles into position. The victim instructed the "Class C" lineman where to position the truck and then went over the job procedures that were to be followed by the crew. After he completed his instructions, the victim began to install the truck's ground rod which was attached to a 30 foot ground cable. The "Class C" lineman climbed onto the truck's platform and raised the boom. This action was in violation of the contractor's policy that the boom shall not leave the cradle on the truck until the truck ground has been installed. The reason why the "Class C" lineman began to raise the boom is unclear. Information collected during OSHA, company, and NIOSH interviews suggests that the "Class C" lineman thought that the truck ground had been installed. The emotional state of the "Class C" lineman precluded his serving as a witness in any of the interviews concerning this incident. The boom contacted the power line running perpendicular to the dirt road. The victim, in contact with the truck, provided a path to ground for the current and was electrocuted.

The second "Class A" lineman heard the sound of the contact and yelled to the "Class C" lineman to drop the truck boom. He then contacted the branch office by truck radio, requested the Emergency Medical Service (EMS), and began cardiopulmonary resuscitation (CPR). The Emergency Medical Service transported the victim to the hospital where he was pronounced dead.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees should strictly adhere to established safe work procedures.

Discussion: Established safe work procedures were violated in this instance when the boom was raised before the truck ground was completely installed. The "Class C" lineman may have thought the ground had already been installed. Additionally, the "Class C" lineman may not have been able to clearly see the victim or whether the victim had finished installing the truck ground. The operator of the boom controls should not move the boom until instructed by the crew chief that the ground is in place or he personally verifies that the ground is in place.

Recommendation #2: An observer should be used when operating a boomed vehicle in proximity to power lines.

Discussion: The crew size in this instance allowed for an observer to monitor the clearance between the boom and the power line. Had an observer been in position in this case, he would have warned the "Class C" lineman that the boom was too close to the power line or that the truck ground had not been completely installed.

FACE 87-40: Painter Electrocuted in Virginia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 17, 1987, a 27-year-old painter (the victim) was electrocuted while he attempted to wrap plastic around an insulator in preparation of painting a steel structure in a substation.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Virginia notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 5, 1987, a DSR safety specialist met with the compliance officer conducting the investigation for the Commonwealth and a company representative. Comparison workers were interviewed and photographs were obtained.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was a temporary full-time employee of an employment service which contracts to perform various types of jobs throughout the area. The company manager is assigned safety responsibility for employees on a collateral duty basis. Employees receive verbal and written safety rules/instructions and training is accomplished by on-the-job instruction and/or structured classroom training depending on the work tasks required.

SYNOPSIS OF EVENTS

On April 15, 1987, a utility had contracted an employment service to paint a steel structure in one of their substations. Two representatives of the employment service (a foreman and a crew leader) met with a representative from the utility to discuss which area of the substation was to be painted. During the discussion a tour of the substation was conducted; however, the crew leader, who was to be involved in the actual painting, did not participate. During this tour two structures were identified: 1) a de-energized 34.5 kV structure to be painted and 2) an energized 11 kV structure to be avoided. Instructions were given to avoid the 11 kV circuit structure because the system was energized. It was also decided that inclement weather would prohibit painting that day, but painting would start at a later date, weather permitting.

Two days later a painting crew consisting of five employees (four workers and the crew leader) arrived at the substation. The crew leader was previously instructed "to start painting on the structure to the right as you enter the substation gate." The crew entered the substation by using a key they had obtained earlier. When the crew entered the substation they looked at the structure on the right (the de-energized 34.5 kV circuit) and decided the system was energized. The crew was not familiar with electrical substations and misinterpreted the presence of the ground connections that grounded the circuit to assure no induced voltages would be present. They then proceeded to the 11 kV energized circuit where they saw the disconnects were open and decided this system was de-energized. Again unfamiliarity with the electrical substation caused the crew to misinterpret the condition created by the open disconnects. (The open disconnects only isolated the 11 kV circuit from the other circuits.)

A ladder was positioned on the east side of the 11 kV structure and the four workers ascended to the top of the structure. The first worker (the victim) proceeded to the southwest corner of the structure where he attempted to wrap the insulators with plastic to protect them during painting. The victim was standing on a steel beam approximately 8" in width and reaching to wrap an insulator when he contacted an 11 kV conductor. The victim's body provided a path to ground through the steel structure and he was electrocuted. The victim fell 22' 6" to the ground.

CAUSE OF DEATH

The coroner's report stated cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Access to substations should be prohibited unless qualified personnel are present.

Discussion: The painting crew entered the substation by using a key which had been provided earlier. Substation personnel were not present, since it was a holiday for utility employees. Access to energized substations should not be permitted without the presence of qualified personnel.

Recommendation #2: Contractors and employees of contractors should obtain verbal or written authorization before beginning work near energized facilities.

Discussion: When work is to be performed in a substation that is energized, authorization should first be obtained from a designated representative of the utility. Energized sections of the substation should also be identified to employers and employees performing any type of work in the vicinity of the energized facility on the same day that the work is to be performed.

Recommendation #3: Employers should require employees to use fall protection when work is to be performed above heights of six feet.

Discussion: Proposed rules in the Federal Register Vol. 51 No. 227 for OSHA safety and health standards (1926.501(a)(1)(ii)) require that employees on floors, low-pitched roofs, and other walking/working surfaces with unprotected sides and edges six feet or more above lower levels shall be protected by the use of guardrail systems, body belt/harness systems, or safety net systems when the floor, roof, or other walking/working surface is less than 18 inches in width. In an incident of this nature, if the painter had received less than a fatal shock the probability exists that a subsequent fall of approximately 22' may have resulted in death.

FACE 87-41: 56-Year-Old Pipe Layer Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 23, 1987, a pipe layer was guiding a load attached to the bucket of a backhoe when the accident occurred. The pipe layer was electrocuted when the boom of the backhoe contacted a 13,200 kV overhead powerline.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 7, 1987, a DSR safety specialist conducted a site visit, collected incident data, photographed the site, interviewed comparison workers, and discussed the incident with the state compliance officer and a representative of the employer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a general contracting company that has approximately 400 full-time employees. The company has a comprehensive safety program and a full-time safety manager.

Employees receive a copy of the company safety policy and employee safety manual. On-the-job training is provided to all new employees for specific job tasks.

SYNOPSIS OF EVENTS

A pipe layer (the victim) was an employee of a general contracting company that was under contract to install a water drain pipe. One phase of the project involved installing a section of drain pipe underneath an asphalt road. In order to bore under the road to install the drain pipe, a pit (9' deep x 7' wide) had been dug to within 10 feet of the roadway berm. Sections of steel track (1' high x 3' wide x 10' long) were being positioned on the floor of the pit in order to support and direct the boring machine.

In preparing to move a section of steel track into the pit, a crawler type backhoe equipped with an articulated (jointed) boom capable of reaching vertically approximately 28' was positioned for the lift. A 13,200 volt overhead powerline approximately 25' 8" from ground level and perpendicular to the roadway was located directly above the pit. A steel chain was then placed around the bucket of the backhoe and attached to a section of steel track. The pipe layer then guided the section of steel track as it was being moved into the pit. As the backhoe operator lifted and swung the boom in the direction of the pit, the upper arm of the boom (above the elbow) contacted the overhead powerline. The victim, who was guiding the load, provided a path to ground for the electrical current and was electrocuted.

A rescue squad was summoned and arrived at the scene eight minutes after receiving the call. When the rescue squad arrived no one was performing CPR even though the victim was not breathing and had no pulse. Resuscitation was attempted at that time, but was unsuccessful. The victim was later pronounced dead at the hospital. Entry wounds were noted on both hands of the victim and an exit wound was located on his right foot. (The length of time that the victim was in contact with the electrical current was estimated to be 20 seconds.)

CAUSE OF DEATH

The coroner's report stated cause of death as electrocution.

Recommendations/Discussion:

Recommendation #1: Employers should enforce existing regulations concerning equipment operating in the vicinity of overhead powerlines.

Discussion: OSHA regulation 1926.600 (a) (6) Subpart 0 - Motor vehicles, mechanized equipment, and marine operations requires that all equipment (i.e., backhoes covered by this subpart) when working or being moved in the vicinity of powerlines rated 50 kV or below must maintain a minimum clearance of ten feet. The backhoe operator did not comply with these requirements.

Recommendation #2: Employees should be trained in hazard recognition.

Discussion: Employees working in the vicinity of electrical powerlines should be trained to recognize electrical hazards. Supervisory personnel of the employer generally conduct daily safety meetings; however, a meeting was not held on the day of the accident. During these meetings employees should be made aware of all hazards associated with the tasks to be performed during the day, including electrical hazards.

Recommendation #3: Non-conductive tag lines should be used to aid in guiding and stabilizing the load.

Discussion: The use of non-conductive tag lines could help prevent exposure of the worker to electrical current in the event of an electrical mishap. Note: Although all ropes will conduct electricity, dry polypropylene rope provides better insulating properties than most commercially available rope.

Recommendation #4: Additional personnel should be used to observe clearances when equipment is being operated in the vicinity of electrical powerlines.

Discussion: A person should be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means.

Recommendation #5: Employees and/or employers should be trained in the use of cardiopulmonary resuscitation (CPR).

Discussion: CPR should begin within 4 minutes (in accordance with American Heart Association guidelines) in order to achieve the best results. To meet this criteria for successful resuscitation, workers should be trained in CPR to support the victim's circulation and ventilation until trained medical personnel arrive. No one at the accident site was trained in CPR and, therefore, critical care was not provided in a timely manner.

FACE 87-42: Apprentice Lineman Electrocuted in Virginia

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On March 12, 1987, a lineman trainee was electrocuted while removing grounds from a 230 kV transmission circuit.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Virginia notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On May 6, 1987, a DSR safety specialist met with employer representatives, collected incident data, and interviewed comparison workers.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electric utility employing a total of 400 workers. The utility has a full-time safety director and a comprehensive safety program. New employees undergo orientation and all employees receive structured classroom and on-the-job training. All employees receive written safety rules and safe work procedures.

SYNOPSIS OF EVENTS

On the day of the incident the crew was replacing a three foot section of a power line that had been damaged by a gunshot. The power line was part of one of the two 230 kV circuits that were suspended from a 120 foot high steel tower. An additional 150 kV circuit was located in the same electrical right-of-way, but on a separate structure. The crew consisted of a lineman, a lineman trainee (the victim), and a supervisor. The circuit with the damaged power line was de-energized and the lineman and trainee climbed the tower. The victim positioned himself on a tower arm above the lineman. Grounds were attached on both sides of the work area from the line being repaired to the tower. These grounds provided a path to ground for any currents induced by the other circuit.

The lineman trainee (the victim) had been assigned to this worksite for six days and served only as an observer throughout the repair process. The repair work was not completed until early evening and the work area was dark. The lineman stated during his interview with the compliance officer that flood lights on the truck were not used to provide lighting for the work area. Upon completion of the repair work the lineman removed the line end of one of the grounds and shook the wire to show the victim which ground he had removed. The lineman then instructed the victim to remove the tower end of that ground. This action was in direct violation of the company safety policy which states that the line end of all grounds will be removed before the tower end of any ground is removed. The victim grasped the tower end of the ground still attached to the line and the induced current present in the line traveled through the victim, down the tower, and to ground. The lineman noticed the victim in trouble and knocked the ground wire from his hand with a hot stick.

The lineman and the supervisor brought the victim to the ground and began cardiopulmonary resuscitation (CPR). The victim was revived for a short time by the lineman and the supervisor. The Emergency Medical Service (EMS) transported the victim to the hospital where he was pronounced dead two hours later. Tests performed by power company personnel after the incident determined that approximately 5,000 volts were present on the line after an initial surge of 11,000 volts.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees must follow established safe work procedures.

Discussion: Employees must understand that established safe work procedures must be followed at all times. The lineman violated established procedure when he instructed the victim to remove the tower end of the ground before the line end of both grounds had been removed. Had established safe work procedures been followed, this accident might have been prevented.

Recommendation #2: Employers should assure that work areas are sufficiently illuminated.

Discussion: The repair work was not complete until early evening. Because of the poor illumination the victim may have been unable to distinguish which ground the lineman wanted him to remove. The supervisor on the ground should have used the available floodlights on the truck to provide a safe level of illumination for the workers on the tower.

FACE 87-43: **32-Year-Old Electrician Electrocuted in Georgia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 12, 1986, a 32-year-old electrician was electrocuted while attempting to replace a socket on an energized fluorescent light fixture. It is assumed that his hand contacted an energized, single strand wire on the secondary side of the ballast (530 volts).

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Georgia notified DSR of this fatality and requested technical assistance. This case has been included in the FACE Project. A DSR researcher conducted an evaluation of this incident and conducted interviews with the safety director, the physician, and the personnel director of the company, union representatives, a surrogate for the victim, and two comparison workers. Discussions were also held with the OSHA compliance officer. The safety director of the company, an electrician, a union representative, and the DSR researcher visited and photographed the accident site. Due to the time interval between the accident and the evaluation, additional photographs taken immediately after the accident were obtained from the OSHA compliance officer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The automotive assembly plant has been in operation for 59 years and employs approximately 3000 workers. This plant is part of a 76-year-old publicly held company. The company has a corporate safety and health headquarters that administers an extensive safety and health program.

The assembly plant is staffed with two full-time safety professionals who are responsible for safety and health at the plant and provide related training. The company's corporate safety and health program provides training and resource materials to the local safety staff.

Varying levels of worker training are required according to the job applicant's experience and demonstrated proficiency with the required tasks of the job. Plant policy dictates that incoming electricians be hired at the journeyman level or enter apprenticeship training programs. Plant safety personnel appear to be conscientious and the employer is working to provide a safe work environment.

SYNOPSIS OF EVENTS

At approximately 1:45 a.m., on August 12, 1986, two journeymen electricians were directed by the maintenance foreman to replace bulbs and make necessary electrical repairs to fluorescent light fixtures in an automobile spray paint booth. The spray booth is 50 feet long. The six foot long fixtures are mounted end to end on the ceiling to provide lighting for the full length of the spray booth. Several of the fixtures needed new sockets and ballasts. Replacement of these sockets and ballasts required the workers to climb on top of the spray booth and work from above the lighting fixtures. The top of the spray booth was congested with pipes and ducts that obstructed visibility and restricted work space and movement. The pipes and ducts made it difficult to assume a balanced, comfortable, or stable posture when working on the roof of the spray booth. Inadequate lighting above the spray booth required the use of flashlights.

The electricians decided to start at opposite ends of the spray booth. There were no witnesses to the accident, but the electrician who was working at the other end of the spray booth stated that he was momentarily distracted when he saw a flash of light, "similar to a cigarette lighter." He continued to work for approximately five minutes and then climbed down and walked to the other end of the booth to retrieve some wire from a tool cart. While cutting wire at the tool cart he smelled a burning odor. He called to the other electrician on the roof of the spray booth, but received no reply. He then climbed up the ladder where he found the victim in contact with a single strand wire from the secondary side of the ballast on one of the fluorescent lights. Needle nose wire strippers were stuck in the left side of his chest. (It is assumed that the victim was stripping insulation from an improperly grounded 530 volt energized single strand wire on the secondary side of the ballast when he contacted the exposed wire.) The electricians were aware that they were working on energized fixtures. However, the breakers within the control panel were not labeled and the lock used for lockout/tagout was inoperable.

CAUSE OF DEATH

The cause of death was accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A readily accessible and properly labeled means of disconnecting energy to electrical circuits must be provided and utilized.

Discussion: The panel containing the circuit breakers to de-energize the fluorescent light fixtures was not labeled and co-workers stated that locating a disconnecting means and de-energizing a circuit often required more time than the actual completion of the task. Article 110-22 of the National Electrical Code requires, "Breaker panels or other means for disconnecting electrical energy should be legibly marked, checked for their correctness, and constantly updated to indicate the corresponding fixtures or appliances that can be de-energized by the breaker, unless the disconnecting means is located and arranged so that the purpose is evident." A clearly labeled panel would have provided the electricians with the proper means for disconnecting the power. Since the accident, a readily accessible system of disconnects has been installed.

Recommendation #2: Employers should assure that workers receive training in safe work procedures to accomplish their assigned tasks.

Discussion: The ballasts should not have been replaced or otherwise accessed while the light fixtures were energized. The circuit(s) for the fluorescent light fixtures should have been de-energized prior to the start of work. Once a circuit is de-energized, it should be tested to verify that it has been de-energized.

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Recommendation #3: Circuits that are de-energized should have a means (i.e., lockout, tagout) to assure that these circuits are not inadvertently energized.

Discussion: At the time of the accident, the lock provided to lock out the circuit was inoperable, and the workers did not take any steps to assure that the circuits they were working on were de-energized. Lockout/tagout procedures were not used.

Recommendation #4: Adequate illumination should be provided for all work areas to assure worker safety.

Discussion: At the time of the accident inadequate lighting required the use of flashlights and limited the visibility of the electricians. The congestion caused by the pipes and ducts in the work area further hindered the electricians in the safe performance of their tasks. Since the accident, additional lighting on independent circuits has been installed above the spray booth to provide an adequate level of illumination.

FACE 87-44: **Construction Worker Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 29, 1987, one construction worker was electrocuted and a second worker received severe electrical burns, while guiding a load attached to a crane, when the boom of the crane contacted a 13 kV power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On June 11, 1987, a DSR research industrial hygienist conducted a site visit, collected incident data, photographed the site, and interviewed the owner and comparison workers.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a construction company that employs 44 workers. The company installs water, sewer, and other underground utility lines.

The company does not have a written safety program and depends on its small size to communicate safety issues and concerns. Prior to the start of each construction project the owner conducts a pre-construction meeting with workers at the job site and occasionally discusses safety issues specific to the job.

SYNOPSIS OF EVENTS

The employer had been subcontracted to install a sewer line under a 47 foot wide highway. A work crew (consisting of a foreman (the victim), a crane operator, and a laborer) was assigned to bore a hole under the paved highway and insert 57 feet of 36 inch diameter steel casing. The sewer pipe was then to be installed inside the casing.

On April 29, 1987, at about 7:00 a.m., the work crew met at the site and began construction. In preparation for boring under the highway a pit (approximately 10' deep x 30' long x 12' wide) had been excavated to within five feet of the edge of the highway, and a steel track (approximately 1' high x 4' wide x 20' long) had been laid on the floor of the pit in order to support and direct the boring machine. The crane provided by the employer was capable of reaching vertically approximately 15 feet. However, for convenience in lifting and moving materials at the site, the victim called the employer and insisted that a boom extension be brought out to the site (giving the crane boom a potential vertical reach of approximately 35 feet). The employer delivered the boom extension to the site and cautioned the crew to ." . be careful, you're working under wire." A 13,000 volt, three-phase overhead power line (28.5 feet from ground level and parallel to the edge of the highway) was located directly above the end of the pit closest to the highway. The boring machine was attached by a steel cable to the end of the crane boom and was lowered into the pit at about 12:30 p.m. The victim and the laborer were in the pit attempting to guide the boring machine onto the track. The victim and laborer would periodically give directions to the crane operator to facilitate placement of the boring machine. Because the sun was almost directly overhead, it was difficult for the workers in the pit to see when they looked up. As the crane operator hoisted the boom upward, the upper end of the boom made contact with one of the power line conductors. The victim and the laborer had both hands on the boring machine when the crane contacted the power line. The victim provided a path to ground for the electrical current and was electrocuted. The laborer, who was wearing rubber work boots received severe electrical burns on his hands. It is estimated that both the victim and laborer were in contact with the electrical current for approximately five seconds.

The emergency medical service (EMS) rescue squad was notified and arrived at the scene about 15 minutes after the accident occurred. When the rescue squad arrived, a county sewer inspector (who had been working nearby) had been administering cardiopulmonary resuscitation (CPR) to the victim for approximately five minutes. Resuscitation was attempted at that time by rescue squad paramedics, but was unsuccessful. The victim was transported by ambulance to a local hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner's report stated the cause of death as electrocution. Electrical burns were noted on the left hand, left arm, and left upper thigh.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning equipment operating in the vicinity of overhead power lines.

Discussion: OSHA regulation 1926.600 (a)(6) Subpart 0 - Motor vehicles, mechanized equipment, and marine operations requires that all equipment when working or being moved in the vicinity of power lines rated 50 kV or below must maintain a minimum clearance of ten feet. The crane operator did not comply with these requirements.

Recommendation #2: Employees should be trained in hazard recognition.

Discussion: Employees working in the vicinity of electrical power lines should be trained to recognize electrical hazards. The employer or supervisory personnel should conduct formal safety meetings with workers regularly. During these meetings employees should be made aware of all hazards, including electrical hazards, associated with the tasks to be performed at each construction site.

Recommendation #3: Non-conductive tag lines should be used to aid in guiding and stabilizing crane loads.

Discussion: The use of non-conductive tag lines could help prevent exposure of the worker to electrical current in the event of an electrical mishap. Note: Although all ropes will conduct electricity, dry polypropylene rope provides better insulating properties than most commercially available rope.

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Recommendation #4: Additional personnel should be used to observe clearances when equipment is being operated in the vicinity of electrical power lines.

Discussion: A person should be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator and workers who are positioning the load to maintain desired clearances by visual means.

Recommendation #5: Primary contractors that subcontract construction projects should require that a safety program be implemented. The primary contractor should assure that all safety requirements are enforced.

Discussion: When hazardous tasks (such as operating cranes in the vicinity of electrical power lines) are to be performed by contractors or subcontractors, the contract should require compliance with safe work procedures. These requirements should be enforced by the company letting the contract.

Recommendation #6: Employees who work around electrical circuits and equipment should be trained in the use of cardiopulmonary resuscitation (CPR).

Discussion: To optimize results, CPR should begin within four minutes (in accordance with American Heart Association guidelines). To meet this criterion employees should be trained to support circulation and ventilation until trained medical personnel arrive. None of the employer's workers at the accident site were trained in CPR and, therefore, critical care was not provided in a timely manner.

FACE 87-48: **Two Workers (a carpenter and a laborer) Electrocuted in South Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 5, 1987, two workers (a carpenter and a laborer) were electrocuted and five other workers seriously burned when scaffolding they were moving contacted a 13,750 volt overhead powerline.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of South Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On June 23, 1987, a safety specialist met with the owner of the company, county coroner, and local police officers. Photographs were taken of the accident site, comparison workers, and a surrogate for one of the victims were also interviewed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victims were employed by a general contracting company that performs various types of construction and employed nine full-time workers. The company has no written safety policy or established safety program. Training for employees is provided on the job by experienced workers and/or the owner. Safety concerning work-related tasks is viewed as requiring common sense.

SYNOPSIS OF EVENTS

A crew of seven workers (carpenters and laborers) were performing various tasks at a construction site located in a small shopping mall. One task, the erection of two single stage tubular welded frame scaffolds, had been completed by several workers. Each section of the scaffolding was four feet wide and seven feet long. The scaffolding consisted of seven tiers, six tiers being 54 inches high and one tier 48 inches high for a total height of 31 feet. The scaffolds were then positioned on one side of a 33 foot high sign that was to be painted. The sign had been partially painted when the crew was instructed to move the scaffolds away from the sign, so that concrete could be poured for an access road into the mall. Both scaffolds remained assembled while they were moved approximately 30 feet away from the sign. (The ground area where the scaffolds were moved to was uneven and would later become saturated with rain water.) A 13,750 volt overhead power line was located approximately ten feet from one of the scaffolds and 27 feet from ground level.

After the concrete for the access road had cured the crew was instructed to move the scaffolds back to the sign to finish painting. The seven workers positioned themselves around the scaffold and attempted to lift the scaffold onto the newly constructed concrete access road, which was approximately 4-6 inches higher than ground level. As the workers lifted the scaffold onto the roadway, the top section of scaffolding uplifted from the adjoining section of scaffolding, (still remaining in contact with the other sections) toppled over, and came into contact with the 13,750 volt powerline.

All seven workers were knocked away from the scaffolding by the electrical shock. A carpenter and a laborer received fatal electrical burns while the remaining five workers were hospitalized with electrical burns.

CAUSE OF DEATH

The cause of death for both workers was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Scaffold should not be moved unless all safety hazards have been identified and abated.

Discussion: Prior to moving or relocating an assembled scaffold consideration should be given to such factors as: (1) height, (2) weight, (3) obstacles, (4) wheels, and (5) ground/floor condition. Consideration of these factors may require that the scaffold be dismantled. In this particular case a dismantled scaffold would have been much more maneuverable and would have eliminated the potential hazard presented by the power line.

Recommendation #2: Locking pins should be used to secure scaffolding panels (tiers) to one another.

Discussion: Scaffolding panels (tiers) should be secured together through the use of pins or other equivalent suitable means (Occupational Safety and Health Administration regulation 1926.45(d)(6)).

Recommendation #3: The employer should develop and implement a written safety program. This program should include safe work procedures and recognition of hazards.

Discussion: The employer has no written safety program or policy. Safety is currently dependent upon the common sense of the employees. A safety program should include training of employees to recognize hazards in the workplace (i.e., hazards associated with working in the vicinity of electrical powerlines).

Recommendation #4: Employers should allocate sufficient time to safely accomplish job assignments.

Discussion: As the scaffold was not equipped with wheels and a number of locking pins were missing, sufficient time to dismantle, move, and re-assemble the scaffold should have been provided.

FACE 87-52: **Driller Electrocuted in Virginia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 13, 1987, a 49-year-old driller was electrocuted when the boom of the drilling machine he was operating contacted a 34,500 volt overhead powerline.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Virginia notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 14, 1987, a safety specialist met with the employer, conducted a site visit, interviewed comparison workers and a surrogate for the victim, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a construction company that constructs and paves highways. The company employs 153 full-time people. The company has a written safety program and conducts weekly safety meetings in the field. Although the majority of employees are hired for their experience, training is provided on-the-job. The company controller is assigned responsibility for on-the-job safety and health on a collateral duty basis.

SYNOPSIS OF EVENTS

There were no eye witnesses to this incident. The following scenario was developed from discussions with the owner and controller of the company, co-workers, the state OSHA compliance officer, and an investigation of the accident site.

The company had been contracted to construct and pave a two-lane highway for the Commonwealth of Virginia. The construction had been in progress for several months prior to the incident.

On June 13, 1987, the victim (a driller) was in the process of setting up a drilling machine to drill holes that would hold explosives (for blasting purposes) to be used in the removing of overburden. The victim was operating a hydraulic drilling machine equipped with a 27 foot 4 inch boom capable of reaching a vertical height of approximately 32 feet. The drilling machine can be operated from on the machine or from ground level. Also, a three phase 34,500 volt overhead power line was located directly (29 feet from ground level) above the area to be drilled.

Prior to the incident on the morning of June 13, 1987, the field foreman told the victim to be careful since overhead power lines were present. The field foreman then left the area and the driller began setting up the drilling machine. The victim was standing on the ground, which was wet from the rain, operating the controls for the placement of the boom. The boom was extended and being positioned vertically when the top section contacted the bottom conductor of the overhead power line. The victim provided a path to ground for the electrical current and was electrocuted.

A local police officer was on the scene approximately four minutes after the incident and performed CPR until the rescue squad arrived. The rescue squad transported the victim to a nearby hospital where he was pronounced dead.

CAUSE OF DEATH

The cause of death was listed as electrocution. Exit burns were noted on the victim's left foot, but no entrance burns were observed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should comply with OSHA regulations concerning the operation of boomed-vehicles near electric power lines.

Discussion: Although the OSHA regulation governing the operation of boomed vehicles near electric power lines does not strictly apply to drilling machines, a safety conscious employer should voluntarily comply with OSHA standard 1926.550(a)(15) which requires that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load (boom) shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" or insulating barriers have been erected "to prevent physical contact with the lines, equipment or machines." Obviously, complying with this standard will often involve cooperation with the power company.

Recommendation #2: Operating controls for boomed vehicles, when designed for use from ground level, should insulate the operator from the vehicle.

Discussion: The victim had approximately 30 years' experience as a drilling machine operator and had been made aware of the presence of overhead power lines only moments before the incident by the field foreman. Even with this experience and warning the fatal accident occurred. It is apparent that the regulations concerning cranes (boomed-vehicles) and overhead power lines are adequate when followed; however, boomed equipment, when operated from ground level, should have electrically insulated operating controls, so that a momentary error in judgment does not result in the loss of life.

Recommendation #3: Additional personnel should be used to observe clearances when equipment is being operated in the vicinity of electrical power lines, especially when visibility is impaired or obstructed.

Discussion: The location of the drilling machine (directly beneath the power line) and weather conditions (overcast and raining) may have interfered with the operator's perception of the distance to the power line. Employers should comply with, where applicable, 29 CFR 1926.550(a)(15)(IV) which requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means.

FACE 87-53: **An 18-Year-Old Groundman Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 1, 1987, a groundman was electrocuted when an energized power line broke and contacted a pole trailer while the victim was attempting to load a pole onto the trailer.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 8, 1987, the DSR research team (two safety engineers) conducted a site visit, met with employer representatives, interviewed comparison workers, interviewed the next-of-kin, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical contractor with approximately 1500 employees. The majority of income is generated through contracts with local utilities.

The employer's safety program appears to be comprehensive; however, this is the third electrically-related fatality involving employees of this employer within 26 months. The employer relies heavily upon on-the-job training.

SYNOPSIS OF EVENTS

On June 1, 1987, a five man crew (a foreman, two linemen, and two groundmen) were replacing an electric pole along a rural highway. The crew arrived at the work site at approximately 8:15 a.m. and by approximately 2:30 p.m. had installed a new pole and transferred four conductors (three energized lines and the neutral) from the old pole onto the new pole. A lineman with the support of a groundman had previously deadended all conductors and moved the saddle connections (connectors used to connect smaller conductors to power lines) away from the pole. In order to load the old pole onto the pole trailer the workers moved the auger truck with the pole trailer into position. The truck and trailer were under the power lines and the workers did not ground the truck. A groundman (the victim) attached a winch cable to the old pole and took up the slack of the cable in preparation to load the old pole onto the pole trailer. The foreman was operating the winch and one of the other linemen was on the ground waiting to put a chain around the pole. The top of the pole was on the trailer and the bottom of the pole was on the ground.

The energized 13.2 kV (phase to ground) power line closest to the road broke approximately seven inches from the deadended assembly and fell, contacting the pole trailer. The victim provided a path to ground for the current through his contact with the winch cable and was electrocuted. At the time of the accident one of the linemen was working from an aerial bucket attaching the lightning protection for the transformers, but reportedly did not do anything that should have caused the power line to break.

The power line was de-energized when an oil switch recloser opened. Co-workers performed cardiopulmonary resuscitation (CPR) on the victim and emergency medical service (EMS) personnel arrived by ambulance shortly after being notified. EMS personnel provided advanced cardiac life support (ACLS) and transported the victim to the hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The cause of death was electrocution. An autopsy was not performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The safety program of the company should be evaluated to identify any shortcomings.

Discussion: Although the employer's safety program appears comprehensive on paper, this is the third fatality occurring to employees of this company during the last 26 months. The employer or an outside consultant familiar with electrical contracting should conduct a thorough evaluation of the safety program and its implementation. Specific areas that should be reviewed are safety procedures to be used during replacement of poles when energized conductors are present and policies concerning hazards associated with equipment that is the responsibility of the organization to which the employer is contracted (in this case the conductor may have been defective).

Recommendation #2: Training of employees should be evaluated.

Discussion: The employer relies very heavily upon on-the-job training of employees. On-the-job training can vary widely, may not address all required tasks and associated hazards, and is dependent upon the employee assigned to conduct the training. The employer or an outside consultant familiar with electrical contracting should conduct a thorough evaluation of all training provided to employees and assess its impact.

Recommendation #3: The employer should require trucks and trailers working under or around energized power lines to be grounded.

Discussion: The auger truck and pole trailer were not grounded at the time of the accident even though the crew was working directly under the energized power line.

FACE 87-54: **Truck Driver Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On April 14, 1987, a 32-year-old truck driver was electrocuted when he raised the bed of the dump truck he was operating into a 12 kV energized power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 8, 1987, the DSR research team (two safety engineers) conducted a site visit, met with employer representatives, interviewed comparison workers, interviewed a surrogate of the victim, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small trucking company that specializes in hauling farm animals. The company has one self-propelled dump truck and employs eight workers.

The employer does not have a written safety program and relies heavily upon the common sense of his employees to work safely. Drivers must have a Class A driver's license from the state of North Carolina.

SYNOPSIS OF EVENTS

On April 14, 1987, a truck driver (the victim), who operated a 60,000 pound self-propelled hydraulic trailer, was to deliver approximately ten loads of lime to a farm supply company. The victim was hauling the lime from a local railhead to the supply company site and was instructed to dump the lime on an existing storage pile. Because of use over time, the storage pile had spread out and been expanded, so that a portion of the area being used for storage was directly under three 12 kV power lines. The power lines ran perpendicular to the road in front of the farm supply company.

The truck driver dumped the first load of lime at approximately a 45º angle to the road. At approximately 11:25 a.m. when the truck driver was delivering the second load of lime, he pulled into the storage area and parked the truck and trailer perpendicular to the road. The truck was approximately six inches under the power line closest to the farm supply company building. The driver, standing on the opposite side of the trailer from the power line, was operating the lever which controlled the bed of the dump truck. As he was dumping the lime, the aluminum stop (a short rod mounted on the bed of the trailer to limit movement of the canvas tarp covering the load) contacted the power line. The driver completed a path to ground and was electrocuted.

The power line was burned into two parts at the point of contact, fell into the trailer bed, and "danced" along the tail gate, electrically energizing the truck. An employee of the farm supply company, who was standing at the back of the truck when the accident occurred, notified the personnel in the farm supply building. Fire department and municipal electrical personnel were notified. Employees of the farm supply company unsuccessfully attempted to push/pull the victim away from the energized truck using broom handles. The victim was in contact with the energized truck for approximately 30 minutes, until the power line could be de-energized by municipal electrical personnel. The victim was severely burned and cardiopulmonary resuscitation (CPR) was not attempted. The victim had been restricted to driving locally because the employer stated that he was "accident prone." He had been fired by this same employer previously for driving "under the influence."

CAUSE OF DEATH

The cause of death was "electrocution."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The storage area or the power lines should be moved to eliminate the hazard associated with the overhead power lines.

Discussion: The storage area should be free of all recognized hazards, including the presence of overhead power lines. The exact same conditions were present at the accident site on the day of the investigation as on the day of the accident. No intervention strategy has been implemented to preclude a recurrence of this accident.

Recommendation #2: The employer should implement a safety program that addresses the hazards associated with operating a dump truck (i.e., overhead power lines, etc.).

Discussion: Safety must be emphasized on a daily basis if employees are to follow safe work practices. Informal safety discussions, sometimes referred to as tailgate meetings, tailored to the hazards associated with operating a dump truck should be conducted periodically.

FACE 87-55: Electrician Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 23, 1987, while repairing a fluorescent light fixture over a kitchen sink in a single-family residence, a 33-year-old journeyman electrician was electrocuted when he contacted an energized wire on the load side of the ballast (400 volts).

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 9, 1987, the DSR research team (two safety engineers) met with employer representatives and interviewed comparison workers.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical contractor that employs approximately 20 people. The largest percentage of the company's income is generated as a subcontractor on commercial projects.

The employer has adopted "Safety Information and Instructions" developed by a major U.S. company and complies with the safety regulations of the company contracting for their services. However, the safety program is not implemented on a daily basis.

SYNOPSIS OF EVENTS

On June 23, 1987, a journeyman electrician (the victim) and an electrician's helper were repairing several electrical malfunctions found throughout a single-family residence. The workers had started at 7:30 a.m. and had worked at the house all day, except for approximately two hours when they went to check on another job. At 4:25 p.m. the victim called his office and notified his supervisor that they would not be able to finish the job by their normal quitting time of 4:30 p.m.

The electrician's helper had been trying to repair a 110 volt, four foot fluorescent light over a stainless steel sink in the kitchen. He had replaced the ballast; however, he could not get the light to operate properly. The electrician's helper asked the journeyman electrician if he would try to repair the light. The electrician was sitting on the sink when he apparently contacted an energized wire on the load side of the ballast. The circuit had not been de-energized at the panel box or at the single-pole switch on the wall beside the sink. (The day following the accident a representative of the employer measured the voltage on the load side of the ballast to be 400 volts. The ballast was rated at 430 mA.)

At 4:35 p.m. the owner of the residence discovered the victim and pulled him away from the light. The electrician's helper and the home owner contacted the local fire department and attempted to make the victim comfortable. The victim responded that he was all right. Fire department personnel were notified and they arrived at 4:50 p.m. The victim was transported to a nearby hospital emergency room where he was pronounced dead a short time later. (The reason the fluorescent light would not operate properly was later determined to be the result of a burned out lamp.)

CAUSE OF DEATH

The medical examiner determined that the cause of death was cardiac arrhythmia due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees who work around electrical circuits and equipment should de-energize those systems prior to initiating maintenance or repairs.

Discussion: It is not clear if the victim realized that the circuit was energized or not. However, maintenance and repair of electrical systems should not be initiated until it is determined that these systems are de-energized and that they cannot be inadvertently energized.

Recommendation #2: Employees who work around electrical circuits and equipment should be trained in cardiopulmonary resuscitation (CPR).

Discussion: To optimize results CPR should begin within four minutes (in accordance with American Heart Association guidelines). To meet this criteria, workers should be trained to support circulation and ventilation until trained medical personnel arrive. Because the home owner and the co-worker were not trained in CPR, critical care was not provided in a timely manner. The employees working around electrical circuits and equipment should be trained in CPR.

Recommendation #3: When working on energized circuits or equipment cannot be avoided, employers should implement the safeguards necessary to complete such work safely.

Discussion: The NIOSH report entitled "Guidelines for Controlling Hazardous Energy During Maintenance and Servicing" dated September, 1983, identifies several considerations that must be addressed prior to working on energized circuits. When these considerations are not addressed electrical circuits and equipment must be de-energized prior to maintenance or servicing.

FACE 87-56: **Utility Person Electrocuted in Virginia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 6, 1987, a 21-year-old utility man was disconnecting the power source to a knitting machine motor when he inadvertently touched an energized prong of the plug and was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Virginia notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 15, 1987, a safety specialist met with representatives of the employer, conducted a site visit, interviewed comparison workers, and photographed the accident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a company that dyes and prints synthetic yarns. The company employs 350 full-time people and has a written safety program. Safety rules, in the form of handouts, are given to employees at the time of employment. The personnel manager is responsible for safety and safety inspections of the plant are conducted on a bimonthly basis.

SYNOPSIS OF EVENTS

As there were no eyewitnesses to this incident the following scenario was developed from interviews conducted with representatives of the employer, co-workers of the victim, the state OSHA compliance officer, and an investigation of the accident site.

On July 6, 1987, a utility man (the victim) had been performing his regular duties. That afternoon the victim observed that four knitting heads on a knitting machine had stopped operating. The knitting machine was equipped with twelve knitting heads (three groups of four heads, each group powered by a separate motor). Upon further inspection of the knitting machine the victim found that a drive belt from the motor to the knitting heads had come off the pulley. The motor is rated at one h.p. and is supplied by a three-phase, 575 VAC, 6OHz power source. The motor is connected to the power source by a flexible cord and a three-prong "twistlock" plug and receptacle. The motor, plug, receptacle, and breaker box for the power source are all located underneath the frame of the knitting machine.

Apparently, the victim decided to reinstall the drive belt even though it was not one of his regular duties. He knelt down and leaned against the supports of the frame of the knitting machine while attempting to disconnect power to the motor. The victim held the twist lock device in both hands (plug in one hand, receptacle in the other hand), twisted the device, and tried to pull apart the plug and receptacle. When a part of the victim's hand contacted an energized prong, he provided a path to ground and was electrocuted. The victim was perspiring heavily at the time of the accident.

CAUSE OF DEATH

The coroner's report stated cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should implement lockout/tag-out procedures into their safety program.

Discussion: The employer does not include lockout/tag-out procedures as part of their safety program. Lockout is normally done with an ordinary padlock placed on the breaker box or switch disconnect. Only the worker who performs the lockout procedure has a key to the lock. The worker "locks out" the power before performing any function that would bring a person into contact with hazardous energy. A less effective method of warning people about the presence of hazardous energy is the danger-tag or tag-out procedure. This method requires placing a tag at the breaker box or disconnect switch warning that the power should not be turned on. This procedure is adequate when the worker can see the disconnect source. However, lockout procedures provide a more substantial level of protection.

Recommendation #2: A comprehensive safety program should include work procedures for disconnecting a power source and training for employees in the recognition of hazards associated with electrical energy.

Discussion: The victim apparently did not recognize the hazard associated with pulling the "twistlock" plug apart without first de-energizing the 575 VAC system. A comprehensive safety program should include training that addresses recognition of electrical hazards and safe work procedures. For example:

Work Procedure for Disconnecting 575 VAC System

1. De-energize with local disconnect
2. Lockout or tag-out local disconnect
3. Mechanically separate "twistlock" plug.

FACE 87-58: **19-Year-Old Electrician's Apprentice Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On June 18, 1987, an electrician's apprentice was assisting his supervisor (a journeyman electrician) install lights on a private dock when he made contact with an energized circuit and was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On July 28, 1987, a research industrial hygienist met with the compliance officer investigating the accident for the state, conducted a site visit, and interviewed the employer of the victim.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical contractor with two employees, a journeyman electrician and an apprentice electrician (victim). The employer has no written safety program. Training of new employees is provided on-the-job. The employer recommends to all employees that they take advantage of courses conducted locally on electrical safety.

SYNOPSIS OF EVENTS

On June 18, 1987, the owner of the electrical contracting company instructed his two employees (the journeyman and apprentice electrician) to finish a pier lighting job. The job originally called for installation of ten 110 volt lights (along the right side) on a private 250 foot pier and a 220 volt circuit from the house to the boat house (along the left side) at the end of the pier. All electrical work had been completed a month earlier, except for the installation of five lights, which were on order.

The day of the accident, the journeyman electrician (supervisor) and the apprentice electrician went to the private residence (after lunch) to complete the job. The employer stated this was an easy task assignment, even for an apprentice electrician. All the two men had to do was install five light fixtures and wire them to the previously installed 110 volt system under the pier. Five separate wires were run through plastic conduit under the pier. The five wires were: one hot, one neutral, one ground, and two trailing wires for multiple switch installation on the same circuit. Plastic junction boxes were located under the pier where each light was wired into the system. The procedure required one worker to screw the fixture into the pier while the other worker wired the fixture to the 110 volt circuit below.

According to the employer, the men parked their truck near the pier and started to work. The apprentice stated he would wire the lights under the pier while the journeyman installed the fixtures above. The apprentice jumped into the water (waist deep) and proceeded to go under the pier to start to work. The journeyman (supervisor) yelled down to him, "Do not touch anything until I check to see if the circuit is shut off." The supervisor started for the boat house (although the circuit breaker for this 110 volt circuit was located at the house on shore) to see if the circuit was shut off, when he heard a loud moan. He immediately ran back to where the victim was working and saw him (back arched) with both hands on a wire stripper, attempting to strip the black (hot) wire. He knocked the victim's right hand loose, and then knocked his left hand loose from the hot wire. The supervisor then jumped into the water and pulled the victim out of the water on to a lower section of the pier. The victim was unresponsive and had no pulse. The owner of the private residence called the emergency fire/rescue squad, who arrived 20 minutes later. The squad found that the victim had no vital signs and cardiopulmonary resuscitation (CPR) had not been initiated. The coroner arrived a few minutes later and pronounced the victim dead at the scene.

CAUSE OF DEATH

The coroner listed the cause of death as "electrocution."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop safe work procedures that address tasks performed by employees, identify safety hazards, and stress safety training.

Discussion: The employer did not have established safe work procedures that were specific to the tasks to be performed. Procedures should be developed and implemented that detail the tasks to be performed and should identify the safety hazards associated with these tasks. The employer should assure that the safety procedures are followed.

Recommendation #2: Employers should ensure that all employees are aware of workplace hazards and safe operating procedures.

Discussion: At the present time the company has no written training program for new employees. Safety training should ensure that the employees are knowledgeable of hazards, including the increased chance of an electrical fatality in wet conditions, and appropriate safety procedures. These procedures should include locking and/or tagging out hazardous energy sources.

Recommendation #3: Circuit testing should be done before any work is commenced.

Discussion: Although a circuit testing device was available on the pier, it was not used to test the circuit. All employees should be instructed on the use of circuit testers and their importance.

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FACE 87-60: Maintenance Manager Dies in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 7, 1987, a maintenance manager was electrocuted while repairing an air conditioning unit at an apartment complex. The victim was trying to make an electrical connection inside the energized unit when his right index finger contacted a capacitor.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 7, 1987, a DSR safety specialist conducted a site visit, met with employer representatives and co-workers, and discussed the incident with the OSHA compliance officer. The next of kin interview was precluded in this case due to the emotional and physical state of the spouse.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed as the maintenance manager at a twenty (20) acre, 262 unit apartment complex. The employer had no written safety policy or safety program. The maintenance manager (the victim) was responsible for providing on-the-job training to new employees.

SYNOPSIS OF EVENTS

On the day of the incident the victim arrived at work and received his work orders from the apartment complex manager. The victim and a helper were to replace the compressor in a 240 volt air conditioning unit at one of the apartments. The air conditioning unit was located in a small service room (floor space four feet by six feet) adjoining the apartment. Removal of a metal screen from an outside wall of the service room allowed access to the unit. A power switch (toggle switch) was located in the service room, directly above the access opening. The unit was de-energized and the compressor was replaced. The unit was then tested and found to be functioning improperly.

The victim inspected the internal connections of the unit and found a loose connection. The victim tried to make the connection without de-energizing the unit. As the victim's right hand entered the unit, his index finger contacted a capacitor, which allowed the current to flow through the victim to ground. The helper, realizing the victim was in trouble, tried to pull him away from the unit and received an electrical shock. The helper then entered the service room, de-energized the unit, and proceeded to the apartment complex office to summon help. The office secretary was a registered nurse and started cardiopulmonary resuscitation (CPR) immediately. The secretary was assisted by a second registered nurse that lived in the complex. The emergency medical service (EMS) arrived after twenty minutes and transported the victim to the hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The coroner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees who work with electrical conductors should de-energize the conductors prior to the start of any work on the conductors.

Discussion: The maintenance manager knew that the air conditioning unit was energized, yet decided to correct the improper connection without de-energizing the unit. The result was a fatality. The unit should have been de-energized before the wiring was attempted. The wiring could then have been performed safely. Since the incident, management has adopted the policy that working on energized conductors is a dischargeable offense.

Recommendation #2: A comprehensive safety program outlining proper safe work procedures for tasks being performed by workers should be developed and implemented.

Discussion: A comprehensive safety program that would clearly outline proper procedures and techniques to be used in the performance of tasks should be developed. The workers should then be instructed in the proper procedures and techniques to perform their everyday duties in the safest possible manner. Since the incident the employer has begun to develop a comprehensive safety program for maintenance activities. Once this safety program is developed, management should ensure that it is implemented!

Recommendation #3: Employers should ensure that all employees are aware of workplace hazards and safe operating procedures. This can be accomplished by a training program.

Discussion: At present the employer has neither formal training programs for new employees nor periodic retraining for all employees. Safety training should ensure knowledge of hazards and proper operating procedures.

FACE 87-61: **Laborer Electrocuted in Virginia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 21, 1987, a laborer/truck driver was collecting scrap metals from property owned by a local municipality. He was grasping the hook suspended from the hoist cable of a truck crane when the hoist cable contacted an overhead high voltage line. He provided a path to ground and was electrocuted.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration (OSHA) for the Commonwealth of Virginia notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On August 13, 1987, a DSR research team (safety specialist and research industrial hygienist) met with the company owner/manager and interviewed one comparison employee. Photographs of the site were taken.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small company that specializes in collecting and removing scrap metal from shipyards and industrial, commercial, and public operations. The company usually has six to eight full-time employees and has no safety program. Only minimal on-the-job training is provided and there is little evidence that personal protective equipment (PPE) is used or available.

SYNOPSIS OF EVENTS

The weather on the day of the accident was clear and hot. The temperature was approximately 95 degrees Fahrenheit. Two trucks and the truck crane were at the site (see figure). The two trucks were positioned for loading under the power lines. The truck crane was operating close to the power lines in order to pick up a "jack boat" made of plate steel. The victim (location X) was a truck driver, but was also working as a "hook-on man" helping the crane operator load the scrap metal, which was a common practice for this company.

As the victim stood on the "jack boat" holding the cable hook, the boom cable of the crane contacted a 19,900 volt overhead power line. The victim provided a path to ground for the current and was electrocuted. The power line burned and separated, falling onto the trucks and starting a fire. Both the emergency medical service (EMS) and the fire department were called, but the victim was pronounced dead at the scene.

CAUSE OF DEATH

The medical examiner's report stated that death was due to "accidental electrocution." Entrance burns were noted on the victim's right hand and exit burns were present on his right foot. Electrical arc burns were seen on the trunk, left upper extremity, and both lower extremities.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should enforce existing regulations concerning crane operations in the vicinity of overhead power lines.

Discussion: OSHA Standard 1910.180(J)(1) requires that a minimum clearance of ten feet be maintained between parts of cranes or loads and electrical power lines rated 50 kV or less, unless the lines were de-energized and visibly grounded or insulating barriers are erected.

Recommendation #2: Employees should be trained in hazard recognition.

Discussion: Employees working in the vicinity of power lines should be trained to recognize electrical hazards. The employer generally did not conduct any safety meetings. Daily safety meetings should be conducted by employers. During these meetings employees should be made aware of all hazards associated with the tasks to be performed during the day, including electrical hazards.

Recommendation #3: Additional personnel should be used to observe clearances when equipment is being operated in the vicinity of electrical power lines, especially if the operator's visibility is impaired in any way.

Discussion: Employers should designate an observer for all operations where it is difficult for the operator to maintain desired clearances by visual means. The accident occurred just before noon, and the sun may have made it difficult for the operator to adequately judge the clearance. The use of an observer might have prevented the accident.

OVERHEAD VIEW OF SITE

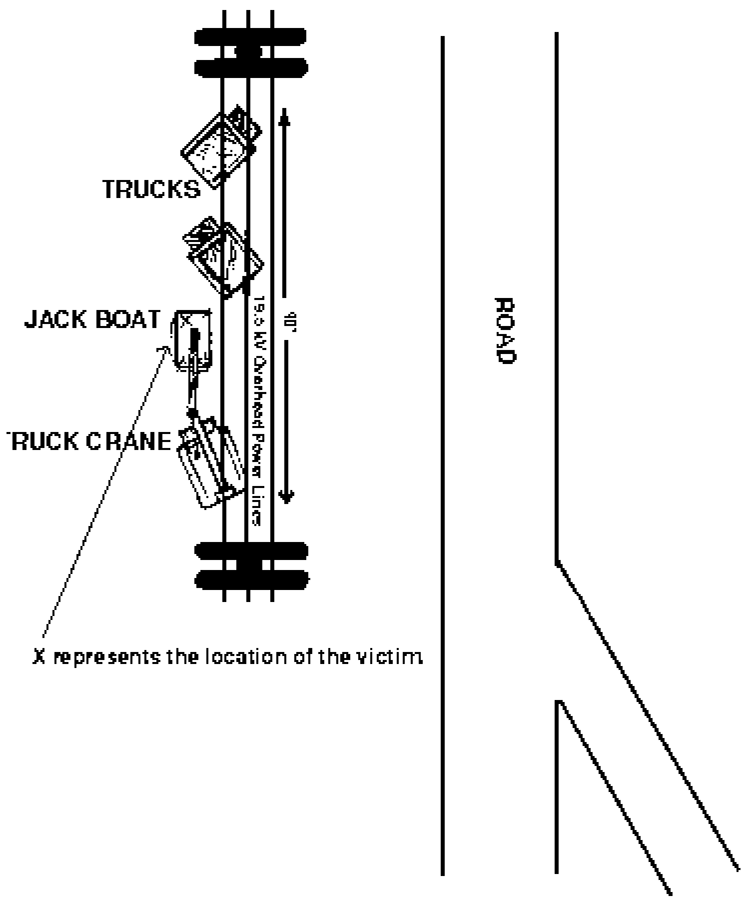

Figure. *Overhead View of Site*

FACE 87-62: Laborer Electrocuted in Indiana

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 4, 1987, a laborer was electrocuted when he contacted an energized cap on a well casing while searching for a water leak.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. During the week of September 21, 1987, a DSR research team visited and photographed the site and interviewed company personnel, co-workers, the victim's supervisor, and the victim's next of kin.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a gas pipeline contractor that has been in business under the present management for fifteen years. The company presently employs 77 people and currently has no formal safety program. A consultant was contracted to develop a comprehensive safety manual, but all training is conducted "on-the-job."

SYNOPSIS OF EVENTS

The victim was employed as a general handyman at the company garage. The company had moved into new facilities the day prior to the incident. The well supplying water for the new facility was 120 feet deep and was located approximately 100 feet from the office/garage complex. The well was encased in four inch pipe with a submersible pump inside the casing to pump water to the complex. This pump was powered by a 220 volt line running from a utility room inside the facility to the pump itself. The pump cycled automatically by a pressure sensing switch located in the utility room to maintain between 35 and 45 psi on the water lines at the facility.

On the day of the incident a water leak was observed in the area of the well casing. The victim and his supervisor attempted to locate the source of the leak in order to repair it. The area surrounding the pump casing was excavated to a depth of 18 inches using a backhoe. The two employees then proceeded to dig around the well casing with shovels. They dug to a depth of approximately 28 inches, but were unable to locate the source of the leak because the pump was not running and the water line was not pressurized. As they were standing in water in the excavation, the pump cycled on automatically. The supervisor received an electrical shock and heard the victim yell. The supervisor noticed the victim slumped over the well casing and ran to the garage to open the circuit breaker for the pump. Co-workers were immediately called to the scene and CPR was begun. A county ambulance was called to the scene and arrived approximately 25 minutes following the incident. The victim was transported to the local hospital where he was pronounced dead on arrival by the attending physician.

Investigation into the incident revealed that the pump was installed by a sub-contractor. The power for the pump was provided by three wires of approximately eight gauge which were buried and ran under ground to a one foot section of 3/4 inch plastic pipe which led the wires up through the metal protective cap and down the well to the submersible pump. No shielding or conduit was provided for these wires. Upon examination of the wires it was found that where the wires passed under the metal cap a "hot" lead was crushed. The damaged insulation on the lead apparently allowed contact between this conductor and the metal cap. This would energize the metal cap when the pump was running. It is assumed that the pump cycled on, the victim contacted the energized metal cap, and current flowed from the metal cap through the victim, who provided a path to ground.

CAUSE OF DEATH

The medical examiner ruled electrocution to be the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should implement a hazard recognition program designed to enhance employee awareness of potentially hazardous situations.

Discussion: No safety training program was in existence with the employer at the time of this incident. Although the employees were working around a piece of electrical equipment in the presence of water, no thought appears to have been given to the possibility of any hazard being present. Employee awareness of the potential danger of working in wet locations near electrical equipment might have prevented this incident.

Recommendation #2: Electrical equipment should be de-energized whenever possible during maintenance/repair work.

Discussion: A work plan which minimized exposure to electrical hazards could have been developed. For example:

(1) de-energize the pump with the circuit breaker located in the electrical panel and perform lockout/tagout procedures;

(2) excavate around the well casing;

(3) with workers well clear of potential electrical hazards, energize the pump to develop water pressure in the lines and locate the leak;

(4) de-energize the pump and perform lockout/tagout procedures (again) prior to repairing the leak.

Recommendation #3: Employers should comply with existing articles of the National Electrical Code that apply to branch circuit underground wiring.

Discussion: Article 339-2 of the National Electrical Code requires that Type UF cable, which has more durable insulation, be used for underground branch circuit wiring. It should be noted, however, that this insulation protects the conductor, not the worker. To increase the safety of workers in wet locations metal sheathed cable could be used. Conductors in metal-sheathed cable are enclosed in a continuous copper sheath and then encased in highly compressed insulation. If a fault occurs in a conductor the copper sheath will carry sufficient ground fault current to open the circuit breaker.

FACE 87-63: **30-Year-Old Electrician Electrocuted in Maryland**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 29, 1987, an electrician was electrocuted when he contacted an energized conductor while installing new wiring.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Maryland notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On September 9, 1987, a member of the DSR research team met with the employer's representative, interviewed comparison workers and an eyewitness to the incident, photographed the accident site, and discussed the incident with the Maryland OSHA compliance officer for this case.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an electrical contractor specializing in commercial and industrial electrical services and employing 40 full-time workers. The safety function is managed by the owner of the company on a collateral duty basis. Individual foremen are also responsible for on-site safety. A safety program addressing electrical safety had been developed and is administered on a routine basis.

SYNOPSIS OF EVENTS

On July 29, 1987, the victim and a co-worker were continuing work on the relocation of conduit and wiring for a CO_2 system (carbon dioxide - coolant used for the facility refrigeration system).

Two electrical supply systems powered the $C0_2$ unit: 1) a No. 8 AWG, three-phase, 480 VAC, 50 ampere system supplied power to the compressor motor, and 2) a No. 10 AWG, three-phase, 480 VAC, 15 ampere system supplied power to the controls and gauges. Disconnect switches for the two systems are located in adjacent panel boxes.

On the afternoon of the incident the victim and a building maintenance man proceeded to the panel box area to disconnect the power to the $C0_2$ unit. The two panel box covers were marked in pencil and the pencil marking for the compressor motor was barely legible. The power supply for the controls and gauges was disconnected, but the power supply for the compressor motor was apparently overlooked and the circuit remained energized.

The victim disconnected the energized conductor from the compressor motor and taped the ends with electrical tape. He then pushed a fish tape (an uninsulated, stiff, steel wire) through the conduit until its end protruded. The victim then attached the conductor to the fish tape. The fish tape was pulled back through the conduit until the end of the energized wire protruded from it. At that time the victim removed the electrical tape from the energized wire while part of the fish tape remained in the conduit. The victim was holding the fish tape, which was grounded against the conduit, and contacted the energized wire. This action completed the path to ground and the victim was electrocuted.

After contacting the energized wire the victim collapsed, breaking contact. A co-worker, working in the vicinity, saw what had happened and ran to a telephone to call for assistance. The local emergency medical service (EMS) responded in approximately five minutes and began cardiopulmonary resuscitation (CPR). The victim was transported to a nearby hospital where he was pronounced dead.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Disconnecting means and circuits should be adequately identified.

Discussion: The control panel box cover for the compressor motor circuit disconnect had been marked in pencil. Only with close scrutiny were the markings legible. Current OSHA standard 1910.303(f) states that: "Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose." An inspection and adequate marking of all the disconnecting devices should be initiated immediately.

Recommendation #2: Employers should reinforce their standard operating procedures concerning circuit testing.

Discussion: Although the victim had a volt meter available, he failed to test the circuit and this omission led to his death. Standard operating procedures should be reviewed, revised as needed, and consistently enforced by the employer.

Recommendation #3: Employees and/or employers should be trained in cardiopulmonary resuscitation (CPR).

Discussion: CPR should begin within four minutes (in accordance with American Heart Association guidelines) in order to achieve the best results. To meet this criteria for successful resuscitation, workers should be trained in CPR to support the victim's circulation and respiration until trained medical personnel arrive. No one at the accident site was trained in CPR and, therefore, resuscitation was delayed until the EMS arrived.

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FACE 87-65: Tree Trimmer Electrocuted in Indiana

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 6, 1987, a tree trimmer performing contract work for a utility company was electrocuted while trimming a tree when he contacted a 7200 volt power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of Indiana notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. During the week of September 21, 1987, a DSR research team visited and photographed the accident site, discussed the case with Indiana OSHA personnel, and interviewed co-workers, company representatives, and a surrogate for the victim.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a large, multi-state tree trimming company which employs 750 people. The company has been in operation since 1945 under the same management. The company has no formal safety program and training consists of "on-the-job" instruction by the crew foreman. The victim had been employed by the company for the past 18 months in the position he held at the time of his death. Awareness of the hazards posed by overhead lines was apparent by the presence of warning signs on company equipment.

SYNOPSIS OF EVENTS

On the day of the incident the employee was working as a part of a crew consisting of four trimmers and one foreman. They were trimming trees along a power line right-of-way in a residential area. The crew had been on the job for three hours at the time the incident occurred. Numerous lines, including both high and low voltage electric, telephone, and cable TV ran through the trees at various heights in this area. Two trimmers were working in the trees cutting away brush while two others were working on the ground.

The victim was working in one tree and his fellow trimmer was in an adjacent tree. The victim was tied-off in the tree and had completed trimming on two major branches. He then began work on a third limb and leaned back to prune some small branches above his head. At this time the back of his neck came in contact with a 7200 volt line and the victim was electrocuted. Co-workers attempted to remove the victim from the tree by the use of his lifeline; however, this line was woven through the various branches of the tree and they were unable to extricate the victim. Employees from the local electric utility were called to the scene and managed to de-energize the line and remove the victim approximately 25 minutes after the incident. The victim suffered extensive burns on his neck and the lower portions of both legs. The victim was pronounced dead on the scene by the county coroner.

CAUSE OF DEATH

The coroner's office listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Formal training regarding the hazards posed by overhead power lines should be given to all employees who work near these lines. In addition, periodic refresher courses should be given to remind employees of the hazards.

Discussion: No formal training had been given to the employee. The company relied on "on-the-job" training by the foreman and co-workers to assure hazard awareness and worker safety. A lack of basic electrical safety knowledge was apparent in a comment made to the DSR research team, that one of the lines in the tree was "only a 110 volt line which might shock him a little, but wouldn't really hurt him."

Recommendation #2: A job site survey should be conducted prior to the start of any work involving overhead power lines. Supervisory personnel should point out potential problem areas to workers prior to the start of work.

Discussion: Although the victim was doubtless aware of the power lines in the area, and had been working close to them all day, he still made a very serious mistake in that he positioned himself between the power line and the tree and worked with his back toward the power line. A discussion by the foreman prior to the start of work which pointed out the hazards and outlined a plan to complete the work safely might have prevented the fatality.

FACE 87-66: **Laborer Electrocuted in Virginia**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 10, 1987, a laborer was electrocuted when the mast of a well drilling rig he was operating came in contact with a 7200 volt overhead power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the Commonwealth of Virginia notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On September 9, 1987 the DSR research team discussed the incident with the OSHA compliance officer, conducted a site visit, met with the employer and family of the victim, photographed the site and drilling rig, and spoke with emergency rescue squad personnel.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is a residential and commercial drilling company with four employees. The victim was the son-in-law of the owner of the company. The company had no written safety program or policies. However, the victim and the owner of the company had worked together for ten years in the well drilling business, six of which were for a large corporation with an extensive safety program. For the past four years they had worked together in the family business. Awareness of the hazards posed by overhead power lines is evident in the presence of "look up and live" signs posted on company equipment.

SYNOPSIS OF EVENTS

Normally the owner of the company visits the work site prior to sending the drilling rig out. However, in this case the company owner had been unable to contact the property owner and locate the site for the well.

On the day of the accident the victim and a co-worker completed work on one well and returned to the company office where the victim was advised that the property owner had called and wanted his well drilled that day. The victim, along with the co-worker, drove the drilling rig out to look for the site of the new well. They experienced some difficulty in locating the site and called the office for additional information. At that time the company owner advised the victim not to begin operations until he (the owner) arrived on the scene.

The victim and his co-worker returned to the property where the well was to be drilled. They then met with the owner of the property who helped them locate the well site. Access to the well site was obtained by backing the drilling rig approximately 150 feet along a power line right-of-way beneath a 7200 volt, three phase electrical line suspended at a height of 24 feet. The drilling rig then backed off the power line right-of-way at a 45 degree angle to reach the well site, which had been selected by the county health department. The victim and his co-worker went to the rear of the drilling rig and the victim stepped up on a steel platform on the rig to raise the mast. As the mast was being raised the co-worker observed smoke coming from under the drilling rig. The victim stepped down from the operator's platform to attempt to locate the source of the problem. He and his coworker observed smoke coming from the tires of the drilling rig, but they apparently failed to associate this with contact between the mast and the overhead power lines. The victim then attempted to enter the cab of the drilling rig to shut-down the rig. As he touched the cab of the truck his body provided a path to ground from the electrically energized vehicle and he was electrocuted. The owner of the property realized then that the truck was energized and used a stick to push the victim away from the vehicle.

Emergency medical service (EMS) for the county where the accident occurred is provided by a volunteer rescue squad. Although the squad was called at 2:48 p.m., response was delayed by the fact that EMS personnel had to respond from their homes. Therefore, the ambulance did not leave the station until 3:05 p.m. and did not reach the scene of the accident until 3:07 p.m. (19 minutes after the call was received). EMS personnel began CPR at the scene and continued it enroute to the hospital where the victim was pronounced dead on arrival. Although the EMS unit had a manual defibrillator on board, the rescue squad was not trained in its operation.

CAUSE OF DEATH

The medical examiner ruled that electrocution was the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A job site survey should be conducted prior to the commencement of any work.

Discussion: A job site survey conducted prior to the start of work would serve as a time for identifying hazards (such as overhead power lines) and for planning work to avoid these hazards. Such a procedure, which was usually routine for this company, could have prevented the fatality.

Recommendation #2: Employers should comply with OSHA regulations concerning the operation of boomed-vehicles near electric power lines.

Discussion: Although the OSHA regulation governing the operation of boomed vehicles near electric power lines does not strictly apply to drilling machines, a safety conscious employer should voluntarily comply with OSHA 29 CFR 1926.550(a)(15) which requires that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load (boom) shall be ten feet, unless the electrical lines have been "de-energized and visibly grounded" or insulating barriers have been erected "to prevent physical contact with the lines, equipment, or machines." Obviously, complying with this standard will often involve cooperation with the power company.

Recommendation #3: Employers should assure that an observer is present whenever elevated equipment is used near overhead power lines, especially when it is difficult for the operator to maintain visual separation.

Discussion: Both employees were at the rear of the vehicle, with the operator 36 feet from the tip of the mast. From this position it would be difficult for the operator to gauge the proximity of the mast to the overhead lines. Employers should comply with OSHA 29CFR 1926.550(a)(15)(IV) which requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means.

Recommendation #4: Periodic refresher training should be made available to employees emphasizing the hazards of working in close proximity to overhead power lines and the danger associated with any piece of equipment in contact with overhead power lines.

Discussion: Neither employee involved in this incident had received any recent training in the hazards associated with overhead power lines. Since they had backed the drilling rig for some distance along the power line right-of-way it would appear unlikely that they failed to note the presence of overhead lines; nevertheless they failed to associate the smoke coming from the vehicle with the power lines. The victim then approached the drilling rig and made contact with the energized vehicle, which resulted in the electrocution. A simple observation ("look up and live") could have prevented this fatality.

Recommendation #5: Personnel responsible for selecting well sites should choose sites well away from hazardous conditions.

Discussion: County health department personnel responsible for the selection of this well site apparently did not recognize the hazard posed by the overhead power lines. The selection criteria used in site selection should be evaluated and revised as necessary.

FACE 87-68: Electrician Electrocuted in Indiana

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On July 29, 1987, an electrician was electrocuted when he contacted a 110 volt conductor while he was installing a heating/air conditioning duct system.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration (OSHA) for the State of Indiana notified the Division of Safety Research of this fatality and requested technical assistance. This case has been included in the FACE Project. On September 16, 1987, the DSR research team (a research industrial hygienist and a safety specialist) conducted a site visit, photographed the site, interviewed comparison workers, the employer of the victim, and a surrogate for the victim.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small heating/air conditioning company which employs eight workers (all licensed electricians). The majority of the employer's business involves the installation of heating and air conditioning systems.

The company has no written safety program. Safety concerns (among other issues relevant to each job) are discussed briefly between the employer and the employees prior to each job. New employees receive a brief job orientation by the employer, on-the-job training, and training in heating/air conditioning service and installation by a private training company.

SYNOPSIS OF EVENTS

On July 29, 1987, a heating/air conditioning system installer (the victim) and two co-workers (an installer and a service technician) were installing a furnace in a single story cottage. Two employees were doing work in the furnace room inside the cottage while the victim was in a 30 inch high crawl space under the cottage installing a flexible galvanized duct system below the cottage floor. The ground under the cottage was damp. After approximately three hours of work at the site, the victim crawled about 30 feet farther into the crawl space (where the vertical clearance tapered from 30 inches to approximately 18 inches). The victim was now working almost directly below the two co-workers who were inside the cottage. The co-workers were raising a trouble light that had been passed through a hole in the floor into the crawl space. When the light caught on something the two co-workers called and asked the victim to dislodge it. After a few minutes, they called down and asked the victim if he had freed the light. He replied, "Wait a minute, it's tight down here." A few seconds passed, then they heard a "thud" on the underside of the floor.

The co-workers called to the victim several times but received no response. One of the co-workers (an installer) entered the crawl space and crawled to the victim who was lying face down. He made an attempt to drag the unresponsive victim out of the crawl space; however, when he touched the victim he felt a mild electric shock. The installer instructed the other co-worker (service technician) to open the main electric service disconnect at the outside fuse box. After the main power switch was turned off, the installer began dragging the victim out while the service technician ran to a nearby cottage and called the local emergency medical service (EMS). It is estimated that the victim was in contact with electrical current, for approximately three minutes. When the EMS arrived (17 minutes from the time the call was received) both co-workers were performing cardiopulmonary resuscitation (CPR) on the victim. CPR was continued by EMS personnel during the ten minute trip to a local hospital. Resuscitation efforts were continued at the hospital, but were unsuccessful. The victim was pronounced dead one hour after arrival.

NOTE: At the time this report was written the exact source of the electric current had not been determined. Several unguarded electrical connections and junction boxes were present in the immediate area surrounding the victim. Any of these could have provided the electric current that resulted in this fatality.

CAUSE OF DEATH

The autopsy report listed the cause of death as asphyxiation due to aspiration of gastric contents. This apparently resulted from prolonged contact with electrical energy.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop and implement a comprehensive safety program that addresses both the recognition of workplace hazards and the procedures to follow in the presence of those hazards.

Discussion: OSHA 1926.21(b)(2) states that "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." A comprehensive safety program should include hazard recognition and the procedures to follow in the presence of those hazards (i.e., de-energize electrical circuits and utilize electrical energy testing equipment prior to the commencement of work).

Recommendation #2: Residential wiring should satisfy the requirements of the National Electric Code.

Discussion: The residential wiring in the cottage crawl space was substandard. The 110 volt cable contained numerous cracks in the lead sheathing, junction boxes were not covered, and connections were unguarded. The electrical system in the residence should be inspected and modified to satisfy the applicable requirements of the National Electric Code. The existence of proper wiring in this incident would have greatly reduced the risk of serious injury. It is recognized that the National Electric Code is not retroactive; however, residential electrical systems should be evaluated prior to beginning work to determine if a safe electrical system has been maintained.

FACE 87-69: Electrician Electrocuted in Tennessee

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. The purpose of the FACE program is to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 20, 1987, an electrician was electrocuted while trouble shooting a 480 volt DC generator which supplied power to a glue machine.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Administration (OSHA) for the State of Tennessee notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) concerning the fatality and requested technical assistance. This case has been included in the FACE Project. On September 25, 1987, a member of the DSR research team met with the company owner, interviewed co-workers, and discussed the case with a representative from Tennessee OSHA. The accident site was visited and photographed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was an electrician working for a small (5 employees) company which performs industrial electrical wiring and maintenance. The company only employs union electricians, who undergo extensive training prior to reaching the journeyman level. However, the company itself has no ongoing safety program.

SYNOPSIS OF EVENTS

One of the electrical company's clients, a large facility which produces containers for various grocery products, asked that a 480 volt DC generator be relocated. The facility engineer agreed to assist the electrician (victim) who was sent to perform the work. On the day this incident occurred, the temperature in the facility was approximately 100 degrees Fahrenheit and the humidity was high.

After the two men finished moving the DC generator and reconnecting the electrical wiring, the victim turned on the power to the generator and asked the plant engineer to push the "start" button. When the generator failed to start, the victim got his voltmeter and verified that control voltage was reaching the starter. The victim then moved to the rear of the generator with the voltmeter to verify that he had made the electrical connections correctly and to check the two fuses located in the rear of the generator. The victim actually had to reach from the side of the generator, since there was only about two feet of clearance between the back of the generator and the glue machine which it supplied.

The plant engineer smelled something burning and called to the victim, who did not respond. He then looked behind the generator and saw the victim slumped over, one arm on a transformer and his head on the floor. He shouted to other employees (working nearby) to call for an ambulance and to cut the power off at the power disconnect switch. The victim was then pulled from behind the generator and cardiopulmonary resuscitation (CPR) was begun. The emergency medical service (EMS) arrived approximately 15 minutes after the incident and began advanced cardiac life support (ACLS). Resuscitation efforts, which were continued enroute and after arrival at a local hospital, were unsuccessful. The victim was pronounced dead in the hospital emergency room.

Notes:

1. The victim apparently contacted one phase of the 480 volt AC power supply to the generator, which was energized at 270 volts (phase to ground).

2. When the generator was moved, some non-conductive, particulate matter was apparently dislodged, which prevented the switch from completing the control circuit when the "start" button was initially pressed. After several subsequent attempts, the starter worked and has continued to function properly.

CAUSE OF DEATH

The medical examiner ruled that death was due to accidental electrocution. No autopsy was performed, but burns were noted on the victim's left hand.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Decisions about equipment location should include consideration of maintenance requirements.

Discussion: The location chosen for the generator ensured that maintenance to the generator would be from an awkward position at the side of the generator. This increased the possibility of contacting an energized conductor. It should be noted that the facility is voluntarily having the generators relocated away from the work area and that sufficient room for maintenance is being provided.

Recommendation #2: Employers should develop and implement a comprehensive safety program that addresses both the recognition of workplace hazards and procedures to minimize those hazards.

Discussion: The fact that safety training is an integral part of the training required to become a journeyman electrician is useful and necessary, but not sufficient. This incident occurred at the end of the workday when the victim, who was hot and covered with perspiration (which lowered his electrical resistance), attempted to work in the vicinity of energized equipment in a cramped space. An active company safety program should be developed which stresses hazard recognition and safe work procedures.

FACE 87-70: Electrician Electrocuted in South Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing on selected work-related fatalities.

On July 19, 1987, a 29-year-old electrician was electrocuted when he contacted the energized metal frame of an electrically powered foundry stoker that he was attempting to repair.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of South Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On October 14, 1987, a DSR research team (a research industrial hygienist and an epidemiologist) met with a company representative, conducted a site visit, collected incident data, and interviewed comparison workers.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is a foundry which smelts iron ore to make ferrous alloys and chrome by-products. At the facility where the fatality occurred there are approximately 300 employees, consisting mainly of laborers and maintenance personnel.

The employer has a written safety program and safety policy and employs a full-time plant safety manager. New employees receive safety instruction from the safety manager and hazardous areas of the operation are pointed out during a plant tour. They also receive on-the-job training from supervisors and co-workers.

The company has two safety committees which meet on a monthly basis: a Supervisor Safety Committee (composed of department managers), and a Union-Management Safety Committee (composed of labor, union representatives, plant supervisors, and the safety manager). The Supervisor Safety Committee is responsible for keeping employees within each department informed of changes in the safety policy, accident rates, and safety training. Members of this committee are also required to evaluate safety practices within each department. The Union-Management Safety Committee is responsible for promoting all aspects of company safety and health, assisting in conducting safety inspections, accident investigations, and implementing accident prevention measures.

The company safety policy requires each department and shift to have at least one five minute safety talk each week (usually conducted by the department supervisor) for the purpose of informing employees concerning safety and health requirements and to encourage worker participation in the safety program. Each employee is required to sign a statement certifying that they have received and read a copy of the company safety policy.

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SYNOPSIS OF EVENTS

The foundry where the fatality occurred uses electrical stokers, located on the second floor of the foundry, to add raw materials to the furnace. The stokers are modified industrial trucks, each powered by a 40 horsepower electric motor. Power to each stoker is supplied by a reinforced flexible cord (440 volt, three phase, four wire, 60 cycle system) on a retractable overhead reel.

At 8:00 a.m. on July 19, 1987, the victim began his shift by attempting to repair the No. 5 stoker which had been reported as being electrically inoperable. Although the victim had not been formally trained to do this type of work, he had worked as a maintenance electrician for the company for seven years and, according to co-workers, had successfully performed similar repair procedures "dozens of times." Using an electrical continuity tester, the victim identified an internal break within the last four feet of the flexible power cord that plugged into a receptacle mounted on the stoker. The victim disconnected the power and locked the "on/off" switch into the "off" position. He then unplugged the flexible power cord to the stoker. The plug and four feet of the flexible power cord which contained the internal break were cut off and the defective section of the cord was discarded. The victim then re-wired the plug back onto the newly cut end of the flexible power cord. During this process the victim inadvertently crossed the wires and connected the ground wire to the hot plug terminal and a hot wire to the ground plug terminal. After reinserting the plug, the victim turned the power switch on. The reversed wiring caused a fuse to blow in the fuse box (located one floor above). When a co-worker (stoker operator) reported the stoker was still inoperable, the victim turned the power switch off, replaced the blown fuse, and turned the power on again. There were no eyewitnesses but evidence (approximately six discarded fuses beside the fuse box) suggests the victim repeated this process several times. Eventually, the ground wire melted off from the lug where it was connected at the fuse box. This interrupted the continuous path to ground and resulted in the frame of the stoker remaining energized. Presumably, in an attempt to check if the stoker was operational, the victim touched the metal foot pedal on the stoker with his left hand. Current entered his left hand and exited to ground potential through both legs. The victim collapsed, breaking contact with the stoker.

A co-worker in the general area of the stoker observed the victim lying beside the stoker on the cement floor approximately 3-4 minutes after the victim was last seen working on the stoker. This co-worker called for help, and several other co-workers carried the victim downstairs and outside of the building, where cardiopulmonary resuscitation (CPR) was initiated. Because it was a hot day with high humidity and the victim and his clothes were wet with perspiration, the co-workers assumed that he had collapsed due to heat exhaustion. It was not until the paramedics arrived (approximately ten minutes after the victim was observed down) that electrical burns were noted on the left arm. CPR was continued by paramedics, who also initiated advanced cardiac life support (ACLS) measures on-site and during transport to a local hospital. The victim arrived at the hospital emergency room approximately 45 minutes from the time that the victim was first observed unconscious beside the stoker. Attempts to resuscitate the victim continued for a short time in the emergency room, but proved unsuccessful and the victim was pronounced dead at 11:26 a.m. by the attending physician.

CAUSE OF DEATH

The medical examiner's report stated that the victim died as a result of cardiac arrest due to a low voltage electrocution. An autopsy which was performed noted electrical burns on both shoulders, the left arm, and both thighs. A urine drug screen indicated the presence of marijuana. This, however, does not

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necessarily imply that the victim's judgement was impaired when the accident occurred, since trace amounts of marijuana can be present in the urine for several days after marijuana is smoked.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should assure that personnel assigned to perform electrical maintenance are trained sufficiently in the recognition and control of the hazards they may encounter in the performance of their daily duties.

Discussion: Fuses are safety features, but they are designed primarily to protect the electrical system rather than the worker. A worker who had been properly trained would have realized a malfunction existed in the electrical system as fuses were repeatedly blown when power was restored to the stoker. Testing devices (ohm meter, continuity tester, etc.) could then have been used to pinpoint the problem (in this case the improper connections). Once the problem was identified, it could have been corrected. Although the victim had a testing device present that would have identified the problem, he instead continued to replace the fuses. This led to the disruption of the grounding path and the creation of a hazardous situation. Had the victim been trained in the recognition of electrical hazards, this fatality might have been prevented.

Recommendation #2: All electrical equipment should be inspected regularly to identify potentially hazardous conditions requiring preventive maintenance.

Discussion: The flexible cord/reel retractor system that provides electrical power to each stoker should be: 1) inspected regularly by qualified personnel to identify the development of potentially hazardous conditions arising from normal use, and 2) re-evaluated to identify possible electrical safety design modifications that may be incorporated into the facility's electrical system (i.e., a means of minimizing stress on the flexible power cord during stoker use).

FACE 88-02: **Painter is Electrocuted in South Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On September 9, 1987, a 49-year-old male painter was electrocuted when he contacted a fluorescent light fixture.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of South Carolina notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. During the week of November 16, 1987, a DSR research team visited and photographed the incident site, and interviewed company personnel and co-workers.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a large, multi-state textile company which employs 10,000 people. The company has been in existence for 92 years and has been under the present management for the past 3 years. The company has a formal safety program with training provided to all employees. Job safety analyses are performed for all positions, and are reviewed twice per year. A review of the OSHA 200 reports filed by the plant for the past several years showed few serious injuries. The company has not had any similar fatalities. The victim had been employed by the company for the last 20 years, and had been working as a painter for the 5 months prior to this incident.

SYNOPSIS OF EVENTS

On the day of the incident, the victim and a co-worker were painting steel "I" beams located approximately 12 feet above the plant floor. Numerous pipes, conduits, and 110-volt fluorescent light fixtures were in the area. The painters had been working around these obstacles while painting the beams. The room where the incident occurred was extremely warm (approximately 100º F).

In order to reach the beam, the victim was standing at approximately the 8-foot level of a 10-foot wooden ladder. He was leaning across a conduit and one of the fluorescent light fixtures suspended from the ceiling, while touching other pipes and conduits with his right arm. The cable that supplied power for the fluorescent light was not secured with a box connection at the point where the cable entered the light fixture; accordingly, any stress applied to the cable was transmitted directly to the connections within the fixture. As the victim leaned across the light fixture an energized conductor within the fixture contacted and energized the housing. Electrical current traveled from the energized housing through the victim's chest and out through the victim's right arm, which was in contact with pipes and conduits at ground potential.

The victim's co-worker stated that he heard a "scraping" noise and observed the victim lying across the light fixture. When he called to the victim and received no reply, he approached to see what was wrong. When he touched the victim he received an electrical shock. He then went for help and returned with two supervisors who disconnected power to the light and helped lower the victim to the floor. Cardiopulmonary resuscitation (CPR) was begun within a few minutes by plant medical personnel. CPR was continued by ambulance personnel who transported the victim to the local hospital where he was pronounced dead after resuscitation efforts failed.

Examination of the light fixture revealed that the ground wire was disconnected. It is presumed that the ground wire had not been reconnected when the ballast was last replaced. It was also noted that numerous burn marks existed within the light fixture at the points where the conductors were connected to the ballast.

CAUSE OF DEATH

The coroner's office ruled the cause of death to be accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical equipment should be installed and maintained in accordance with the applicable requirements of the National Electrical Code (NEC).

Discussion: At sometime in the past, a new light ballast had been installed in the light fixture. The ground wire for this ballast had been clipped off and a proper ground connection was not completed as required by NEC 410-18. In addition, the power supply cord was neither secured nor protected at the point where it entered the fixture, a violation of NEC 410-28. Therefore, any stresses put on the cord were transmitted directly to the wiring connections within the fixture. Also, the conductor insulation became abraded due to rubbing against the metal housing at the point where the conductor entered the fixture. These factors led to the energization of the fixture housing.

Recommendation #2: Employees responsible for electrical work should be trained in the requirements of the National Electrical Code.

Discussion: The fact that this fixture was improperly wired is evidence that a training/retraining program is needed for employees performing electrical work within the plant. In addition, the performance of employees should be periodically monitored to identify those individuals in need of refresher training, and to verify that hazards are not being created through human error.

Recommendation #3: Periodic re-evaluations of job safety analysis (JSA) for each position should be accomplished to ensure that hazards and potential hazards for each task are addressed.

Discussion: While the plant conducts JSA for all positions and reviews them twice per year, it appears that these reviews do not address changes in work which may result in other than normal exposure to various hazards. In this case the victim, a painter, apparently was not aware of the hazards posed by the electrical equipment in his work environment. In addition, the improper wiring of the light fixture would seem to indicate that the employee who had repaired this fixture was unaware of the hazard being created by failure to properly wire and ground the unit.

Recommendation #4: A general safety training program should be developed for all employees whose work activities expose them to the potential hazards of electrical energy. This training should address the identification of electrical hazards and measures for controlling them.

Discussion: The victim was leaning with his weight across an energized piece of electrical equipment (light fixture), subjecting the light fixture to stresses beyond its capacity. The victim created the potential for electrocution by providing a "path to ground" through contact with the fixture and overhead pipes. This ground path involved vital human organs which are adversely affected by electrical energy. If the employee had understood the hazards of electrical energy and the methods of controlling the release of this energy, this incident may have been avoided. For instance, wet skin can have a resistance as low as 1000 ohms, although the resistance of dry skin to electrical current may be as high as 100,000 ohms. Reduced resistance (ohms) results in increased current (amps), which can make the difference between a barely perceptible shock and electrically induced cardiac arrest. If the victim had realized that his resistance to electrical energy was probably lowered significantly by perspiration (due to the warm working conditions) he may not have leaned on the fixture. A safety training program should include such basic electrical safety training for all employees.

FACE 88-03: Apprentice Lineman Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On November 4, 1987, a 30-year-old male apprentice lineman working as a member of a power line construction crew was electrocuted while installing a new length of overhead distribution conductor.

CONTACTS/ACTIVITIES

City police officials notified DSR concerning this fatality and requested technical assistance. During November 4-5, 1987, a DSR research team conducted a site evaluation, interviewed company officials and co-workers, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a large power line construction company with more than 350 employees. The company has been in operation for 66 years and has a formal safety program. Both classroom and on-the-job training are provided to employees. The victim had been employed by the company for 2½ months but had not attended the formal company training program.

SYNOPSIS OF EVENTS

On the day of the incident, the victim was part of a five-man crew stringing a new circuit conductor beneath an existing 12,000-volt, 3-phase overhead electrical service. The crossbars for suspending the new circuit were mounted 5 feet below the energized conductors. This circuit was to be approximately 2,400 feet in length, supported by power poles at 200-foot intervals. The new conductor was being supported on crossbars mounted on the existing power poles. Due to the hilly, wooded terrain and two turns in the system, it was impossible to see from one end of the pull area to the other.

At the time of the incident, the victim was working at a trailer-mounted line tensioner. The victim was leaning over the side of the tensioner trailer and a co-worker was at the rear of the trailer. The new conductor was being pulled from the tensioner by a pulling rig located at the other end of the run. A "loop" developed in the new conductor between the tensioner and the nearest pole because of insufficient tension on the line. A second loop of cable occurred on the spool when the cable struck the trailer axle, which prevented it from feeding properly from the spool. Tension on the new conductor increased as the pulling unit continued to operate. This caused the loosely-strung new conductor to raise by several feet between the supporting crossbraces. The new conductor contacted an existing energized conductor which was sagging approximately 10 feet below the elevation of the crossbrace mountings for the new conductor. Current flowed through the new conductor and energized the tensioner trailer. The victim was electrocuted when his body provided a path to ground from the trailer. The co-worker was apparently struck on the foot by the second loop of the energized new conductor.

A supervisor standing several feet away from the trailer heard the co-worker cry out, and turned in time to see him fall backward down a steep embankment. The supervisor notified the operator of the pulling unit, via radio, to stop pulling operations. The supervisor ran to the victim lying on the ground near the trailer and began cardiopulmonary resuscitation (CPR). He continued CPR until advanced cardiac life support (ACLS) procedures were administered by rescue squad personnel. The victim was transported to a local hospital where he was pronounced dead. The co-worker received serious burns to the left foot.

CAUSE OF DEATH

The medical examiner reported that the victim had electrical burns on his stomach and right arm. Electrocution was cited as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should perform a job hazard analysis of each project prior to initiating work, and communicate hazard information and control measures during work crew safety meetings.

Discussion: Each project differs in the scope of work to be accomplished, the makeup of the work crews, the physical layout of the job site, and the equipment required to perform the work. This uniqueness creates differing situations for exposure to job hazards. Therefore, the hazards associated with each work effort must be analyzed so that appropriate control measures can be planned and implemented. A serious safety hazard which existed at this job site, the potential that the new conductor being pulled would contact an existing energized conductor, was not recognized and, therefore, not controlled. Two factors combined to increase the potential: 1) a lack of communication during the line stringing operation, and 2) the sagging condition of existing energized conductors. These factors should have been identified prior to the initiation of work. Corrective measures to prevent the hazardous contact might then have been adopted and communicated to the crew.

Recommendation #2: Where new conductors are being installed near existing energized conductors, the employer should install guards, as necessary, to prevent inadvertent contact between new conductors and existing energized conductors.

Discussion: A system of guards, such as an inverted "U"-shaped configuration composed of utility poles erected between the two levels of conductors, could minimize the chance of contact during installation of the new conductors.

Recommendation #3: All equipment used in line-stringing operations should be grounded when work is being performed in proximity to energized power lines.

Discussion: Although work was being performed in proximity to existing energized power lines, neither the tensioner trailer nor the truck to which it was attached was grounded. Grounding of the units could help prevent electrocutions should inadvertent contact with energized conductors occur.

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Recommendation #4: The feasibility of incorporating electrical isolation into the design of the tensioner trailer should be studied.

Discussion: In this incident, the new conductor made contact with conductive parts of the trailer as it exited the spool. This allowed the trailer to become energized when the new conductor contacted an energized conductor. If the new conductor and spool were electrically isolated from the body of the tensioner, inadvertent energization of the trailer and truck would be less likely, thereby enhancing worker safety.

Recommendation #5: The employer should train all employees in the identification, recognition, and control of electrical hazards prior to assigning them work on energized systems.

Discussion: Although the employer does provide formal classroom training to employees who work with or near energized electrical equipment and systems, the victim had been employed for 2½ months as an apprentice lineman without benefit of this formal training.

FACE 88-04: Painter Electrocuted in North Carolina

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing on selected work-related fatalities.

On September 1, 1987, a 28-year-old painter was electrocuted when the 40 foot aluminum extension ladder he and a co-worker were raising contacted a 7200 volt power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 18, 1987, a DSR research safety specialist collected incident data, photographed the site, interviewed a comparison worker and a surrogate for the victim, and discussed the incident with the OSHA compliance officer and a company representative.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small painting contractor which employs seven workers. The company has no written safety program. Safety training consists only of telling the workers to be careful.

SYNOPSIS OF EVENTS

On September 1, 1987, a painter (the victim) and three other workers were assigned the task of cleaning the outside brick of a convalescent home. The brick on the three story convalescent home was being prepared for eventual painting.

The crew of four workers were divided into two equal groups to work on opposite sides of the convalescent home. The victim and a co-worker were using a bleach solution to prepare the building brick for painting. A 40 foot aluminum extension ladder was used to reach the upper sections of the convalescent home. A three-phase 7200 volt overhead power line was located 31 feet above ground and 15 feet away from the convalescent home. Telephone lines, which were heavily covered with vines, ran directly below and parallel to the power lines. The telephone lines were located approximately 18 feet above ground.

The victim and co-worker, upon finishing cleaning one section, lowered the ladder and moved it to the next area to be cleaned. The victim, standing on the ground, held and balanced the ladder as the co-worker simultaneously climbed and raised the extension. The ladder, after being raised approximately 34 feet, tipped backwards and contacted the power line. The co-worker was knocked from the ladder and the victim, who provided a path to ground for the electrical current, was electrocuted.

The injured co-worker ran inside the convalescent home and summoned help. An on-duty nurse called the emergency rescue squad, which was located two blocks away, and went to aid the victim. Cardiopulmonary resuscitation (CPR) was administered until the rescue squad arrived. The victim was transported to the local hospital, three blocks away, where he was pronounced dead.

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CAUSE OF DEATH

The coroner's report stated that the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Ladders used near energized power lines should be made of non-conductive materials.

Discussion: OSHA Standard 1926.450(a)(11) states that "portable metal ladders shall not be used for electrical work or where they may contact electrical conductors. " The aluminum ladder used in this incident was conductive. If a ladder made of non-conductive material had been used in this case, the fatality might have been prevented.

Recommendation #2: The employer should develop a safety program designed to recognize and avoid hazards (e.g., electrical overhead power lines).

Discussion: The danger of overhead power lines appears to be obvious; however, contact with overhead power lines and the subsequent occupationally-related fatalities continue. OSHA Standard 1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." The company does not provide training in safe work procedures and does not have written safety rules. The tasks performed by workers should be evaluated and the hazards identified. A safety program should be developed which addresses these hazards.

Recommendation #3: To assure proper protection for anyone working near electrical power lines, arrangements should be made with the power company to de-energize the lines or cover the lines with insulating line hoses or blankets.

Discussion: Energized power lines in proximity to a work area constitute a safety hazard. Extra caution must be exercised when working near energized power lines. A safe distance between power lines and ladders, tools, or scaffolds should be maintained at all times. At least one state (California) requires that a six foot minimum clearance be maintained. The power line in this instance was within 15 feet horizontally from the convalescent home, but due to miscellaneous items in this area (e.g., air conditioner, natural gas main, and a retaining wall), a safe distance from the power lines could not be maintained. When this type of situation occurs, overhead power lines should be de-energized or covered with insulating equipment.

Recommendation #4: Utility companies should regularly inspect and clear right-of-ways for utility lines.

Discussion: The telephone lines in the area where the incident occurred were heavily covered with vines. The vine growth on the lower telephone lines may have obstructed the victim's and co-worker's vision and judgement in determining safe placement of the ladder. Utility companies should regularly inspect and clear right-of-ways for utility lines so unnecessary obstructions aren't encountered in work of this nature.

FACE 88-05: **Construction Worker Electrocuted in North Carolina**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing on selected work-related fatalities.

On September 24, 1987, an 18-year-old construction worker was electrocuted and two co-workers received an electrical shock when the 32 foot aluminum extension ladder they were using contacted a 7200 volt overhead power line.

CONTACTS/ACTIVITIES

Officials of the Occupational Safety and Health Program for the State of North Carolina notified DSR concerning this fatality and requested technical assistance. This case has been included in the FACE Project. On November 19, 1987, a DSR safety specialist conducted a site visit, collected incident data, photographed the accident site, met with an employer representative and co-workers, and discussed the incident with the OSHA compliance officer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed as a part-time construction worker for a small residential/commercial contractor. The company consists of an owner, two full-time employees, and part-time workers who are employed as necessary. The company had no written safety program when this incident occurred, but has since developed and implemented a safety program addressing the recognition and avoidance of hazards.

SYNOPSIS OF EVENTS

The employer had been contracted to remodel the roof of a two-story office building. On September 24, 1987, the owner, victim, and two other employees were awaiting the arrival of roofing shingles at the construction site. In the interim the victim and the two employees positioned a fully extended 32 foot aluminum extension ladder between a three phase 7200 volt overhead power line and the side of the office building. The power line is located 27 feet above ground level and six feet horizontally from the building.

While the victim and one employee held the ladder, another employee climbed it in an attempt to locate an area on the roof to store the shingles. The employee on the ladder then indicated that the roof was too steep to store the shingles and that he was coming down. As he descended, the ladder tipped backwards, contacting the power line. The employee on the ladder and one employee stabilizing the ladder were shocked and knocked away from the energized ladder. The victim, who was gripping the ladder to stabilize it, remained in contact with the energized ladder for approximately 10 seconds before falling and breaking contact.

The owner, after seeing what had happened and determining that two of the employees who received electrical shocks were not seriously injured, then turned his attention to the victim. The victim was unconscious and not breathing, so the owner ran inside the office building and telephoned for help.

An emergency rescue squad arrived on the scene in less than 10 minutes and provided advanced cardiac life support (ACLS) measures, which were unsuccessful. The victim was transported to the local hospital, seven minutes away, where he was pronounced dead.

CAUSE OF DEATH

The coroner's report stated the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should inspect and identify all hazards at a work site prior to beginning work.

Discussion: Energized power lines in proximity to a work area constitute a safety hazard. A safe distance between power lines and equipment should be maintained at all times. A thorough inspection by the employer should have disclosed the hazards of working in this particular area, since the power line was within six feet of the office building. Arrangements could then have been made with the power company to de-energize the lines or to cover the lines with insulating hoses or blankets prior to beginning this work.

Recommendation #2: Ladders used near energized power lines should be made of non-conductive materials.

Discussion: OSHA Standard 1926.450 (a)(11) states that "portable metal ladders shall not be used for electrical work or where they may contact electrical conductors. " If a ladder made of non-conductive material had been used in this case, the fatality might have been prevented.

Recommendation #3: Employees and/or employers should be trained in cardiopulmonary resuscitation (CPR).

Discussion: CPR should begin within four minutes (in accordance with American Heart Association guidelines) in order to achieve the best results. To meet this criteria for successful resuscitation, employees/employers should be trained in CPR to support the victim's circulation and respiration until trained medical personnel arrive. No one at the accident site was trained in CPR and, therefore, resuscitation was delayed until the EMS arrived.

FACE 88-11: **Maintenance Supervisor Electrocuted**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On February 25, 1988, a 33-year-old male maintenance supervisor was fatally injured when he inadvertently contacted an energized conductor (22,000 volts) in a high-voltage control cabinet. On February 28, 1988, state Occupational Safety and Health Administration officials notified NIOSH of this fatality and requested technical assistance.

CONTACTS/ACTIVITIES

On March 17, 1988, NIOSH met with a representative of the employer, discussed the incident with the OSHA compliance officer, photographed the incident site, and interviewed a paramedic and a witness who were at the scene of the incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim's employer has 50 employees. The company, which has been in operation for 9 years, uses laser equipment for precision cutting, drilling, and welding. Safety orientation is provided to new employees, but a written comprehensive safety program does not exist. In 1986, the victim received safety training from the laser manufacturer, including instruction in high-voltage safety procedures.

SYNOPSIS OF EVENTS

On the afternoon of February 25, 1988, a laser operator reported an electrical output problem with the laser he was using. The problem was referred to the maintenance supervisor (the victim) . The victim and his assistant arrived at the work area and told the operator to stop the operation, but not to shut down (de-energize) the equipment. The victim stated that the problem would be visible once he opened the high-voltage control cabinet. The high-voltage cabinet contains rectifiers, step-up transformers, capacitors, and other equipment that converts alternating current (AC) into direct current (DC), and increases voltage to supply 22,000 volts to the ultraviolet laser. The assistant questioned the victim about safety procedures to be used in opening the cabinet. With the laser, the manufacturer had included an 11-step safety procedure calling for de-energizing the cabinet prior to performing repairs. Although the victim had received specific training from the manufacturer on the procedure, he failed to follow these guidelines.

The victim opened the cabinet door and slid out a drawer containing conductors. The drawer was designed to be held in place by four screws and a cover panel, also held in place by four screws. An installed safety device (interlock) was designed to automatically de-energize the equipment when the screws and cover panel were removed. However, the screws and cover panel had been previously removed and the safety device had been made inoperable during previous maintenance work. As a result, the victim was exposed to energized conductors in the open drawer.

The victim removed a metal precision screwdriver from his pocket to point out the problem area to the assistant. As he pointed, he inadvertently contacted an energized conductor with the screwdriver and created a path to ground for the electrical current. The current entered the victim's right thumb and index finger, passed through his chest, and exited through his left foot. The victim suffered cardiac arrest due to electrocution, and fell to the floor.

A local emergency medical service (EMS) was notified. In the interim, an employee who worked for another company in the same building, administered cardiopulmonary resuscitation (CPR). When the EMS personnel arrived 6 minutes after being called, they found the victim unresponsive, and without a pulse. Basic life support was started, defibrillation was attempted, and the victim was transported to the hospital (5 minutes driving distance) where he was later pronounced dead.

CAUSE OF DEATH

The coroner reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should require that employees follow standard written operating procedures, particularly procedures provided by manufacturers of potentially dangerous equipment.

Discussion: The danger of high-voltage equipment appears to be obvious; the high-voltage control cabinet had signs mounted which included the following phrase: "WARNING! HIGH VOLTAGE - DANGER TO LIFE." Additionally, the manufacturer of the high-voltage laser equipment had provided an 11-step safety procedure, including steps to de-energize the control cabinet when access to the high-voltage control cabinet was necessary. Although the victim had received instructions on the safety procedure from the manufacturer, he failed to follow the procedures. This suggests that passive communication of hazard awareness and safe operating procedures may be ineffective. Management's commitment to safety should include, but not be limited to, a written comprehensive safety program which is instituted, practiced, and enforced.

Recommendation #2: Electrical safety devices should never be altered.

Discussion: An internal safety device securing the drawer containing the energized conductors had been altered and made ineffective prior to the victim's entry. Employers should provide electrical maintenance personnel with instruction in the location, operation, and purpose of all interlock safety devices. This training should emphasize that these devices should not be removed nor altered in any way because they are designed to passively protect workers from the release of hazardous energy. Workers may be tempted to remove or bypass any equipment perceived as non-functional or inconvenient unless management adopts a policy of explaining and enforcing strict adherence to written safety procedures. An inspection/repair program should be instituted by the employer to identify and correct any other safety hazards within the company.

FACE 88-13: Cement Finisher Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On February 25, 1988, a 42-year-old male cement finisher was electrocuted when the metal handle of a cement-finishing bull float he was using contacted a 13.8-kilovolt (kV) power line. The victim then fell 55 feet to a concrete sidewalk.

CONTACTS/ACTIVITIES

State Occupational Safety and Health Administration officials notified DSR of this fatality and requested technical assistance. On March 30, 1988, NIOSH met with employer representatives, conducted a site visit, and discussed the incident with the OSHA Compliance Officer and the county coroner.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim had been employed for the past 7 months by a general construction contractor. At the time of the incident the company employed 450 people. The company has a written safety policy and safety program and provides on-the-job training for all new employees. The president of the company manages the safety program.

SYNOPSIS OF EVENTS

In June 1987, the company began construction of a hospital parking garage in a metropolitan area. The company asked the local utility company to insulate three-phase 13.8 kV power lines in the vicinity of the garage since a crane used for handling materials would be operating nearby. Of the three existing lines, the utility company covered only the line closest to the structure with an insulating sleeve. When the job foreman asked why they had not insulated all three lines, representatives of the utility company replied that they had insulated the line most likely to be contacted.

By February 1988, construction had progressed to the fifth level. The parking garage was designed with a 42-inch-high barrier around the perimeter of each level. This concrete barrier was placed on the floor of each level and served as fall protection. Additionally, a 3-foot-wide walkway with 3-foot-high guardrails was installed around the outside of, but somewhat lower than the barrier.

On the day of the incident, the victim was using an aluminum bull float to finish concrete placed for the floor of the fifth level on the power line side of the structure. The handle of the bull float consisted of two 10-foot sections of aluminum pipe. The fifth floor was at approximately the same level as the power lines, which ran parallel to the edge of the structure at a distance of 14 feet.

At some point when the victim was pulling the bull float toward him, the aluminum handle contacted one of the uninsulated power lines. The victim then fell approximately 55 feet to a concrete sidewalk. Although a hospital security guard heard a man yell and saw the victim falling, no one actually saw the victim fall over the barrier and walkway guardrail. The victim may have been sitting on top of the barrier when the bull float handle contacted the power line. This could explain how he fell over the walkway as well.

The security guard summoned the emergency medical service (EMS) personnel. The EMS personnel transported the victim to the hospital where he was pronounced dead. Meanwhile, a construction worker was stationed as a guard near the bull float since the handle was still lying across the power lines. The electrical utility company personnel arrived approximately 1 hour later, de-energized the lines, and removed the bull float.

CAUSE OF DEATH

The deputy coroner listed the cause of death as electrocution and traumatic injury.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The construction company should conduct separate hazard analyses prior to initiating each distinct phase of the project.

Discussion: The process of construction results in a continually changing worksite. Each phase introduces new hazards or changes the characteristics of existing hazards. Therefore, construction companies should use a phase hazard analysis approach.

Initial notification of the electrical utility company occurred during an early phase of the project, when the primary electrical hazard was the possibility that a crane would contact nearby power lines. The finishing work on the fifth level of the structure introduced additional hazards, including the potential that the bull float handles would extend beyond the nearest insulated line and contact an uninsulated line. Although the job foreman noted that not all power lines were insulated, this observation was not made within the context of a formal hazard analysis. Hazard analysis requires not only the identification of potential hazards, but also the development of methods of eliminating or controlling the hazards.

In this case, the construction company should have insisted that all three power lines be insulated.

Recommendation #2: Upon request, the electrical utility company should routinely insulate all power lines which are in such close proximity to a work area that workers, or their tools or equipment, could potentially contact them.

Discussion: In this incident, only the power line closest to the structure was insulated since it was thought to be more likely contacted. Although electric company representatives may not have foreseen that tools with long, conductive handles (such as bull floats) would be used as the construction progressed, routinely insulating all lines proximate to a worksite is a prudent approach. If all the power lines in this instance had been insulated with sleeves, this death might not have occurred.

Recommendation #3: Tool handles used in proximity to power lines should be constructed of non-conductive material.

Discussion: The bull float handle in this incident was constructed of aluminum, an excellent conductor of electricity. This fatality might have been prevented if the bull float handle had been constructed of a non-conductive material such as fiberglass.

FACE 88-19: **Deputy Sheriff Electrocuted**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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 the fatal injury, and the role of management in controlling how these factors interact.

On February 7, 1988, a 39-year-old male deputy sheriff was electrocuted while attempting to move a 7,200-volt power line which was down across a highway due to a motor vehicle crash.

CONTACTS/ACTIVITIES

Officials of the State Occupational Safety and Health Administration notified DSR of this fatality and requested technical assistance. On April 19, 1988, a DSR research team met with the employer's representative to review this incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a county sheriff's department as a full-time deputy sheriff. The sheriff's department employs 40 full-time and 6 part-time deputies. Each new deputy receives 8 weeks of on-the-job training, as well as 2 weeks of classroom training in law enforcement. The classroom training includes instruction in safety procedures regarding power lines.

SYNOPSIS OF EVENTS

At approximately 1:00 a.m. on February 7, 1988, a car struck a utility pole at a curve on a U.S. highway. The insulator attaching the primary (hot) wire to the pole snapped allowing the primary wire to fall. The energized power line, still attached to the utility poles on both sides of the severed pole, drooped to within a few inches of the surface of the highway. A portion of the broken insulator was still attached to the drooping wire.

A state trooper dispatched to the scene arrested the driver of the vehicle for driving under the influence of alcohol, then secured the area and began to direct traffic with the assistance of a male civilian who had stopped. The state trooper was informed by his dispatcher that the local utility company had been notified of the car crash and the downed line.

As the traffic load increased, the trooper called the local sheriff's department for assistance. A deputy sheriff (the victim) arrived to assist the state trooper and was informed by the state trooper that the utility company was on the way. During subsequent discussion the victim assured the trooper that the downed power line was a ground wire because it was not wrapped with insulation, and therefore, could be safely moved. The deputy grasped the power line and began to carry it to the side of the road. The state trooper was returning to his vehicle when he saw a flash behind him. When he turned around he did not see the deputy and asked the civilian what happened. The civilian stated that when the deputy stepped off the road onto the wet berm the "line got him." He informed the trooper that the deputy had rolled over the bank. The power line had swung back to its previous position. The trooper had his dispatcher summon an ambulance, and then went to the victim and covered him with his overcoat.

Local emergency medical service (EMS) personnel arrived approximately 13 minutes later. EMS personnel performed cardiopulmonary resuscitation (CPR) and advanced life support (ALS), which was continued enroute to the hospital. The victim was later pronounced dead at the emergency room of the hospital.

Utility company personnel arrived at the scene and informed the trooper that the pole was the property of a local electrical co-op. The co-op was notified and subsequently repaired the power line. Investigation by the co-op revealed that the fuse in the disconnect on the pole was operable. Additionally, the breaker for the line, located two poles down from the pole involved in the incident, had never been opened. This meant the line had remained energized throughout the incident.

Why the deputy was not electrocuted when he initially grasped the primary wire is unknown. Since the night was cold with frost, the humidity was very low, and the deputy was wearing thick rubber-soled shoes, he may not have created a path to ground until his soles were moistened by the wet berm. Or, the deputy may have initially grasped the portion of the broken insulator still attached to the line. A 36-inch-high galvanized pole with an attached reflector had been set on the berm of the highway near the point where the incident occurred. The deputy may have intended to attach the primary wire to the galvanized pole to keep it from swinging back over the highway. If so, he may have grasped the uninsulated wire as he approached the galvanized pole. In any case, a brief duration of time apparently elapsed between the moment the victim contacted the wire and/or the insulator and the moment he was electrocuted.

CAUSE OF DEATH

The coroner's report stated that the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Personnel assigned responsibility to coordinate activities at an incident site (e.g., deputy sheriffs, etc.) should follow established safety procedures.

Discussion: The victim had received 2 weeks of law enforcement classroom training sessions, including instruction in power line safety procedures. These procedures require that the utility company be called to de-energize downed power lines before they are moved or otherwise contacted. The victim apparently believed that all energized power lines are wrapped with insulation, and that the bare wire, therefore, was a ground wire that could be safely moved by hand. The current procedure of staying away from downed power lines and calling the power company appears to be adequate if followed; however, in this case the procedure was not followed. Classroom session material should be reviewed to ensure that electrical hazards are being adequately addressed. Also, personnel should periodically review established safety procedures to reinforce initial safety training.

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Recommendation #2: Employers whose workers must routinely respond to emergency situations where exposures to specific hazards can be anticipated, should supplement on-the-job and classroom training with simulation training, or other forms of training which allow an evaluation of the worker's understanding of the hazards.

Discussion: The victim had completed 8 weeks of on-the-job training and a 2-week law enforcement training session upon hire. That the fatality still occurred suggests that the mere communication of hazards may not be adequate to protect all individuals. If the worker will be exposed to specific hazards, the training program should include an evaluation of the worker's understanding of these hazards. One method is to provide simulation training where the worker is faced with a task involving a hazard. Such simulations are commonly used in training police officers to respond to perpetrators with lethal weapons.

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FACE 88-21: Maintenance Worker Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On March 9, 1988, a 20-year-old male maintenance worker trainee died when he contacted an energized conductor in an uncovered electrical junction box.

CONTACTS/ACTIVITIES

State Occupational Safety and Health Administration officials notified DSR of the fatality and requested technical assistance. On April 28, 1988, a safety specialist met with company representatives and witnesses, photographed the incident site, and met with local officials to investigate the incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim's employer was a textile manufacturer producing synthetic fibers. The company has been in existence for 13 years and employs approximately 70 workers. Three workers (including the victim) were maintenance worker trainees. The company has a safety manual that all workers are required to read; however, no task-specific rules and procedures are contained in this manual. The company has had no serious incidents in the past. The victim had been employed by the company for 2 months at the time of his death.

SYNOPSIS OF EVENTS

The victim was a 20-year-old male maintenance worker trainee who performed various types of maintenance operations within the plant.

On the evening prior to the incident, a 440-volt electric motor on a texturing machine was replaced. However, the cover on the electrical junction box supplying power to the motor was not replaced.

On the day of the incident, the victim had the task of replacing a 4-inch flexible plastic suction (vacuum) hose on the texturing machine. First, electrical power to the machine was disconnected. Then the victim climbed a 3-foot-tall metal utility buggy and replaced the hose.

After replacing the hose the victim leaned down and told the operator to turn the machine on so that he could check the new hose for leaks. When the operator turned on the machine, the victim's left hand was in contact with one of the conductors within the uncovered junction box and his stomach was in contact with the metal frame of the texturing machine. The victim cried out and fell from the buggy to the floor. He then rose, walked ten feet to two supervisors, and began to collapse. The supervisors lowered him to the floor.

Two co-workers immediately began cardiopulmonary resuscitation (CPR) while another employee called the local fire department rescue squad. The ambulance and two paramedics were on the scene within 5 minutes of the time of the incident. The paramedics performed advanced cardiac life support while the victim was transported to the local hospital. The rescuers repeatedly checked but observed no vital signs.

The victim was pronounced dead at the local hospital 1 hour and 39 minutes after the incident.

CAUSE OF DEATH

The medical examiner's report gives the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should develop and implement a written, step-by-step hazardous energy control (lockout/tagout) procedure, and ensure that workers use it while performing maintenance on, or otherwise servicing energized equipment.

Discussion: Although the electrical power to the texturing machine was properly disconnected before maintenance work was initiated, a very important step in hazardous energy control was omitted. The operator who re-energized the machine failed to verify that the victim was clear of danger. The use of written, step-by-step procedures is recommended for ensuring that hazardous energy control is effective. Such documented procedures are particularly important when workers are inexperienced and/or performing non-routine tasks. For more information on developing hazardous energy control procedures, see "Guidelines for Controlling Hazardous Energy During Maintenance and Servicing," DHHS (NIOSH) Publication No. 83-125.

Recommendation #2: All companies should have active safety training programs which stress the hazards posed by electrical equipment.

Discussion: In this case no formal safety training program existed. Although he did shut the power off to the machine before he replaced the hose, the victim failed to recognize the hazard posed by the uncovered junction box. A comprehensive safety training program which stressed the hazards posed by electrical equipment could have increased the employee's awareness of these hazards and prevented this fatality.

Recommendation #3: All maintenance and repair work should be performed in a competent manner with follow-up inspection by supervisors to ensure that existing safety features are not by-passed or deleted.

Discussion: The cover on the junction box had been removed the previous evening when the electric motor was replaced. However, the unit was placed back in service with this cover missing. This cover was in an easily accessible area and was readily visible to anyone standing near the machine; nevertheless, no one acted to report or repair this obvious safety hazard. If this cover had been replaced as required by the National Electrical Code, 370-18 (c), this fatality would not have occurred. Covers over electrical wiring and contacts provide a passive protection against electrical hazards.

FACE 88-22: **Two Pipefitters Electrocuted**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On March 26, 1988, a 51-year-old male pipefitter/welder and a 36-year-old male pipe welder died when a crane they were using to move a metal building contacted an energized overhead power line.

CONTACTS/ACTIVITIES

State Occupational Safety and Health Administration officials notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. On March 27, 1988 a research safety specialist met with state officials and company officials. Witnesses to the incident were interviewed and the incident site was photographed.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim's employer was a plumbing/pipefitting contractor with 32 employees. Although the employer has been in business for 9 years, the company has no formal safety program. Instead, the employer relies upon the large corporations for which they work to provide safety training for employees. The employer had never before had a serious incident.

SYNOPSIS OF EVENTS

On the day of the incident, a five man crew was working at a large multi-national chemical corporation plant. The crew was using a rented 58-foot, 7 1/2 ton crane to move various tanks and other equipment within the chemical company compound. The victims were new employees, having only worked for the employer for 4 days. The other three crew members all had several years of experience with the employer and had worked at the chemical plant numerous times in the past. Because they had previously worked at this plant, the experienced men were all familiar with the overhead power lines in the area where they were working.

At the time of the incident the crew was moving a 30 foot by 10 foot by 8 foot high welding shed. This shed consisted of a pipe and angle iron frame supporting a corrugated metal roof. The structure was open, with welding "tarps" forming the sides of the building. Just prior to the incident, the building had been moved approximately 100 feet to its location beneath the power lines.

The building had been set down in a north-south orientation; the final position was to be east-west. Placing the structure in an east-west orientation required lifting the building and then rotating it manually. A 12.4-kilovolt (kV), three-phase power line was suspended 27 feet above the ground at this point, with a ground wire and a telephone wire suspended 16 1/2 feet below the energized power lines. Approximately 20 feet behind these lines ran an additional series of utility poles containing numerous service lines.

To prepare for the final lift, the building was disconnected from the crane, the boom on the crane was extended between the ground/telephone wires and the power lines, and one member of the crew climbed onto the roof of the shed to reconnect the crane's hoist cable to the chains being used to lift the building. At this time, the distance between the end of the crane's boom and the "ball" on the hoist cable at the top of the hook was approximately 8 feet.

The crew then took up positions for turning the building 90 degrees, with the foreman at the northeast corner, one worker (victim) at the southeast corner, another worker (victim) at the southwest corner, and a third worker on the west side approximately 5 feet north of the southwest corner. The foreman and the victims were holding the steel pipes forming the corners, while the worker on the west side was grasping a piece of 6 inch angle iron which served as a lower brace for the building.

The foreman was holding the corner post through the "tarp", which he had pulled back for visibility. He was wearing work boots with thick rubber soles and was standing on asphalt. One of the two victims was wearing cloth work gloves, while the other had unprotected hands. Both victims were wearing neoprene soled work boots and were standing in grass. The worker at the side of the building was wearing leather gloves and work boots with thick rubber soles, and was standing on asphalt. The crane operator, another pipefitter, was standing on the control platform near the front of the crane.

When the foreman gave the order to lift the building, the crane operator elevated the boom instead of operating the winch. The building rose approximately 4 feet and the boom contacted an energized overhead line, establishing a "path to ground" (7200 volts phase to ground). The foreman felt a "tingling" and saw the victims "smoking." He cried out to the crane operator who began to retract the boom. By this time, the overhead line had burned in half and fallen to the ground.

The victims collapsed to the ground. Both men suffered extensive burns. Chemical company personnel attempted to revive the victims by administering cardiopulmonary resuscitation (CPR), but were unsuccessful.

The worker standing at the side of the building suffered a dime sized burn on the middle finger of his left hand (through his leather work glove) and numerous burns on the outside of his right foot (through a heavy white work sock and the leather uppers of his boot). He was released from the hospital 2 days after the incident, still experiencing some problems with cardiac arrhythmia.

The foreman and the crane operator were uninjured.

CAUSE OF DEATH

The medical examiner's report specified electrocution as the cause of death for both victims.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Cranes and other boomed vehicles should not be operated in the proximity of energized power lines.

Discussion: 29 CFR 1926.550 (a)(15)(i) prohibits the operation of cranes within 10 feet of energized power lines of less than 50 kV. Had this requirement been followed, this incident would not have occurred.

Recommendation #2: Only trained and experienced operators should be permitted to operate powered equipment.

Discussion: The operator in this incident was a pipefitter and had no formal training in the operation of cranes. A more experienced operator could possibly have foreseen the danger posed by the lines and may have used different techniques to move the building. For example, in the above case the building could have been moved into the required position with the boom of the crane actually below the telephone/ ground line. Training for operators of all types of equipment is required by 29 CFR 1926.20 (b)(4). If this training had been given, this fatality might not have occurred.

Recommendation #3: Employers should ensure that their employees receive training addressing the hazards in their work environments, and that these employees fully understand the potential consequences of underestimating or otherwise failing to control such hazards.

Discussion: This employer had no formal safety program. Instead, employees were expected to abide by the programs in place at the various facilities where they were performing their jobs. The employer's responsibility in this area is clearly defined in 29 CFR 1926.21(b)(2).

Recommendation #4: When a job requires working in proximity to power lines, employers should ask the local electrical utility company to de-energize and ground such lines, and verify that they have, in fact, been de-energized. (See 29 CFR 1926.550(a)(15)).

Discussion: Moving the shed required working near the power lines, however, the lines were not de-energized. The employees working in the area, while aware of the presence of the lines, were unaware of the danger they posed. In interviews after the incident one of the surviving workers said they "knew it was a ground wire because it was not insulated." In actuality, all of the wires on the pole, both "ground" and "live" were uninsulated, as are most high voltage lines.

FACE 88-23: Lineman Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 7, 1988, a 41-year-old male journeyman lineman with 23 years' experience was electrocuted when his hands contacted both sides of a switch on a pole-mounted capacitor bank.

CONTACTS/ACTIVITIES

State Occupational Safety and Health Administration officials notified DSR of this fatality and requested technical assistance. On June 21, 1988, a DSR research team conducted a site visit and met with employer representatives to investigate this incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was an employee of an electrical contractor that has been in operation for over 19 years. The contractor employs 300 workers, including 17 journeyman linemen. The contractor has a written safety policy, a comprehensive safety and training program, and a full-time safety officer. The employees receive periodic training and re-training. Daily tailgate safety meetings, including discussions on safe work procedures for hazard control, are conducted at the job site. Additionally, the safety officer visits each crew at least once a week to conduct a site evaluation and crew safety meeting.

The employer has developed a list of "absolute don'ts" as their primary job site safety rules. These rules are carefully explained to the workers. This list includes items such as: 1) do not begin work before truck and equipment are properly grounded, and 2) do not enter a bucket without all personal protective equipment in place. A violator of these "absolute don't" rules is sent home upon committing an infraction two times. The third infraction warrants dismissal.

The employer implements an additional safety measure at job sites. Multiple grounding of all trucks and equipment is required in an effort to prevent electrocutions due to inadvertent energization of this equipment. This procedure is not required by legal or consensus standards, but is felt by the company to be essential in reducing workers' risk of injury during line work.

SYNOPSIS OF EVENTS

Development in the metropolitan area where the incident occurred, had increased the load on the existing 7200-volt distribution system causing voltage dips in the supply. In order to correct this problem, the local electrical utility company contracted the employer to install pole-mounted capacitor banks and connect them to the system.

On the day prior to the incident, a crew had installed a pole-mounted capacitor bank, but had not connected it to the system.

On the day of the incident, the victim and a crew leader arrived at the site to connect the capacitor bank. They first held a tailgate safety meeting just prior to the arrival of the company safety director to conduct his weekly site safety evaluation and meeting. Following the meetings, the safety director told the victim that the day was going to be extremely hot. He instructed the victim to take all the extra time and precautions necessary to complete the job safely, and to drink plenty of fluids.

By approximately 7:30 a.m. , the truck had been grounded, line hoses and blankets were in place, and the victim, wearing his required personal protective equipment, had begun work. At approximately 11:50 a.m., the victim notified the crew leader that his hands were cramping and that he was very hot. The crew leader instructed the victim to take a break and get a drink while he called the utility company to ask a technical question on the electrical hook-up of the capacitor bank. The victim lowered himself to the ground and removed his gloves, hanging them on hooks in the basket.

The crew leader then turned away and walked toward a pay phone approximately 100 feet away. The crew leader had walked about 50 feet when he heard an electrical arc. He turned to see that the victim had raised the bucket up to the power lines. The victim was upright in the bucket but leaning backwards. His gloves were still hanging on the hooks on the bucket. The crew leader ran to the truck and lowered the bucket. He pulled the victim from the bucket and immediately began cardiopulmonary resuscitation (CPR). When he could detect no pulse, he called his dispatcher to summon the emergency medical service (EMS). He then returned to the victim and continued CPR with the assistance of a passing motorist who had stopped. The EMS arrived and transported the victim to the hospital where he was pronounced dead-on-arrival.

Electrical burns on the victim's hands and a switch at the capacitor bank indicate that the victim's left hand contacted the jaw of the switch and his right hand contacted the base of the switch. The current passed across the victim's chest causing the electrocution. No explanation could be given as to why the victim raised the bucket or why he had his gloves off. During his 23 years as a lineman he had a perfect safety record.

CAUSE OF DEATH

The medical examiner reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Personal protective equipment should be evaluated under different environmental conditions while employees perform tasks.

Discussion: A review of the employer's safety program reveals that the employer is taking every step to ensure safety of their workers. In this case, an environmental factor (extreme heat) may have contributed to the death. The personal protective equipment (gloves) were uncomfortable under these circumstances and because the worker did not use the gloves, he was electrocuted. Whether this was intentional (due to the discomfort) or unintentional (due to stress induced by the heat) is unclear. Personal protective equipment should be designed so that it is comfortable and easy to use under all environmental conditions a worker might be exposed to.

FACE 88-24: Laborer Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 8, 1988, a 23-year-old male laborer was electrocuted when he contacted a 115-volt power source while adjusting the limit switches on an overhead door opener.

CONTACTS/ACTIVITIES

State Occupational Safety and Health officials notified DSR of this fatality and requested technical assistance. On June 22, 1988, a DSR research team met with employer representatives to review this incident and photographed the motor operator wiring panel involved in the incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a company that installs and maintains overhead doors. The company has been in operation 37 years and employs 26 people. The company has no written safety policy or safety program; training is provided on-the-job. Since the incident, the company has obtained electrical safety pamphlets for all workers and is in the process of establishing a safety training program.

SYNOPSIS OF EVENTS

Two months prior to the incident, the company installed a 14-foot overhead door at a manufacturing plant. The door was subsequently struck by a piece of machinery and damaged. The victim and his crew leader were sent to replace the two damaged bottom panels of the door and adjust the limit switches so that the door would open and close properly. After the damaged door panels were replaced, the crew leader began to adjust the limit switches.

The limit switches were located in the lower portion of the door opener below the motor operator wiring panel. The voltage of the motor operator wiring panel was 115 volts. The voltage was stepped down to 24 volts in the lower portion of the door opener where the limit switches were located.

A 25-foot aluminum extension ladder was used to reach the limit switches. The crew leader stood on the ladder, removed the door opener cover, and began to adjust the limit switches. The victim periodically raised and lowered the door by operating the control switch at ground level to test the adjustments. The crew leader informed the victim that he needed a different screwdriver, then descended the ladder and went outside to his service truck. When he returned the victim was standing on the ladder. The victim told the crew leader to clean up the area while he made the final adjustments. As the crew leader began to gather the tools he heard a groan and looked up to see the victim on the ladder, but slumped forward into the door opener. The crew leader ran into the next room to throw the power switch and de-energize the door opener. When he returned he found the victim slumped forward in a sitting position on the ground. The victim was bleeding profusely from a cut on his forehead and right cheek.

Manufacturing plant personnel summoned the emergency medical service (EMS) and a medical doctor whose office was next door. When the doctor arrived (within 2 minutes) the victim had no vital signs. Cardiopulmonary resuscitation (CPR) was initiated and continued enroute to the hospital by EMS personnel. The victim was pronounced dead on arrival.

Although there were no eyewitnesses to the incident, circumstantial evidence suggests that the victim contacted the 115-volt power source with his right arm. As a result, current passed through his chest and legs to the ladder and to ground. When he lost consciousness and slumped forward, his head struck the sharp edge of the door opener causing the facial lacerations.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All workers required to work near electrical equipment and/or circuits, particularly those which must remain energized, should be trained to: 1) recognize associated hazards, and 2) employ effective, documented control methods and safe work practices to prevent contact.

Discussion: NIOSH recognizes the need to perform certain maintenance and troubleshooting tasks on energized equipment. However, to maximize safety, procedures for performing such tasks should be developed, tested, and documented. Workers should be trained to recognize hazards and to use established control methods, including safe work procedures (Guidelines for Controlling Hazardous Energy During Maintenance and Servicing, DHHS (NIOSH) Publication No. 83-125).

The victim had 5 years' experience in installing overhead doors and adjusting the limit switches. Apparently, however, he did not realize the hazards associated with working around energized circuits. The victim was working on a 24-volt circuit, but was directly below a 115-volt circuit. OSHA Standard 1926.416(a)(1) prohibits an employee from performing work in such proximity to any part of an electric circuit that the employee might contact in the course of work.

Additionally, the victim was standing on an aluminum ladder, which is an excellent conductor of electricity. OSHA Standard 1926.450(a)(11) prohibits the use of aluminum ladders for electrical work. Workers involved in the installation and maintenance of door openers are required to work in the vicinity of electrical circuits. These workers should receive training in safe electrical work practices.

Recommendation #2: A means to de-energize the door opener should be installed within reach of the opener.

Discussion: The employees in this company routinely adjusted the limit switches with the door opener circuitry energized. One reason is the lack of access to the means for disconnecting the circuit. A disconnecting device such as a simple toggle switch incorporated into the wiring of the door opener and within reach of the opener would provide access. After the worker on the ground has raised and lowered the door to test the limit switches, the worker making the adjustments could de-energize the door opener and make further adjustment if necessary. Since the incident, the company has required this disconnecting means in all new contracts.

FACE 88-25: Apprentice Lineman Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 20, 1988, a 23-year-old male apprentice lineman was fatally injured when he contacted a 13.2-kilovolt (kV) line

CONTACTS/ACTIVITIES

On June 21, 1988, a state Occupational Safety and Health Program official notified DSR of this fatality and requested technical assistance. On June 22, 1988, NIOSH met with a co-owner of the company, discussed the incident with the OSHA compliance officer, photographed the incident site, and interviewed a witness who was working with the victim at the time of the incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was an apprentice lineman working for an electric utility construction company. The company has been in business for 11 years and currently employs 54 employees, including 12 linemen. The company uses a state-approved electrical safety plan and provides on-the-job training to employees. The company owners and crew foremen are responsible for administering the safety plan. The victim had been in training as an apprentice lineman for approximately 3 weeks. Two other company employees had been killed on the job during the past 6 years.

SYNOPSIS OF EVENTS

The electric utility construction company was contracted to relocate power lines prior to the widening of a highway. On June 20, 1988, a crew of five employees (a foreman, a lineman, an apprentice lineman, a groundman, and an operator) were given instructions to relocate power lines on a number of utility poles. The crew foreman held a morning tailgate meeting during which work details, including safety procedures, were discussed.

The crew divided into three work groups. One group consisted of the foreman and operator. Another group consisted of the groundman and apprentice lineman (the victim). The lineman worked by himself. The first task was to de-energize the power lines leading to the intersect pole from both sides to allow the apprentice lineman to work on the pole.

The lineman climbed and positioned himself on an adjacent utility pole approximately 150 feet from the intersect pole. He then began de-energizing power lines leading to the intersect pole. The foreman and operator positioned themselves approximately 150 feet on the other side of the intersect pole and also began de-energizing power lines leading to the intersect pole. The apprentice lineman, who had been verbally instructed to stay on the ground until the lines were de-energized, climbed the intersect pole. The groundman asked the victim why he was climbing the pole. The victim replied that he "wasn't going up the pole too far."

The victim either assumed the power lines had been de-energized or didn't realize his position relative to the lines. Although wearing personal protective equipment (a hard hat, insulated gloves and sleeves, climbers, and a safety belt), he contacted a power line with the back of his neck as he climbed. A path to ground was created through his neck, torso, leg and knee, which was in contact with the pole.

The groundman saw the victim slump and ran to get the foreman. The foreman immediately climbed the pole and lowered the victim to the ground. He administered cardiopulmonary resuscitation (CPR) until the emergency medical service (EMS) personnel arrived approximately 8 minutes later. The victim was transported to the local hospital (approximately 5 minutes away) where he was pronounced dead on arrival.

CAUSE OF DEATH

The coroner reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should evaluate all components of the safety plan now being used and ensure that employees understand fully the nature of electrical hazards, and the methods for controlling them.

Discussion: Even though the employer uses a state-approved safety plan and the victim had been instructed on safety procedures the day before the incident, the fatality still occurred. Additionally, the employer experienced two other electrical-related fatalities in the previous 6 years. This suggests that passive communication of hazard awareness and safe working procedures may be ineffective. The apprentice lineman violated standard operating procedures when he climbed the intersect pole before being notified that the power lines were de-energized. If established safe work procedures had been followed, this incident would have been prevented. The employer should evaluate the safety plan currently used, modify the plan where necessary, instruct employees in the proper procedures outlined in the plan, and enforce the requirements strictly.

FACE 88-26: Yard Maintenance Worker Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 14, 1988, a 33-year-old male yard maintenance worker died when a crane moving the beam he was guiding contacted an overhead power line.

CONTACTS/ACTIVITIES

The county coroner contacted DSR about this fatality and requested technical assistance. On June 28, 1988, a safety specialist discussed this incident with officials from the coroner's office, met with the employer's representatives, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small business engaged in erecting structural steel. The company has been in business for 11 years and currently employs 13 individuals. The victim was the only yard maintenance worker. The company has no written safety policy or written standard operating procedures for any of the tasks performed by employees. All employees are trained on the job.

SYNOPSIS OF EVENTS

The victim and one co-worker were assigned the task of cleaning up the yard where construction materials and equipment are stored. This yard is located in a remote area approximately 2 miles from the company office and shops. The cleanup involved placing several steel "I" beams into one stack.

On the day of the incident the victim and his co-worker, one of the company's regular mobile crane operators, reported for work at noon, and drove to the yard to begin their assigned task. The site selected by the workers for the stack of beams was directly beneath an overhead power line. The crane operator had the boom to its full 70-foot length. The victim rigged a beam to the crane and the crane operator raised it approximately 3 feet above the ground and began to move it toward the selected site. The victim was guiding the beam with his left hand when the crane boom came into contact with the highest overhead power line wire. The crane and the beam became energized upon contact with the 13-kilovolt (kV) line. The victim became the "path to ground" as current passed from his hand through his arm, chest, right leg, and right foot. When the crane was moved from contact with the overhead line, the victim collapsed. The victim was conscious and talking immediately after the incident, and complained of difficulty in breathing. While help was being summoned, the victim lapsed into unconsciousness.

Cardiopulmonary resuscitation (CPR) was performed by rescue squad personnel at the scene and enroute to the hospital. The victim was pronounced dead on arrival at the hospital. The victim had burns on the fingers and palm of his left hand and on the toes of his right foot.

CAUSE OF DEATH

The coroner's office listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All employers should develop and implement a safety program to protect their employees (required by 29 CFR 1926.20).

Discussion: This employer had no formal safety program. There were no standard operating procedures for any of the tasks performed. In addition, no provision was made for any formal training or verification of the ability of employees to perform the tasks to which they were assigned.

Recommendation #2: The employer should conduct job site surveys prior to the start of any operation to ensure that all involved employees are aware of the hazards associated with their tasks.

Discussion: A pre-job survey in this case would have revealed the presence of the power lines. The beams could have been relocated in some other manner. The crane operator had previously worked in this same area and should have been aware of the presence of the overhead power lines.

Recommendation #3: Employers should make every effort to ensure that cranes are not operated in the proximity of overhead power lines unless it is absolutely necessary.

Discussion: The yard where this incident occurred is an open field, bordered by a road on one side. The overhead power lines follow the right-of-way of this road. The steel beams could easily have been stacked in another area away from the overhead lines. During the inspection of the site it was noted that pre-cast concrete slabs had previously been placed near the incident site, also under the overhead lines. As with the steel beams, these slabs could just as easily have been placed in the open part of the field away from the overhead lines. The storage of materials which are handled by crane beneath overhead lines increases the likelihood of an incident such as this occurring.

Recommendation #4: Employers should ensure that adequate clearance is maintained between cranes and nearby overhead power line.

Discussion: 29 CFR 1926.550(a)(15) requires that a minimum clearance of 10 feet be maintained between cranes and power lines of 50 kV or less. In addition, this standard calls for an observer to be posted to give warning whenever it is difficult for the operator to maintain the required clearance by visual means. None of these actions were taken in the above case.

Recommendation #5: Employers should train their employees in the proper operation of the equipment they are required to operate.

Discussion: The crane operator in this case had received no formal training in the operation of the mobile crane. He had worked as a crane "operator" for only 1 year prior to this incident. His lack of experience in crane operations is demonstrated by the fact that the crane's boom was extended to its full 70-foot length for a move of only 20 feet. This move could have been accomplished with the boom retracted preventing potential contact with overhead lines.

FACE 88-28: **Asbestos Worker Electrocuted**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On July 6, 1988, a 23-year-old male laborer on an asbestos removal crew died when he contacted an exposed overhead conductor in a utility tunnel.

CONTACTS/ACTIVITIES

Officials of a state Industrial Commission notified DSR of this fatality and requested technical assistance. On July 11, 1988 a safety specialist from DSR and representatives of the Industrial Commission visited and photographed the site, and met with representatives of the property owner and police, fire, and ambulance squad personnel.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this case was an asbestos abatement contractor with 30 employees. The company has been in business for 3 years. Company safety training focuses on asbestos removal procedures; however, other hazards likely to be encountered in the course of this work are not addressed.

SYNOPSIS OF EVENTS

The victim and a co-worker comprised one of two 2-man teams removing asbestos from steam lines in a utility tunnel which serves a large educational facility with numerous buildings. The tunnel is approximately 55 inches high by 52 inches wide and runs in a north/south direction. The steam lines run along the east wall of the tunnel. The west wall of the tunnel is covered with numerous heavy electrical cables and signal wire sets. A walkway approximately 36 inches wide extends down the center of the tunnel. Four separate, insulated wires suspended from individual insulators run along the top of the tunnel directly above the walkway. This wiring serves as the power supply for numerous 110-volt light bulb sockets hanging down on flexible conductors ("pigtails") at intervals along the tunnel. At the time of the incident, one of the "pigtails" did not have a light socket attached. Therefore, bare, energized conductors were hanging down over the walkway from the wiring circuit.

The victim was removing insulation containing asbestos from the stem lines within the tunnel, while his co-worker was following behind him bagging the insulation. During removal activities, the victim's shoulder contacted the exposed conductors hanging from the roof of the tunnel. A path to ground was established from the victim's shoulder through his right arm which was in contact with the steel steam line. The co-worker, who heard the victim yell and saw that he was in contact with the overhead wires, used his body to knock the victim away from the wires. The victim collapsed to the floor of the tunnel.

The co-worker then called the other crew to help remove the victim from the tunnel. The closest way out of the tunnel was the entry to a basement about 57 feet from the incident site. The workers dragged the victim to this entry, took down the plastic containment wall isolating the tunnel from the basement, and removed the victim from the tunnel. A university police officer who was in the basement heard the men and reported the incident via radio to his dispatcher, who called the local fire department and emergency medical service (EMS) unit. The EMS unit and the fire department were on the scene 6 minutes later. Cardiopulmonary resuscitation (CPR) was initiated at the scene and continued while the victim was transported to the local hospital. The victim was pronounced dead at the hospital 57 minutes after the police officer initially reported the incident.

[NOTE: Co-workers and rescue personnel stated that the victim was wet with perspiration at the time of the incident. The high ambient temperature in the tunnel and the protective clothing required for asbestos removal work combined to create a hot working environment for the removal crew.]

CAUSE OF DEATH

The coroner's office reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Job site surveys should be conducted prior to the start of all construction/ demolition projects to ensure that hazards within the area are identified, employees are informed of the hazards, and methods of eliminating or controlling the hazards are implemented.

Discussion: The suspended wires for the lighting circuit should have been identified as potentially hazardous. The bare conductors on the "pigtail" involved in this incident would have been detected if a survey of the actual job site had been performed prior to the start of this project. Once the hazard was identified, corrective action could have been taken to prevent this fatality from occurring.

Recommendation #2: In an area where asbestos removal work is being performed, electrical equipment should be de-energized whenever possible. If the equipment cannot de-energized, workers should be isolated from potential contact with the energized lines or equipment.

Discussion: Workers performing asbestos abatement work typically wear personal protective clothing which serves to trap body moisture within the suit. In addition, it is standard practice in asbestos removal work to use "wet" removal techniques in which a surfactant-treated water mixture is used to saturate the asbestos-containing materials to control the release of asbestos fibers. The combination of a wet environment and energized electrical circuits or equipment sets the stage for potential disaster.

In this case, the victim was wet with perspiration when the contact with electrical energy occurred. The resistance of the human body to electrical energy (as high as 100,000 ohms when the skin is dry) may be reduced to 1,000 ohms when the skin is wet. This reduced resistance results in the potential for a much greater current flow through the body than would otherwise occur, significantly increasing the potential for a fatal electrical shock.

Shutting down the major electric lines which run through this tunnel was not feasible since they control power to half of the campus; however, these armored cables posed a relatively small threat to the workers.

Plastic sheeting along the side of the tunnel could have been erected to isolate these lines from the workers. The lines which actually caused the fatality served only to provide lighting for the tunnel. These lines could have been de-energized prior to the start of the project and a substitute lighting system utilizing ground fault circuit interrupters (GFCI's), battery powered lights, or similar safe system, could have been installed to ensure worker protection.

[NOTE: Further information on electrical hazards encountered during asbestos abatement work is included in Appendix D, "General Safety Considerations," of A Guide to Respirator Selection for the Asbestos Abatement Industry, a joint publication of NIOSH and the Environmental Protection Agency (Doc. # EPA-560-OPTS-86-001).]

Recommendation #3: Property owners should periodically inspect all areas of their facilities and grounds for the purpose of identifying safety hazards. Unsafe conditions identified during such inspections should be corrected and potential hazards should be controlled in a timely manner to prevent injuries.

Discussion: The lighting circuit in the utility tunnel was an outmoded type of single insulated wire suspended upon individual insulators. The light sockets that hung down from these wires were otherwise unsupported. As a result, the insulation on the wires, as well as the unguarded light bulbs, were subject to damage.

The bare conductors which caused the fatality posed a threat to anyone using the tunnel. A comprehensive safety inspection program conducted by the property owner would have revealed these hazards. Corrective action could have been taken to protect both the employees of the property owner and contract personnel working in or moving through the area.

FACE 88-31: Welder/Pipefitter Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On July 20, 1988, a 26-year-old male welder/pipefitter died when he contacted an energized electrical conductor, was electrocuted, and fell to a concrete floor 29 feet below.

CONTACTS/ACTIVITIES

State officials notified DSR of this case and requested technical assistance. On August 11, 1988, a research safety specialist conducted a site evaluation, met with the county coroner and company officials, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a pipefitting and steel erection company with 15 employees. Six other employees perform the same type of work as the victim. The victim had received training at a local technical school and on the job. The company had no formal safety program in place.

SYNOPSIS OF EVENTS

The victim was a member of a crew involved in the assembly and installation of a large steel storage rack in a carpet warehouse. The top of the 29-foot-high rack formed an open-sided platform. Safety belts and lanyards were available but were not being used by employees. A row of 23 6-foot-long fluorescent light fixtures was located 2 feet above the rack; one additional fixture was mounted beyond the end of the rack. The lights were wired so that every fourth fixture was on a circuit that provided "nightlights" in the warehouse. The temperature in the warehouse was high due to the summer weather.

The victim was helping one co-worker (an electrician) remove these light fixtures at the time of the incident. The main power supply to the lights had been disconnected; however, the power for the "nightlights" had not been disconnected and these units remained on during the entire operation.

The electrician and the victim had removed all the fixtures above the storage rack including those on the "nightlight" circuit, which were removed while still energized. The electrician used insulated hand tools to remove the lights from the energized circuit, leaving the energized "pigtail" hanging from the joist-supported conduit. The final fixture could not be reached from the rack. The electrician told the victim they would remove the remaining light after the cluttered area below was cleared so that a hydraulic manlift could be used. The electrician left the room, leaving the victim on the rack to gather the tools.

When the electrician returned, he observed the victim sitting on a bar joist of 2-inch angle iron preparing to remove the remaining light. The electrician told the helper to get down, but the victim replied that he was almost finished, and cut the energized 110-volt power lead for the light with a pair of uninsulated metal wire cutters. A path to ground was established from the victim's hand (holding the wire cutters) to his legs which were in contact with the metal joist. The victim was electrocuted and fell from the joist to the concrete floor 29 feet below, landing on his head.

Cardiopulmonary resuscitation was begun within 2 minutes of the incident; however, when local emergency medical personnel arrived they were unable to find any vital signs. The incident occurred at approximately 5:00 p.m. and the victim was pronounced dead at the scene at 5:53 p.m. by the county coroner.

CAUSE OF DEATH

The coroner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that all employees are adequately trained for their assigned tasks.

Discussion: The victim in this case had formal vocational training as a welder/pipefitter; however, at the time of the incident he was working as an electrician's helper. He did not understand the hazards of electrical work or he would not have cut an energized electrical conductor with uninsulated wire cutters. A knowledge of the danger posed by this act could have prevented this incident. Employees should also be trained in the use of "lockout" procedures to ensure that all electrical conductors are de-energized.

Recommendation #2: Employers should ensure that hazards in a work area are identified and proper control measures are implemented and explained to the employees prior to the start of work. In addition, employers should periodically monitor the performance of their personnel to ensure that safe work practices are followed.

Discussion: The employer failed to identify the problem posed by two separate circuits servicing the light fixtures in the warehouse. While the one circuit was de-energized, the second was allowed to remain "hot" throughout the job. In this case, the second circuit should have been de-energized and locked out to prevent re-energization while the workers were exposed to contact with the conductors. This measure may have prevented this death. The victim and his co-worker had already removed several energized lights while working from steel decking. With only a 2-foot clearance between these lights and the metal decking it is fortunate that the employees had not previously contacted the energized "pigtails."

Recommendation #3: Employers must ensure that personal protective equipment appropriate for the hazards encountered is both available to and used by workers. All tools and other equipment should be appropriate for the work being performed.

Discussion: Employees assigned electrical work should be provided with and required to use appropriate insulated tools. In addition, employees required to work from elevated workstations should be provided some form of fall protection. Employees in this case were working from an open-sided platform 29 feet above a concrete floor. Although safety belts and lanyards were available, they were not used by the workers during actual job operations. The victim's safety belt was found in the manlift following the incident. Although the coroner listed the victim's cause of death as electrocution, both workers were exposed to a fall hazard without appropriate fall protection.

FACE 88-32: **Welder Electrocuted by Contact with an Energized Overhead Crane Conductor**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On July 9, 1988, a 41-year-old male welder died when he came in contact with an energized overhead crane contact conductor and was electrocuted.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On August 10, 1988, a research safety specialist met with company officials, and visited and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a multi-state corporation specializing in steel fabrication. The company employs 490 individuals, a majority of whom work in welding operations. The company has a comprehensive written safety program and provides formal safety training programs for its employees. The victim had been employed by the company as a welder for more than 16 years.

SYNOPSIS OF EVENTS

The victim had worked a production shift from 5:00 a.m. to 12:00 noon on the day of the incident. He and one co-worker were asked to work overtime with their supervisor to add reinforcing steel to the bridge of an overhead crane.

The men were working on one of three rail-mounted, overhead-traveling cranes which run the length of the 600-foot shop building. Directly below these units is a smaller rail-mounted crane which serves only one end of the shop (approximately 150 feet). Power for the three large cranes is provided, via collector leads, by a 440-volt 3-phase circuit composed of three bare copper contact conductors which run below the cranes for the length of the building. An identical power supply for the small crane runs parallel to, and about 8 feet below these conductors.

Power for the large crane had been disconnected prior to the start of work. The small crane had not been used that day and was not involved in the repair work being performed. The supervisor who was normally in charge of the small crane always de-energized it at the end of his shift. However, he went on vacation the day prior to the incident. Unfortunately, the repair workers assumed the small crane had been de-energized.

Since the outside temperature was near 100^0 F, the temperature inside the building may have exceeded 100^0 F. The victim and co-worker completed their task on the overhead crane and lowered their equipment to the supervisor on the floor below. The victim began climbing down a steel lattice column on the east side of the building while his co-worker climbed down a similar column on the west side. After coiling the welding leads on the floor, the supervisor looked up and noticed that the victim had left the column he was descending and was sitting on a crossbrace below the cranes. While presumably resting, the victim moved around and the back of his neck came in contact with one of the small crane's contact conductors. The victim provided a path to ground for the electrical energy, and he collapsed on the crossbrace. The supervisor and the co-worker called to the victim but there was no response. The supervisor disconnected the power to the small crane contact conductors and summoned the local emergency medical service (EMS).

EMS personnel arrived at the scene, reached the victim, but were unable to find any vital signs. The victim was pronounced dead at the scene by the Deputy Coroner 1 hour and 10 minutes after the incident.

CAUSE OF DEATH

The coroner's office listed the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Prior to the start of any new job the employer should review the project for potential hazards. Completion of a job hazard analysis is a viable method of identifying potential hazards and appropriate methods of controlling them.

Discussion: While power to the crane being serviced had been disconnected, the small crane remained energized. The clearance between the columns and the contact conductors was adequate; however, the fact that the workmen would be in the vicinity of these bare energized conductors should have prompted the employer to verify that the small crane conductors were de-energized. Had this precaution been taken, these conductors would have been de-energized prior to beginning work.

Recommendation #2: The employer should require that existing plant safety features be used whenever possible.

Discussion: Normal access to the large overhead-traveling cranes is provided by permanently installed ladders at one location in the building. The ladders are physically isolated from the contact conductors, thereby eliminating the risk of inadvertent contact. The workers failed to move the crane to the ladders, choosing instead to climb the lattice columns. As a result, they were unnecessarily exposed to the unanticipated electrical hazard.

Recommendation #3: The employer should implement Article 610-21(a) of the National Electrical Code entitled "Locating or Guarding Contact Conductors."

Discussion: This Article states "Runway contact conductors shall be guarded and bridge contact conductors shall be located or guarded in a manner that persons cannot inadvertently touch energized current-carrying parts." The National Electrical Code defines guarded as "covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger." The runway conductors were not guarded when this particular incident occurred.

Recommendation #4: The employer should ensure that personal protective equipment appropriate for the hazards encountered is available and used by employees during all work operations.

Discussion: The victim and co-worker were assigned to work in an unprotected area with a fall distance of 25 feet to the shop floor below. A fall to the shop floor, which was covered with numerous pieces of structural steel, could reasonably have been expected to produce serious injury or death. Nevertheless, the employer did not provide fall protection for the employees.

Recommendation #5: Employers should become aware of the potential problems resulting from employee exposure to excessive temperatures, and implement programs to minimize such problems.

Discussion: The two employees working on the crane near the top of the building had been working in excess of 1 1/2 hours in an extremely hot area. This followed a full 8-hour production shift. The effects of extreme temperature may have prompted the victim to stop for a rest during his descent. Additionally, heavy perspiration can lower the skin's resistance to electrical current, increasing the risk of electrocution should contact occur. An "off and on" work schedule, as recommended by the American Conference of Governmental Industrial Hygienists, including rest breaks at regular intervals, would serve to minimize these hazards.

FACE 88-34: Laborer Electrocuted when Metal Work Platform Became Energized

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On August 5, 1988, a 19-year-old male laborer was electrocuted when a metal work platform on which he was standing penetrated the covering of an overhead crane 440-volt contact conductor and became energized.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On August 11, 1988, a DSR safety specialist discussed the incident with the OSHA compliance officers, state officials investigating the incident, the employer, and witnesses. A site visit was conducted jointly by the DSR team, a state investigator, the Human Resources Manager of the plant where the incident occurred, and four safety consultants representing the plant.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a company which installed and serviced security and communication systems. The company employed five workers, three of whom were part-time. The company had no written safety policy or safety program. The victim had been employed for 2 1/2 months and had received only on-the-job training.

SYNOPSIS OF EVENTS

The victim's company had previously installed a security system at the stamping plant where the incident occurred. This same plant recently had an overhead door installed and another door relocated. The security system circuitry had been cut, spliced, and relocated during these structural changes. As a result, the system was inoperable. Personnel from the stamping plant contacted the victim's employer to correct the malfunction.

On the day of the incident, the victim and a co-worker began installing a new wire to correct the problem. Standing on a wooden stepladder, the victim used an electric glue gun and wire ties to fasten the wire to the front wall of the structure. The co-worker fed the wire to the victim from ground level. When they completed the job in the area of the splices, they continued replacing wire in an adjacent area on the front wall of the plant. Though plant personnel stated during interviews only the area of the splices was to be rewired, the employer thought the entire front wall of the structure was to be rewired. After installing approximately 20 feet of wire in this area, they needed to pass the wire over two 24-inch I-beams (serving as the runway for an overhead-traveling crane). These beams were 5 feet apart and perpendicular to the front wall. Three 440-volt energized contact conductors (power source for the 10-ton overhead crane) were anchored to one of the I-beams. There was about a 6-foot clearance between the wall and the end of the contact conductors.

The wooden stepladder was too short to allow the victim to get the wire over the I-beams; he requested and received the plant foreman's permission to have a forklift raise him up to the I-beams. A steel basket 4-feet wide, 5-feet long, with 3-foot-high sides was secured to the forks of the lift. The victim got into the basket and the operator raised it up to the beams. The victim wound the wire into a ball and threw it halfway across the span. The operator then lowered the basket and repositioned the forklift on the opposite side of the beams where the contact conductors were anchored. The operator raised the basket while watching the victim's hand signals. Later, the operator stated that he never watched for clearance between the energized rails and the basket.

As the basket approached the top of the beam the victim signaled the operator to stop. The victim reached over the beam to grasp the ball of wire. Apparently the basket had contacted the energized rail farthest from the I-beam, breaking its anchoring clip and damaging the rail's insulation. When the victim, in contact with the basket, reached out and contacted the I-beam, the current passed across his chest resulting in electrocution. When the operator noticed that the victim was not moving, he lowered the basket. As the basket lowered, the victim fell backwards striking his head on the basket. When the basket reached the ground, the operator and a co-worker observed that the victim wasn't breathing and called for help. A worker at the plant began cardiopulmonary resuscitation until the emergency medical service arrived. Paramedics provided advanced cardiac life support at the plant and then transported the victim to a local hospital where he was pronounced dead on arrival by the attending physician.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Methods of identifying potential hazards and appropriate countermeasures should be utilized during the job planning phase.

Discussion: Confusion existed as to what work was to be completed. Plant personnel thought only one area was to be rewired; the employer thought the entire front wall of the structure was to be rewired. If rewiring the entire wall was necessary, the entire area should have been inspected. The energized crane rails would have been recognized as potentially hazardous, and the plant's lockout/tagout procedures would have been used. These actions may have prevented the electrocution.

Recommendation #2: Supervisors should ensure that employees understand and follow safe work procedures.

Discussion: The Human Resources Manager of the plant stated that the forklift operator had recently completed safety training addressing electrical hazards. Nevertheless, the forklift operator ignored established lockout/tagout procedures while working in proximity to the energized rails. Supervisors must continually stress the importance of following established safe work procedures.

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FACE 88-35: **Assistant Pool Manager Electrocuted**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On July 25, 1988, a 17-year-old female assistant pool manager was electrocuted when she contacted an ungrounded electric motor.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On August 18, 1988, a DSR safety specialist conducted a site visit and discussed the incident with the Occupational Safety and Health Administration (OSHA) compliance officer and an employer representative.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim had worked for 3 months as an assistant pool manager for a municipality. The municipality operates 3 city pools and employs 25 people, including 6 assistant pool managers. Employees receive a 1-week orientation and on-the-job training for assigned tasks. A written safety program describing safety procedures for various operations is also used.

SYNOPSIS OF EVENTS

On August 25, 1988, the victim was performing her assigned duties as assistant pool manager at one of the three municipal swimming pools. At about 1:30 p.m., the victim was told to add soda ash to the swimming pool water to maintain the pH level. This is usually done 2-3 times a day by the pool manager or an assistant. This procedure consists of the following steps:

- fill a plastic drum with 35-40 gallons of water
- plug the mixing motor cord into a 110-volt wall receptacle and turn the mixing motor switch on
- add soda ash to the drum and mix until the soda ash dissolves
- place the motor switch in the off position and unplug the electrical cord
- plug the pump motor cord into wall receptacle and turn the pump motor switch on
- insert the pick-up suction tube into the drum and allow the pump to run until all the solution is added to the swimming pool water (approximately 3 hours)

- place the pump motor switch in the off position after the drum empties.

The event was unwitnessed; however, circumstantial evidence suggests the following scenario. The barefooted victim entered the pump room, which was below ground level, adjacent to the swimming pool. The concrete floor of the room was covered with water at the time of the incident.

The victim filled the plastic drum with water, plugged in the mixing motor, and placed the motor switch in the on position. She was apparently in the process of adding soda ash to the drum when she inadvertently contacted the mixing motor, which had developed a faulty ground and was energized. The victim, standing barefoot in water, contacted the energized motor with her left hand and created a path to ground for the electrical current, causing her electrocution.

At 2:23 p.m., a co-worker was sent to find the victim. As the co-worker entered the pump room she observed the victim slumped over the drum with her face submerged in water. The co-worker summoned help and called an ambulance. Another co-worker tried to remove the victim from the drum but received an electrical shock. A broom was then used to remove the victim. The ambulance and police arrived, and emergency medical personnel checked the victim's vital signs and began cardiopulmonary resuscitation. The victim was transported to the local hospital, 5 minutes away, and was pronounced dead on arrival.

CAUSE OF DEATH

The coroner's report stated that the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: employers should maintain all equipment in safe operating condition.

Discussion: Section 680-25(c) of the National Electric Code (NEC) states, "Pool-associated motors shall be connected to an equipment grounding conductor." An inspection of the pump room revealed that the mixing motor was old and in poor working condition. The grounding pin on the male plug had been removed from the power cord resulting in a faulty electrical ground. Employers should routinely inspect and repair or replace equipment that is faulty, damaged, or presents a safety hazard. An electrical supply cord with the grounding pin intact may have prevented this fatality.

Recommendation #2: All pool area electrical circuits should be installed by qualified electricians in accordance with Article 680 of the NEC.

Discussion: Section 680-24 of the NEC requires that ground-fault circuit-interrupters (GFCI) be installed. In this incident one wire to the GFCI, contained in the junction box and used for the circuit to the wall receptacle, was disconnected. Another wire, the ground conductor to the GFCI, had not been connected and a wire nut had been used instead. Therefore, the GFCI was not functioning as designed. A properly wired and functioning GFCI could have sensed the faulty electrical ground condition and de-energized the circuit, thereby preventing the fatality.

Recommendation #3: The work environment should be free of safety hazards and employers should ensure that workers are aware of the importance of using personal protection equipment.

Discussion: The floor of the pump room was covered with water, increasing the risk of injury or death. In accordance with Section 680-11 of the NEC (Equipment Rooms and Pits), electric equipment shall not be installed in rooms which do not have adequate drainage to prevent water accumulation during normal operation or filter maintenance. Management should ensure adequate drainage of the pump room. Also, all employees entering the pump room should wear insulated boots/shoes. Had the floor been dry and had the victim been wearing insulated boots or shoes, this fatality may have been prevented.

FACE 88-37: Electrician Electrocuted when He Contacted an Energized Wire

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On July 7, 1988, a 31-year-old male electrician was electrocuted when he contacted an energized wire while attempting to install a floodlight on a new residential home.

CONTACTS/ACTIVITIES

On September 8, 1988, NIOSH met with a representative of the employer, discussed the incident with the occupational Safety and Health Administration (OSHA) compliance officer, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a multi-state electrical contractor employing 700 workers, including 350 electricians. The company's safety officer administers a comprehensive written safety program and the company's worksite foreman conducts weekly tailgate safety meetings with all workers. The victim had 2 years' experience as a journeyman electrician and had been working for the company for 4 months.

SYNOPSIS OF EVENTS

On the day of the incident the victim and his foreman were finishing the electrical wiring of an outdoor floodlight located on a side wall of a residential home. The victim borrowed a 35-foot aluminum extension ladder from an employee of another contractor working in the vicinity. He positioned the ladder and climbed to a height of approximately 18 feet, while the foreman stayed on the ground to steady the ladder.

The victim, using insulated wire strippers, began removing the insulation from the "14-2" standard house wiring (i.e., a cable containing two copper wires, size number 14) when his right thumb and right index finger contacted the uninsulated part of the wire stripper. The 110-volt circuit had not been de-energized at the panel box prior to the incident. The victim received an electrical shock and fell to the ground.

The foreman, unsure of what had happened, simultaneously checked the victim's vital signs and requested help from a nearby worker. An ambulance was called while the foreman performed cardiopulmonary resuscitation (CPR) on the victim. The emergency medical service personnel arrived approximately 8 minutes later and continued CPR while transporting the victim to the hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner's report listed electrical injury as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employees working on electrical circuits should always de-energize circuits prior to initiating electrical work of any type.

Discussion: It is not clear whether the victim or foreman realized that the circuit was energized. However, work on electrical circuits should not be initiated until it is determined that these circuits are de-energized and cannot be inadvertently energized. To ensure the circuit remains de-energized during access, a lockout procedure should be used and enforced.

Recommendation #2: An accessible and properly labeled means of disconnecting energy to electrical circuits must be provided and used.

Discussion: The investigation revealed that the panel box containing the circuit breakers to de-energize the circuits was not labeled. Article 110-22 of the National Electric Code requires, "Breaker panels or other means for disconnecting electrical energy should be legibly marked, checked for their correctness, and constantly updated to indicate the corresponding fixtures or appliances that can be de-energized by the breaker, unless the disconnecting means is located and arranged so that the purpose is evident." A clearly labeled panel would have informed the victim how to disconnect the power.

Recommendation #3: Employers should ensure that workers not only receive but understand and follow training in safe work procedures.

Discussion: Although the employer has comprehensive safety rules and procedures and the foreman conducts weekly tailgate safety meetings, the death still occurred. Employers should not only ensure that workers receive training in safe work procedures but that they understand and follow these rules and procedures. A recurring theme emerging from the investigations conducted by NIOSH is that properly trained and licensed electricians still may be electrocuted. Other factors (e.g., timesaving short cuts, over-confidence, monotony, lack of respect for electrical hazards, etc.) may contribute to these electrocutions. Employers should consider these factors in administering their safety programs.

Recommendation #4: Employers should not use portable metal ladders for electrical work or when they may contact electrical conductors.

Discussion: OSHA Standard 1926.450 (a) (11) states that, "Portable metal ladders shall not be used for electrical work or where they may contact electrical conductors." Although the ladder did not contact the energized circuit it did provide a path to ground for the electrical current. If a ladder of non-conductive material had been used in this case, the fatality might have been prevented.

FACE 88-40: **Laborer Electrocuted After Contacting Crane Touching Power Line**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On August 22, 1988, a 56-year-old male construction laborer was electrocuted when he touched the hoist cable of a crane in contact with an energized overhead power line.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On September 7, 1988, a research safety specialist met with company officials, photographed the incident site, and met with local emergency medical personnel.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a multi-state construction company employing 500 workers, including about 175 laborers. The company has been in business for the past 35 years and has been under the present management for the last 5 years. There is a formal written safety program and a designated safety officer. Periodic safety training programs are presented to all employees. The victim had been employed by the company during the past 5 years.

SYNOPSIS OF EVENTS

The victim was a member of a construction crew building an elevated highway entrance ramp. He was removing forms from a concrete retaining wall which had been poured several days previously. As he removed the forms they were placed on a "choker" (a short length of cable with eyes spliced into both ends, which is wrapped around a load, threaded through itself, and hooked to a crane). This worksite was directly beneath an overhead power line.

A co-worker was operating a rough terrain crane with a 65-foot boom in the immediate area. When the victim had finished piling the form material on the choker, he signaled the crane operator to extend the boom to the area where the materials were lying. These materials would then be moved by the crane to another worksite.

The crane operator extended the boom to the desired location and lowered the hoist cable. Both the victim and the crane operator failed to observe that the crane's boom had made contact with an energized 2400-volt overhead power line. The victim looked up, and then reached down to connect the choker to the hoist cable. Immediately after making this connection, he collapsed. When the crane operator observed the victim fall to the ground, he jumped from the crane and approached the victim as he called for help to other employees in the area. The victim's co-workers immediately began cardiopulmonary resuscitation

(CPR). The local fire department rescue squad was summoned and arrived on the scene approximately 4 minutes after the incident occurred. They were unable to obtain any vital signs and noted no visible burns. The victim was transported to a local hospital, where he was pronounced dead on arrival.

Five of the victim's co-workers reported receiving mild electrical shocks while attempting to aid the victim. Only after the arrival of the rescue squad did anyone on the scene realize that the crane was in contact with the overhead power line. All those present had assumed the victim had suffered a heart attack. After the incident the utility company was contacted to disconnect the power prior to moving the crane.

CAUSE OF DEATH

The coroner's office gave the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Cranes and other boomed vehicles should not be operated in the vicinity of overhead power lines.

Discussion: operation of a crane within 10 feet of an energized power line is specifically prohibited by 29 CFR 1926.550 (a)(15)(i). If this standard had been observed, this death could have been prevented. This incident could have resulted in multiple fatalities if co-workers had contacted the crane.

Recommendation #2: If it is necessary to work in the vicinity of overhead power lines, employers should verify that adequate clearances will be maintained between equipment and any lines in the area. If adequate clearances cannot be guaranteed, the employer should contact the local utility company and request that the lines be de-energized and grounded as specified in 29 CFR 1926.550(a)(15). Employers should verify that lines have been de-energized prior to the start of work.

Discussion: The retaining wall from which the form materials were removed was adjacent to the overhead lines. While the materials could have been placed in an area farther from the overhead lines, the victim placed them directly below a power line. The employer should ensure that the work environment is free from hazards by conducting an inspection of the area prior to the start of work.

Recommendation #3: Employers should ensure that their employees receive training which addresses the hazards to which they are exposed, and that they understand the danger posed by these hazards.

Discussion: In this case it appears that the employee may have been aware of the power lines (since he looked up prior to connecting the choker to the crane) but did not recognize the danger posed by this hazard. Training which increases the understanding of the danger of working in the vicinity of power lines could have prevented this death.

FACE 88-41: **Journeyman Electrician Electrocuted by Touching Energized Light Socket**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On August 10, 1988, a 49-year-old male journeyman electrician contacted an energized light socket containing a broken light bulb and was electrocuted.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On September 8, 1988, a research safety specialist contacted state and local officials, met with company representatives, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a multi-state tobacco manufacturing and production corporation. The facility where the incident took place has been in operation for 68 years. The company employs 197 people at this site; the victim and one co-worker were the only two electricians. The victim had worked for the company for the past 31 years, serving as plant electrician for the last 12 years. The company has a formal occupational safety and health program with written policies and procedures. Safety training programs are periodically presented to employees. The victim had received both formal and on-the-job training in electrical work.

SYNOPSIS OF EVENTS

On the day of the event the victim was tracing electrical conduit in a 5-foot-high "crawlspace" between the first and second floors of one of the older buildings in the facility. The lighting within the crawlspace was provided by unguarded light bulbs in ceramic sockets hanging from the ceiling.

Access to the crawlspace was obtained by climbing a 15-foot portable ladder and stepping from the ladder through a 4-foot-high access panel. At the foot of the ladder was a doorway leading to the facility's dispensary and the company nurse's office. A male co-worker, standing on the ladder, was looking into the crawlspace and speaking with the victim.

At the time of the incident the victim had been working in the crawlspace for several hours and was on his way out. When he was about 12 feet from the entrance, he appeared to straighten up slightly and stretch. His left shoulder contacted a broken light bulb in one of the ceiling-mounted light sockets and the top of his head contacted a steel water pipe. The victim immediately collapsed.

The co-worker called out for help and entered the crawlspace to aid the victim. The co-worker, trained in cardiopulmonary resuscitation (CPR), promptly began to perform CPR on the victim. The company nurse, a CPR instructor, heard the co-worker call for help, and assisted in performing CPR. She was unable to detect any vital signs.

Emergency medical service personnel arrived on the scene approximately 4 minutes after the incident. They were also unable to detect any signs of life. The coroner pronounced the victim dead at the scene 45 minutes after the incident. Examination of the victim's body revealed a burn mark on the left shoulder and a 4-inch burn on the top of the head.

CAUSE OF DEATH

The coroner gave the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Periodic inspection of all work areas should be performed to identify hazards. These hazards should be corrected immediately.

Discussion: The damaged light which caused the electrocution was located in the center of a walkway near the entrance to the crawlspace. An inspection of this area would have revealed this hazard, allowing it to be corrected before an injury occurred.

Recommendation #2: Guarding should be installed around light fixtures in service areas which are susceptible to damage.

Discussion: A metal basket guard around the light fixtures in the crawlspace would have prevented the damage to the light bulb, thus preventing this incident. This would provide passive protection of workers in this vicinity.

Recommendation #3: Employers should strive to make employees aware of the need to immediately correct damage to electrical devices that might expose an employee to an electrical hazard.

Discussion: The light bulb which was involved in this incident had been damaged at an unknown time in the past. The victim and other employees had walked past this unit many times in order to gain access to the interior of the crawlspace. If the individual who broke the bulb, or another worker, had replaced the damaged unit this fatality might have been prevented.

FACE 88-45: Electrical Contractor Crew Leader Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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 interacts

On September 1, 1988, a 35-year-old male crew leader for an electrical contractor was electrocuted while connecting a newly installed, concrete pad-mounted transformer for a new residence.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On September 22, 1988, a research safety specialist conducted a site visit, met with an employer representative, and discussed the incident with the county coroner and the Occupational Safety and Health Administration (OSHA) compliance officer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by an electrical contractor who has been in operation for over 19 years. The contractor employs 300 workers. The contractor has a written safety policy, a comprehensive safety and training program, and a full-time safety officer. The employees receive periodic training and retraining. Daily tailgate safety meetings, including discussions of safe work procedures for hazard control, are conducted at each job site. The safety officer also visits each crew at least once a week to conduct a site evaluation and job crew safety meeting.

The employer has developed a list of "absolute do's and don'ts" as primary jobsite safety rules. These rules are carefully explained to the workers and laminated copies are posted in all company vehicles and at all jobsites. A violator of these rules is sent home after twice committing an infraction. The third infraction warrants dismissal.

The employer implements an additional safety measure. Multiple grounding of trucks and equipment is required in an effort to prevent electrocutions due to inadvertent energization of this equipment. This procedure is not required by legal or consensus standards, but is felt by the company to be essential in reducing workers, risk of injury during line work.

Three weeks prior to the incident the victim completed a 1-week training course in underground power transmission. The victim, with 10 years of experience working for the contractor, was considered by the employer as "the best and most experienced underground transmission crew leader" in the company.

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SYNOPSIS OF EVENTS

The employer had been contracted by the local electrical utility company to install encased transformers on concrete pads (i.e., pad-mounted transformers) for a 15,000-volt underground transmission system. The pad-mounted transformers were being installed for new residences under construction.

On the day of the incident the victim (crew leader) and two crew members were given the work order to splice a previously installed, pad-mounted transformer into an existing underground 7,200-volt primary cable. The primary wire was one of three that originated in a main switch cabinet approximately three-quarters of a mile away. The primary continued to a second switch cabinet which contained no fuse holders and was de-energized (see Figure). Therefore, the current could reach the incident site (transformer) only from the direction of the main switch cabinet. The victim went to an adjacent transformer he thought was on the incoming power side of the primary line, de-energized the line (i.e., opened a switch) and grounded it. The victim then returned to the worksite and told the crew members to cut the primary wire and begin the splicing operation. When the primary wire was cut an arc occurred. The victim then realized that the worksite was between the de-energized transformer and the power supplied by the main switch cabinet. He also knew that the arc would cause the fuse on the primary wire in the main switch cabinet to blow.

After instructing the crew members to stop working until his return, the victim drove to the main switch cabinet and removed the blown fuse and its holder. He did not ground the primary wire at this point as required by company procedures. (Before splicing operations had begun, the victim and crew had been visited by the employer's district supervisor and safety officer. The proper procedures to be followed, including grounding procedures for this task, were reviewed during this visit.)

The victim returned and instructed the crew members to test both ends of the primary wire to ensure that they were de-energized. When both ends of the primary wire were found to be de-energized the victim instructed the crew members to prepare the ends for connection to the transformer.

Although company procedures required that both ends of the primary wire be grounded, no grounds were installed. The victim went to his truck and replaced the blown fuse in the holder he had removed from the main switch cabinet. He left this unit in the truck. He then walked to the adjacent transformer, removed the ground wire he had installed, and returned the transformer to normal service (i.e., closed the switch). The primary wire remained de-energized because the fuse and fuse holder had been removed from the main switch cabinet. The victim returned to the worksite and informed one of the crew members that he would finish work on that end of the primary wire to speed up operations.

It was determined during investigation that the victim was working on the end that returned to the main switch cabinet from which he had removed the fuse and fuse holder. The victim had been working on the wire for 1 1/2 minutes in a squatting position when he groaned and fell backwards onto the crew member who was observing him. The crew member received a shock and jumped away from the victim. The crew members pulled him away from the transformer and began cardiopulmonary resuscitation (CPR). One of the crew members contacted the electrical utility office by truck radio and requested an ambulance. The emergency medical service arrived within 10 minutes and performed advanced cardiac life support (ACLS) procedures on the victim. The victim was transported to the local hospital where he was pronounced dead on arrival.

The incident was immediately investigated by electrical utility engineers, employer engineers, and linemen. The only other electrical attachment to the primary wire between the incident site and the main switch cabinet is a bank of two 25-kilovolt ampere pad-mounted transformers that served an emergency battery powered generator for the water pumps. If the power from the electrical utility's line to the water pumps is interrupted, a switch automatically transfers the electrical load of the pumps to the battery-operated generator.

Tests on the automatic transfer switch showed it to be in proper working condition. The designer of the transfer system (i.e., the automatic transfer switch and the battery-operated generator) was summoned to the site to explain the mechanics of the system. The designer stated that if the transfer switch was operated manually after the generator was activated (i.e., transferring the load from the generator back to the electrical utility's primary line) current would feed through the two transformers and automatic transfer switch to the electrical utility's primary line. By using a voltmeter at the incident site it was determined that 4500 volts appeared on the primary line when the automatic transfer switch was operated in this manner.

Electrical utility engineers, employer engineers, and the system designer agreed that at some point after the battery-powered generator had been activated, the automatic transfer switch had been operated manually, allowing current to appear on the primary wire, causing the electrocution of the victim.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should stress the importance of established safe work procedures to all workers.

Discussion: The victim, considered by the employer to be the most experienced underground crew leader in the company, had recently received training in the proper techniques and procedures for grounding underground power systems. He had discussed grounding procedures necessary for the task to be performed with the district supervisor and the safety officer on the day of the incident. Still, he did not ground the primary line at the main switch cabinet or the ends of the primary line at the incident site. Employers must ensure that all workers understand the importance of always following established safe work procedures.

Recommendation #2: Prior to any work being performed on an electrical system, all involved workers should be familiar with the operation of all components of that electrical system.

Discussion: In this incident it appears that the victim was not aware of the existence of the back-up generator; therefore, he was not aware that current could feed back through the transformers to the primary line even with the fuse and fuse holder removed from the main switch cabinet. Before beginning work on any electrical system, all persons involved in working on that electrical system should be made aware of the function of all components of the systems. Workers should be made aware of any hazards that might be created by the functions of these components before any work is performed on the electrical system.

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This is especially important when working on underground systems because the lines or the direction of current flow cannot be visibly traced. The victim thought he had de-energized the primary line at the beginning of the job. Yet, when the crew members cut the cable an are occurred. This illustrates the fact that the victim was not familiar with all components of the system. If the victim had been aware of the possibility of the feedback of energy, he may have placed the required grounds on the primary line and placed a danger tag on the automatic transfer switch. These measures might have prevented this fatality.

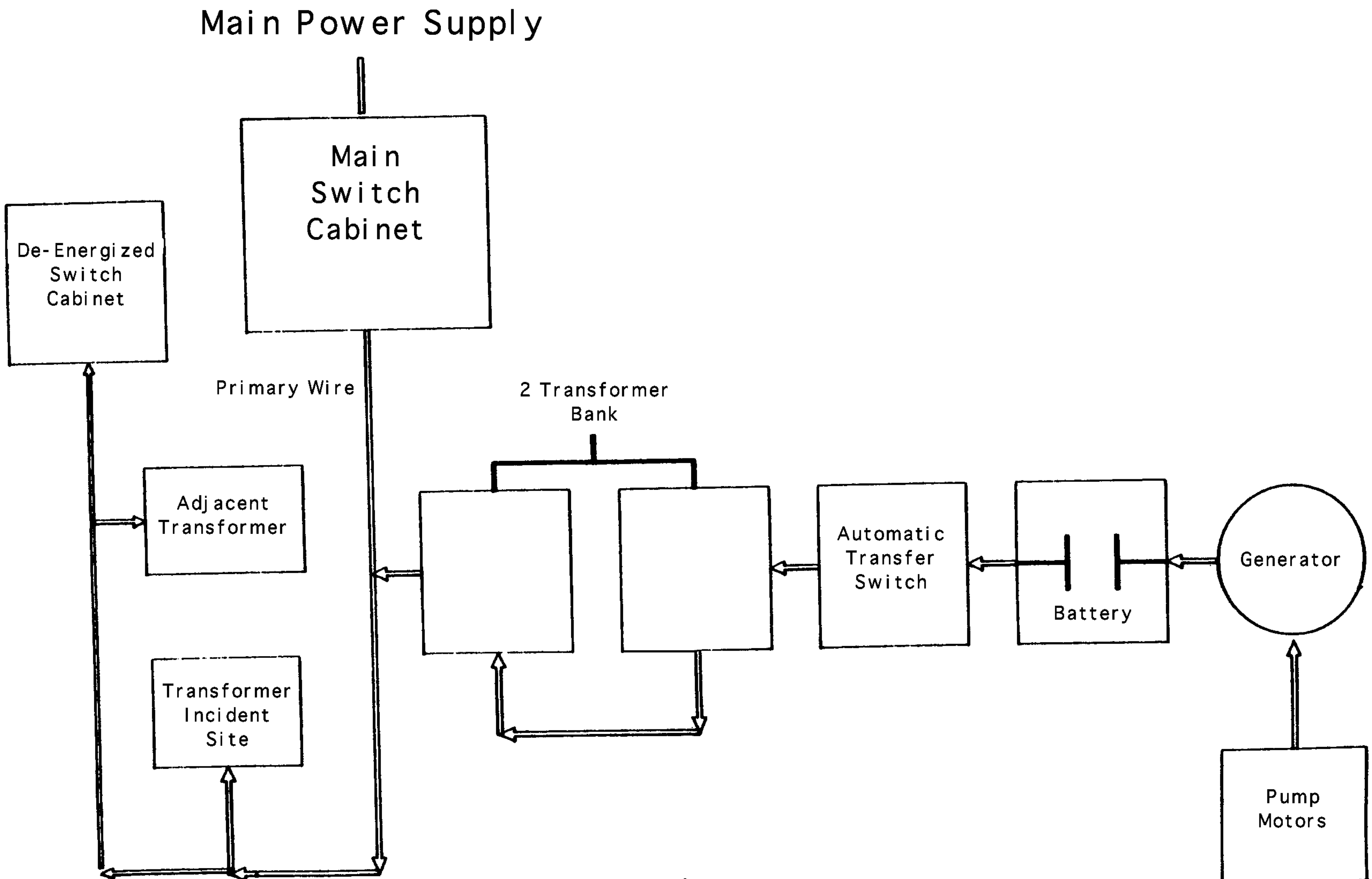
Main Power Supply
Main Switch Cabinet
De-Energized Switch Cabinet
Primary Wire
2 Transformer Bank
Adjacent Transformer
Automatic Transfer Switch
Battery
Generator
Transformer Incident Site
Pump Motors

Figure.

FACE 88-47: **Equipment Operator/Lineman Electrocuted**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On September 12, 1988, a 47-year-old male equipment operator/lineman died when the wooden crossarm on a utility pole failed, dropping energized electrical lines onto him.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. A research safety specialist discussed this incident with state officials and on September 29, 1988, met with company representatives, investigated the incident, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer, a power line construction company with 12 employees, has been in operation for 32 years without a serious incident. The company has written safety policies and procedures and safety meetings are held periodically with all employees. The victim had worked for the company for 8 years.

SYNOPSIS OF EVENTS

The victim was a member of a 6-man crew installing a new electric distribution system to replace an existing system in a rural area. The victim, a qualified journeyman lineman, functioned as both an equipment operator and a lineman for the crew.

The existing 7200-volt system consisted of three conductors installed on wooden crossarms. The power lines were 29 feet above the ground at the utility poles, which were located at 300-foot intervals. The power line right-of-way was adjacent to and parallel with a rural road.

To obtain clearance for the installation of new poles and conductors, the existing poles were leaned over away from the road. The pole where the incident occurred had both a transformer and telephone leads for a residence attached so it was not practical to lean the pole over. Instead, a fiberglass "hot arm" (a 6-foot-long, 2 1/2-inch-diameter extension arm) was attached to the wooden crossarm. Two of the three energized conductors were then moved to this hot arm; the third was relocated on the wooden crossarm to the insulator nearest the hot arm. This relocation of energized conductors was completed two weeks prior to the incident. This movement, along with the leaning of the adjacent poles, left the power line right-of-way clear for the crew to install new poles and conductors.

On the day of the incident the crew had installed the new poles and conductors and were in the process of switching the electric service over to the new system. A pole for this new service had been installed approximately 20 feet from the pole with the transformer. The transformer was to be removed from the existing pole and installed on the new pole, at which time electrical power for the residence would be switched to the new service.

The victim and one co-worker were standing near the pole from which the transformer was being removed. The transformer was to be lowered to the ground and the two men were to carry it to the new pole for installation. As the transformer was lifted from the old pole, the wooden crossarm supporting the hot arm and the live conductors failed, dropping the energized lines onto the victim.

When the victim was struck by the energized lines, his body provided a path to ground, and he fell with the wires across his body. His co-workers, using insulated equipment, immediately moved the wires off the victim and began cardiopulmonary resuscitation (CPR). The local emergency medical service (EMS) squad was summoned and arrived on the scene within 5 minutes. The EMS personnel continued administering CPR while enroute to the local hospital, but the victim was pronounced dead on arrival.

CAUSE OF DEATH

The coroner listed the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Supervisors should ensure that workers understand the hazards they routinely encounter in the workplace.

Discussion: In this incident the worker was standing directly under energized power lines. If he had been standing to the side with his co-workers, his death would not have occurred. The employee had been engaged in similar work on numerous occasions without incident and apparently did not recognize the potential for injury or death from working on the ground beneath energized lines. A verbal reminder of the hazards posed by this practice might have prevented the incident.

Recommendation #2: Standard company practices should call for workers not actually engaged in a specific work task to remain a safe distance from the actual worksite until their presence is required.

Discussion: The victim and his co-worker were observing other workers when the incident occurred. Their assigned work task was not to begin until the transformer had been lowered to the ground. If they had been required by company policy to remain a safe distance from the worksite until their services were required, this incident would not have occurred.

FACE 89-01: **Steelworker Electrocuted when He Contacts Fan with Damaged Power Cord**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of those evaluations is to 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.

On September 30, 1988, a 33-year-old male lead steel mill adjuster was electrocuted when he contacted a ventilation fan with a damaged power cord.

CONTACTS/ACTIVITIES

Officials of the state Occupational Safety and Health Program notified DSR of this fatality and requested technical assistance. On October 13, 1988, a DSR safety specialist conducted a site evaluation, interviewed company officials, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The facility at which the incident occurred was a steel manufacturing plant employing 534 workers. The plant has a comprehensive safety program and a written safety policy. Training for all work-related tasks is on the job.

SYNOPSIS OF EVENTS

On the day of the incident the victim, a lead steel mill adjuster, had just finished adjusting the shear machine. (The shear machine cuts the finished steel product to size and had been adjusted to change the length of the finished product.) The victim then walked toward an enclosed pulpit located adjacent to the shear machine and approximately 6 feet above floor level. An operator monitored the shear machine controls that were housed inside the pulpit. The victim walked around the back side of the pulpit on a metal grid walkway, acknowledged the pulpit operator, and then descended metal steps to the floor in front of the pulpit.

A large steel-based, 480-volt ventilation fan (5 feet high) was located on the floor 1-1/2 feet from the handrails for the stairs. Four metal hooks had been attached to the wire-mesh front cover of the fan. Samples of the steel were hung from these hooks to cool.

When the pulpit operator looked toward the fan he noticed the victim standing immediately in front of the fan with a startled look on his face. The pulpit operator thought the victim was joking, but when he looked over a short time later and noticed the victim in the same position he realized the victim was in trouble. The pulpit operator immediately ran to the rear of the pulpit and opened (de-energized) the circuit for the fan.

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The victim seemed unconscious but was still in a standing position. The pulpit operator, thinking the fan was still energized, pulled on the power cord and ripped it from the entrance box on the fan. The victim then fell to the ground. The pulpit operator later stated that he had contacted the victim while pulling on the power cord but had not received a shock. It is possible that the victim's clothing had caught on one of the metal hooks, momentarily holding the victim in an upright position.

Cardiopulmonary resuscitation (CPR) was begun immediately by the pulpit operator and continued until the emergency medical service personnel arrived. The victim was transported to the local hospital where he was pronounced dead on arrival.

An inspection revealed that the power cord of the fan was underneath, and had been damaged by the steel base of the fan. The damaged insulation on the conductors allowed the bare conductors to contact the steel base of the fan, energizing the entire frame. Also, when the electrical system for this part of the steel mill had been installed, a continuous ground connection was not established. The fault current present on the frame of the fan had no path to ground until the victim leaned against the fan and simultaneously contacted the handrails for the metal steps which were at ground potential. The current could then pass through the victim down the handrail to ground, causing the victim's electrocution.

CAUSE OF DEATH

The county coroner listed accidental electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical systems should be installed in accordance with existing applicable articles of the National Electrical Code.

Discussion: Article 250-5(b)(2) states that alternating current circuits and systems of 50 to 1,000 volts shall be grounded. Because of the improper installation of the receptacles, a continuous ground path for this system was not in place. If this system had been installed in compliance with the National Electrical Code, this fatality may not have occurred.

Recommendation #2: Employers should initiate preventive maintenance programs for electrical systems in their facilities and ensure the implementation of these programs.

Discussion: Employers should initiate preventive maintenance programs including inspections of the electrical systems by a qualified electrician. These inspections should include, but not be limited to:

1) testing of the system components to ensure electrical continuity (i.e., proper wiring) and proper grounding

2) visual inspection of cord and plug-connected equipment for physical damage to components

3) visual inspection of machinery to ensure that all live conductors are properly guarded.

These inspections should be documented and any identified problems or hazards should be immediately corrected. Also, all workers should be instructed to visually inspect their work areas for possible hazards on a daily basis. A visible inspection in this instance may have identified the damaged cord, thus reducing the possibility of a serious electrical incident.

Since the incident, the employer has corrected the electrical system in the plant addition. Additionally, new power cords have been installed on the cord and plug equipment in the entire plant in an effort to eliminate excess slack in the cords. This reduces the chance that the power cords would be caught underneath portable equipment and damaged.

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FACE 89-04: Equipment Operator Electrocuted by Contact with Power Line

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On November 2, 1988, a 47-year-old male equipment operator was electrocuted when he contacted a 7,600-volt power line.

CONTACTS/ACTIVITIES

On November 3, 1988, a state occupational safety and health program official notified DSR of this fatality and requested technical assistance. On November 17, 1988, a safety specialist met with an employer representative, discussed the incident with the OSHA compliance officer, obtained photographs of the incident and reports from the local fire/rescue service and police department.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident, a large municipality which was chartered over 128 years ago, currently has over 9,000 employees. The victim was one of approximately 200 employees who work for the Department of Transportation/Traffic operations. The victim had worked for the municipality for 22 years, 8 years of which were in his current occupation of equipment operator.

The city employs three safety specialists (one safety officer and two injury prevention specialists) who work with each of the city departments. Although the city uses written safety rules and procedures in all departments, written procedures for certain tasks, such as traffic signal installation, have not been developed.

SYNOPSIS OF EVENTS

A crew installing new traffic signals at a four-way intersection in a residential section of the city consisted of a field supervisor, two laborers, and an equipment operator (the victim). Prior to installing the signals, the crew erected four metal poles (approximately 28 feet high) on each corner of the intersection to support the traffic signals suspended from span wires.

The crew installed two traffic signals, and began work on the third signal. A 1/4-inch-diameter steel wire cut to length (approximately 50 feet) was to be attached to two of the metal poles in order to support the third traffic signal and associated wiring.

The field supervisor and two laborers were on the ground at the corner opposite where the victim was working. The victim picked up one end of the cut steel wire lying on the ground and looped it over his shoulder. He then climbed into the bucket of the vehicle and began raising the boom. While attempting to position the bucket close to the metal pole, the victim apparently misjudged either the height of the power lines (the secondary wire was 19 feet 5 inches from ground level) or their proximity to the metal pole. He contacted the bottom phase of the 7,600-volt (phase to phase) power line with his bare head. This contact provided the electrical current a path through the victim's body and down the steel span wire to ground, causing his electrocution.

The other crew members heard the sound of electricity arcing, and looked up to see the victim in contact with the power line. They contacted the local fire/rescue service. Emergency personnel arrived at the scene approximately 7 minutes later. The victim remained in contact with the power line until the line burned in two and fell to the ground. The local utility company personnel arrived, de-energized the line, and lowered the boom and bucket containing the victim to the ground. The victim was pronounced dead at the scene.

CAUSE OF DEATH

The coroner reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should communicate and coordinate activities with the local utility company before working near energized power lines.

Discussion: The local utility company should be notified prior to initiating work near electrical power lines. The utility company can de-energize and ground power lines, or at least insulate them with lineguards, rubber line hoses, or other insulating devices before employees begin work. Had the power line in this incident been de-energized or properly insulated, this death probably would not have occurred.

Recommendation #2: Employers should ensure that minimum clearances between boomed vehicles and power lines are maintained according to existing OSHA regulations.

Discussion: OSHA regulation 1910.67 (b)(4)(i) (*Vehicle-mounted Elevating and Rotating Work Platforms*) requires that a minimum clearance of 10 feet be maintained between electric power lines rated at 50,000 volts or less and any part of an aerial lift being operated proximate to, under, over, by or near such power lines. The equipment operator did not comply with these requirements and was electrocuted.

The location of the articulating boom platform (beneath the power lines), weather conditions (cloudy and windy 23-29 mph), and the work environment (tree limbs with leaves around the metal support pole, numerous telephone lines, and primary and secondary electric power lines) may have interfered with the operator's perception of the distance to the power line. Employers should designate a person to observe clearance of equipment and to give timely warning when it is difficult for the equipment operator to maintain sufficient clearance by visual means.

Recommendation #3: The employer should design, develop, and implement a comprehensive safety program which includes specific written procedures for all work near energized power lines.

Discussion: The employer should design, develop, and implement written procedures for specific tasks such as traffic signal installation. These procedures should include, but not be limited to: 1) worker training, 2) electrical hazard recognition, 3) use of personal protective equipment, 4) supervisory job site surveys prior to the start of work, and 5) first aid/cardiopulmonary resuscitation (CPR) certification training.

FACE 89-06: **Lineman Electrocuted by Contacting Energized 12,000-Volt Power Line**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On September 9, 1988, a 48-year-old male journeyman lineman was electrocuted when he inadvertently contacted an energized 12,000-volt power line while performing maintenance work on a utility pole.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On December 15, 1988, a research safety specialist met with an employer representative, and visited and photographed the site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a power line construction and maintenance company employing approximately 300 individuals. The company has been in business for 18 years. The company has written safety policies and procedures addressing all phases of company operations. Refresher training programs and periodic safety inspections are conducted by company safety personnel.

SYNOPSIS OF EVENTS

On the day of the incident the victim was part of a four-man crew installing squirrel guards (plastic covers which fit over transformer connections to prevent a squirrel from contacting two points on the transformer and shorting out a circuit thereby causing a power outage).

At the time of the incident the victim was working on a pole which held a 25,000-volt transformer. A guy wire ran from the pole to the ground. The crew foreman was on the ground at the base of the pole, while the remaining two members of the crew were working on an adjacent pole from a bucket truck.

A cut-out switch on the jumper to the transformer had been opened, de-energizing the transformer so the squirrel guard could be installed. The victim was wearing a lineman's belt and was tied off above the neutral wire. His right foot was near or on the neutral wire insulator. The victim had removed his insulated lineman's gloves and was working bare-handed on a connection when he apparently slipped. As he did so his left hand contacted the energized side of the cut-out switch and a path to ground was established from the victim's left hand, across his chest, to the inside of his right calf, which was in contact with the bare neutral wire. The victim immediately collapsed, breaking the connection.

The foreman, observing the incident, immediately called for help. The occupant of a nearby residence also observed the incident and summoned local authorities. One of the co-workers attempted rescue but was unable to lower the victim from the pole. The bucket truck used on the adjacent pole was moved into position beneath the victim, and the victim was removed from the pole and lowered to the ground approximately 10 minutes after he had collapsed.

Responding emergency medical personnel were unable to detect any vital signs and immediately began cardiopulmonary resuscitation (CPR) on the victim. The victim was then transported to a local hospital where he was pronounced dead.

CAUSE OF DEATH

The medical examiner listed the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should require and enforce the use of personal protective equipment to protect employees from hazards associated with their work.

Discussion: The employer requires the use of lineman's insulated gloves for maintenance work on utility poles. Although the victim was wearing his gloves, he removed them prior to the incident. Had he continued to wear his gloves, he might have survived the inadvertent contact with the energized connection. A company foreman observing the victim from the ground failed to ensure that the victim was wearing his gloves, permitting him to violate written company policy. Supervisors must ensure that company safety procedures are enforced in the field. Failure to do so may be perceived by employees as lack of management commitment to safety, or may give the false impression that safety policies are not necessary to prevent injury.

Recommendation #2: Employees should be taught to maintain clearance when working in the vicinity of energized circuits. When adequate physical separation to prevent inadvertent contact is not possible, physical guards (barriers) should be placed between the worker and the hazard.

Discussion: The victim was working in a position where he unintentionally contacted energized components on the utility pole. By positioning himself slightly lower on the pole, the task could have been completed from a position where such contact was not possible. OSHA regulation 1926.950 (c)(1)(i) specifies that an employee cannot approach within 2 feet of a 12,000-volt power line unless that employee is insulated or guarded from the energized part or the energized part is guarded or insulated from the employee. If a safe work position had been used, or if a line blanket or hose had been placed on the energized conductor, this death might have been prevented.

Recommendation #3: Supervisory personnel for electrical contractors should conduct pre-job surveys of all worksites to determine what components can be de-energized prior to the start of work.

Discussion: Whenever possible all electrical service should be de-energized prior to any work being performed in the proximity of such service. This provides passive protection of the worker. When this is not possible, guarding and physical isolation, as noted in recommendation #2, must be utilized to prevent contact with energized components. A pre-job survey conducted by the on-site supervisor affords the opportunity to identify hazards and consider options for controlling them. Had this approach been taken, this fatality might have been prevented.

FACE 89-08: **Sign Technician Electrocuted Stepping from Energized Ladder Truck**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On November 29, 1988, a 45-year-old male sign technician was electrocuted when a steel cable attached to the extended ladder of the ladder truck he was operating contacted a 12-kilovolt (kV) overhead power line, and he stepped from his truck to the ground while holding the energized door.

CONTACTS/ACTIVITIES

State Occupational Safety and Health Administration officials notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this fatality and requested technical assistance. On January 10, 1989, a research safety specialist met with a state OSHA compliance officer, the local police chief, emergency medical personnel, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The two-man company (the owner and a helper), a sign and service business, had been in operation for 4 years. The company had no written safety rules or procedures. The helper was trained on the job.

SYNOPSIS OF EVENTS

On the day of the incident the owner (the victim) and the helper were changing light bulbs in the pole-mounted lighting fixtures of a shopping center parking lot. The procedure used for this task was: 1) position the aerial ladder truck next to a light pole, 2) extend the ladder to the proper angle, 3) rotate the ladder toward the light pole, 4) extend the ladder to the proper height, 5) change the bulb, 6) rotate the ladder back over the cab of the truck, and 7) move the truck to the next light pole requiring service without retracting the ladder to its original position. A steel cable attached to the tip of the ladder was used to hoist materials to the person on the ladder.

Just prior to the incident the victim had changed a light bulb and was moving the truck (following the procedure described above) to the next light pole, which was located on the shopping center's entrance roadway. The helper was following in a pick-up truck approximately 50 yards away. As the victim was driving the ladder truck down the entrance roadway toward the main highway, the steel cable hanging from the tip of the extended ladder contacted a 12-kilovolt (kV) overhead power line. Apparently the victim realized a problem had occurred (presumably he heard an electrical arcing noise), and proceeded to get out of the truck. As the victim stepped onto the ground while holding the door, he completed the "path to ground" for the electrical current and was electrocuted. He was engulfed in flames when the ladder truck caught fire as a result of the arcing electricity.

Local fire, police, and emergency medical service (EMS) units were called; all responded in approximately 4-5 minutes. Also, the local utility company was notified. Utility company personnel arrived in approximately 10 minutes to de-energize the power line. Firemen extinguished the truck fire and EMS personnel removed the victim's incinerated body and transported it to the hospital morgue.

CAUSE OF DEATH

The coroner ruled that death was due to electrocution and severe burns.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that adequate clearance is maintained between aerial ladders and nearby overhead power lines.

Discussion: 29 CFR 1910.67 (b)(4)(A) requires that a clearance of a least 10 feet be maintained between any part of an aerial lift and power lines of 50 kV or less. The practice of moving a ladder truck while the ladder is extended is extremely hazardous. Overhead power lines can be difficult to see from the ground, particularly if attention is focused on operating a vehicle, and vision is limited by the cab enclosure. The victim apparently did not know (or had forgotten) that the power line was located in the path of the extended ladder, or saw the power line and misjudged the clearance. In either case, avoiding the practice of moving the truck with the ladder extended should prevent similar future incidents.

Additionally, each specific job or worksite introduces potential hazards. Therefore, employers should conduct a jobsite survey, identifying all potential hazards and implementing appropriate control measures, prior to starting any job. A pre-job survey in this case would have identified the power lines and all associated hazards. The aerial ladder could have been retracted prior to the truck being moved thereby preventing the incident.

Recommendation #2: The employer should begin to develop and implement a safety program by performing job hazard analyses and pre-job surveys to identify and control hazards.

Discussion: This employer had no safety program. Since the primary reason for establishing a safety program is worker protection, a logical first step is identification of potential hazards. One way of identifying hazards is to analyze each step in routine operations, anticipate hazards that could arise during each step, and develop procedures or other control measures which effectively eliminate or reduce each hazard. This process is known as job hazard analysis. In this case, an informal operating procedure (moving the ladder truck while the ladder was extended) was inappropriate for the task being performed. Employers should perform job hazard analysis of all jobs, starting with those thought to be most hazardous, and develop and implement controls that protect all workers.

Recommendation #3: Manufacturers should design a passive engine interlock system that prevents engine start-up unless the ladder is fully retracted, and install such systems on all new aerial ladder trucks.

Discussion: An engine interlock system that requires the aerial ladder be in the down (highway transport) position before the truck can be started and moved, would automatically ensure that a moving truck could not come into contact with any overhead powerlines.

Recommendation #4: Shopping center/mall owners should consider installing lighting systems that can be serviced from the ground level.

Discussion: Installation of lighting systems that can be raised and lowered from the ground level should be considered by the owners of shopping centers/malls. Servicing these units would not require use of aerial ladder trucks (or other boomed-vehicle) and would therefore eliminate the possibility of contacting power lines. Also, the possibility of workers falling from ladders while changing light bulbs would be eliminated. Work environment modifications can eliminate or reduce hazards without placing the total responsibility for injury prevention on the worker at risk.

Recommendation #5: All organizations with an interest in protecting worker health, including government agencies such as Federal and State OSHA, NIOSH, trade associations, labor unions, safety societies, universities, insurers, etc., should increase efforts to communicate basic and essential safety information to all levels of society.

Discussion: Everyone in society is exposed to electrical energy. The nature of the hazards presented by overhead power lines and other electrical conductors and equipment must become thoroughly ingrained in our collective consciousness if electrocutions are to be prevented. Had the victim realized that he would have probably remained safe if he stayed inside the vehicle, or if he jumped clear instead of maintaining contact with the energized truck, this death might have been prevented.

FACE 89-09: Supervisor Dies Following Electrical Fire

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On November 24, 1988, a 45-year-old male hydroelectric supervisor died as a result of massive burns sustained in an electrical fire on October 16, 1988.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On January 4, 1989, a research safety specialist and an occupational health nurse met with company officials, and visited and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a large textile firm with 800 employees which has been in existence for 107 years. In addition to the textile operation, the company owns and operates two hydroelectric plants as well as the water treatment and wastewater treatment plants for a small town which was initially built to support the mill. The company has a detailed safety program, with safety meetings held on both a weekly and monthly basis. The victim had been employed by the company for 28 years, initially serving as an apprentice and later as the only journeyman hydroelectric supervisor in the company.

SYNOPSIS OF EVENTS

As hydroelectric supervisor, the victim served as supervisor and maintenance foreman for two hydroelectric plants and more than 8 miles of high voltage power lines serving both the textile plant and the community. He was also responsible for a small municipal water treatment plant, a sewer plant, and several homes and other buildings owned by the company.

On the day of the incident the victim and an apprentice went to one of the hydroelectric plants to calibrate an analog meter which monitored the level of voltage being generated. Because this level fluctuates with the power usage of the textile mill, this task was always performed on Sunday when the mill was closed. Both workers were wearing "dress-type" clothing, instead of their normal work clothing.

A 100-to-1 step down unit reduced the generated voltage (3280 volts) to 32.8 volts at the analog meter. A digital meter, located at a utility company substation outside the hydroelectric plant, was showing the nominal 32.8 volts, (indicating that the desired 3280 volts was being generated); however, the analog meter in the plant was showing 32.2 to 32.3 volts.

Before adjusting the analog meter, the victim decided to check the actual voltage being supplied to the meter to verify that it was 32.8 volts as indicated by the digital meter. To perform this task the victim and his co-worker climbed up to the next level of the plant and entered the high voltage area directly above the analog meter. This area is designated "off limits" to all personnel when the plant is operating.

The victim had a large, high capacity volt-ohmmeter in his service truck, located outside the hydroelectric plant. However, because the supply leads he was planning on testing were conducting only approximately 32 volts he decided to use a small pocket-size volt-ohmmeter he had with him. This unit was designed for use on residential 120- and 240-volt circuits.

While the apprentice was holding the small volt-ohmmeter in his hands, the victim extended the leads into the high voltage area in an attempt to take a reading. In doing so he inadvertently contacted a high (3280 volts) voltage line. The volt-ohmmeter, which had no overload protection (fuses), immediately overheated, burning the apprentice's hands. The apprentice dropped the unit onto exposed high voltage buss bars (metal conductors), creating a short circuit and an electrical fire. This fire ignited the clothing of both workers.

The hydroelectric plant operator, a paramedic, observed the entire incident. He immediately extinguished the clothing fire and summoned help via two-way radio. The local rescue squad was on the scene approximately 5 minutes after the incident, and both men were promptly transported to a local medical center. About 1 1/2 hours later the men were transported to a burn center.

The victim, who had been wearing polyester clothing, suffered third degree burns over 40 percent of his body, and burns to the respiratory system. The apprentice, who had been wearing cotton/polyester blend clothing, sustained second and third degree burns over 28 percent of his body.
The victim survived for 5 weeks before dying as a result of infection.

CAUSE OF DEATH

The coroner's autopsy report for this incident has not been completed at this time, but death is presumed to be due to an infection subsequent to severe electrical burns.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Electrical test instruments should be adequate to deal with any current which may be encountered during their use.

Discussion: While the test instrument used in this case was adequate for the anticipated voltage (32.8 volts), it was inadequate for the high voltage (3280 volts) encountered. The improper use of this instrument in an area where voltage was present which exceeded its capacity, was the primary factor which caused the injurious electrical fire.

Recommendation #2: Appropriate personal protective equipment should be used when working near known hazards.

Discussion: The victim was working in the immediate vicinity of known high voltage lines without using personal protective equipment of any type. While insulated gloves would not have prevented this particular incident, they could have prevented electrocution if the victims' hand contacted the energized high voltage lines. The clothing worn by both men was inappropriate for the work being performed. When the fire occurred, the polyester clothing readily burned and melted, resulting in severe burn injuries to both workers.

Recommendation #3: Work areas containing high voltage lines should be prominently marked, with signs indicating the voltage present.

Discussion: The workers in this case were working on very low voltage equipment. While it is relatively certain that the victim knew that high voltage was present in the area, a prominent sign, indicating the presence of 3280 volts, might have reminded the victim of this hazard, possibly preventing this incident.

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FACE 89-10: Machine Operator Electrocuted when Crane Contacts Overhead Power Line

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On December 5, 1988, a 24-year-old male boring machine operator was electrocuted when the crane moving the pipe he was guiding contacted an overhead power line.

CONTACTS/ACTIVITIES

State officials contacted DSR about this fatality and requested technical assistance. On January 4, 1989, a research safety specialist and an occupational health nurse met with employer representatives, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a small company engaged in horizontal boring operations. The company has been in business for 7 years and employs on average 15 individuals, most of whom are boring machine operators. The company has neither a written safety policy nor standard operating procedures for any of the tasks performed by employees. All employees are trained on the job. The victim had been employed by this company as a boring machine operator for 2 years.

SYNOPSIS OF EVENTS

On the day of the incident a three-man crew consisting of a foreman and two boring machine operators were working at an excavation pit 7 feet deep, 5 feet wide and 34 feet long. The pit had been dug to allow a boring machine to be positioned to drill under an existing roadway. A 12,000-volt power line, suspended 20 feet above grade, was directly adjacent and parallel to the pit. The employer had made no attempt to contact the power company to have the power line de-energized or isolated. The boring machine was installed on a 30-foot-long track in the pit.

The foreman, who had been with the company 4 years, was operating the truck-mounted, 8-ton-capacity crane. He parked it perpendicular to the pit facing down a slight incline. He extended the boom to about half its length (30 feet) to pick up a 10-foot-long by 16-inch-diameter, 1/4-inch-wall steel pipe (approximate weight 1000 pounds). The crane lifted the pipe via a sling, and the two boring machine operators, standing in the pit on the track that the boring machine was mounted on, attempted to guide the pipe into position in the pit. When the pipe became lodged due to misalignment in the pit and the victim attempted to free it by pulling the pipe toward him with one hand, the boom moved slightly causing it to make momentary contact with the overhead power line. The boom, cable, and pipe became energized, and the victim was electrocuted when he formed a "path to ground" as current passed from the pipe through his hand, arm, chest, and legs. He fell clear of the pipe. (The other worker, although not directly in contact with the pipe, received an electric shock.) Cardiopulmonary resuscitation (CPR) was performed by paramedics who arrived at the scene in 10 minutes. The victim was transported by a medical helicopter but was pronounced dead on arrival at the hospital emergency room.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that adequate clearance is maintained between cranes and nearby overhead power lines.

Discussion: 29 CFR 1926.550(a)(15) requires that a minimum clearance of 10 feet be maintained between cranes and power lines of 50,000 volts or less. In addition, this standard calls for an observer to be posted to give warning whenever it is difficult for the operator to maintain the required clearance by visual means. None of these actions were taken in the above case.

Recommendation #2: When a job requires working in proximity to power lines, employers should ask the local electrical utility company to de-energize and ground such lines, and verify that they have, in fact, been de-energized. (29 CFR 1926.550(a)(15))

Discussion: According to the employer, the workers were aware of the presence of the power line and discussed it prior to going to the site on the day of the incident. However, they did not take any of the required precautions or attempt to contact the utility company to have the lines de-energized. Their failure to do so was a primary factor in this incident.

Recommendation #3: Non-conductive tag lines (lines used by workmen to snub or control the load) should be used to aid in guiding and stabilizing the load.

Discussion: The use of non-conductive tag lines could help prevent exposure of the worker to electrical current in the event the crane touched the power line. Although all ropes will conduct electricity, dry polypropylene rope provides better insulating properties than most other types of commercially-available rope.

Recommendation #4: Employees who work around electrical circuits and equipment should be trained in the use of cardiopulmonary resuscitation (CPR).

Discussion: CPR begun within four minutes (in accordance with American Heart Association guide-lines) is more likely to be successful. To meet this criteria employees should be certified in CPR to initiate resuscitation attempts until trained medical personnel arrive. None of the workers at the site were trained in CPR and, therefore, emergency care was not initiated in a timely manner.

Recommendation #5: All employers should develop and implement a safety program to protect their employees as required by 29 CFR 1926.20.

Discussion: This employer had no formal safety program. There were no standard operating procedures for any of the tasks performed. In addition, no provision was made for any formal training or verification of the ability of employees to perform the tasks to which they were assigned. The essential reason for developing a safety program is to protect workers. A logical first step is to identify all potential hazards. One way is by analyzing the sequential steps in routine operations to identify potential hazards, and attempting to develop procedures or other control measures which effectively eliminate or reduce the hazards. This type of analysis is known as job hazard analysis. Additionally, each specific job involves hazards particular to that job or the working environment. Therefore, employers should conduct a job site survey, identifying all hazards and implementing appropriate control measures, prior to starting any job.

Although the workers in this case were aware of the overhead power line, they apparently did not understand the nature of the hazard. The presence of the power lines should have prompted the workers to consider the control options outlined in the preceding recommendations and implement appropriate protective measures.

Both job hazard analysis and pre-job survey techniques can be effectively used to train workers in hazard identification and appropriate control measures.

FACE 89-11: Lineman Supervisor Dies Following Contact with Energized Conductor

INTRODUCTION

The National Institute for Occupational safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On October 25, 1988, a 40-year-old male lineman supervisor died when he contacted an energized conductor.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On January 5, 1989, a research safety specialist and an occupational health nurse met with company officials and obtained photographs of the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this case is a small rural electric cooperative employing 72 individuals. The company has a written safety program and conducts weekly safety meetings with all employees. Company policies and procedures, prepared in association with a statewide electric cooperative association, address all phases of work performed by company employees. Daily tailgate safety meetings are held prior to the start of work on all jobs. The victim had been employed by the company for 18 years.

SYNOPSIS OF EVENTS

On the day of the incident the victim, who was the assistant foreman of the powerline construction crew, was in charge of the crew due to the foreman's illness.

The crew was rebuilding power lines. During these operations it is normal to create temporary switching points to minimize both the extent and number of power outages experienced by customers. At the job site on the day before the incident, the victim and the manager of operations had discussed the planned change in the direction of the electrical feed (supply). The manager of operations cautioned the victim about the two-way electrical feed (electricity supplied from two different directions) and they developed a detailed plan to make the required changes.

This plan called for manually opening a pole-mounted circuit breaker (reclosure) and removing the existing power leads. The second step was to move to the next pole and remove a jumper wire connection from the lines de-energized in the first step. The third and final step was to go to a third location three poles away and install a fuse in an existing fuse holder, thereby reenergizing the involved circuits with electricity fed from the opposite direction.

The victim assigned the members of his crew to the work area (approximately 3 miles from the incident site) and then, accompanied by an inexperienced apprentice lineman, began following this procedure. The victim had completed the required work at the first two locations and, with the apprentice, drove to the third location.

At this time the victim climbed the pole to replace the fuse, rather than use the available fiberglass "hot stick" to install the fuse from the ground. The victim took both a fuse and an 8-foot-long fiberglass "hot stick" up the pole with him. The victim disconnected the de-energized (upper) lead with this "hot stick," left the end of this lead in the "hot stick," and lowered the stick to his belt. At this time he called down to his apprentice and told him to go back to the service truck and get another hotline clamp. The victim then grasped the metal brace supporting the fuse holder to pull himself further up the pole. As he did so he contacted the energized (lower line) 7200-volt lead of the fuse holder with his right forearm. A "path to ground" was established from the victim's right arm through his body, out his feet, and down the pole which had recently been coated with creosote.

The apprentice heard the victim scream and observed the victim fall away from the line. The victim was held on the pole by his lineman's belt and climbers. The apprentice promptly summoned help via two-way radio, and the remaining members of the crew, along with the rescue squad arrived on the scene approximately 10 minutes after the incident occurred. Two members of the crew lowered the victim to the ground where cardiopulmonary resuscitation (CPR) was begun by members of the rescue squad. The victim was transported to a nearby hospital where he was pronounced dead on arrival.
Examination of the body after the incident revealed an entry wound on the right forearm and exit wounds on the bottom of both feet.

CAUSE OF DEATH

The medical examiner's office listed the cause of death as electric shock.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Personnel should be taught to avoid exposure to electrical hazards.

Discussion: The victim in this incident exposed himself to electrical hazards. The task to be performed, the installation of the fuse barrel in the bracket, could have been done from the ground using the telescopic fiberglass pole designed for this purpose. By climbing the pole (contrary to company standard operating procedures) to perform this task, the victim exposed himself to a known hazard with fatal results.

Recommendation #2: Personal protective equipment should be provided and utilized. Strict enforcement of company policies with regard to use of this equipment must be provided.

Discussion: The victim in this case was not wearing the protective gloves and sleeves provided by the company, even though the company procedures require that they be worn whenever workers climb on a pole with energized lines. The failure to use this personal protective equipment, by a person in a supervisory position, indicates a lack of understanding why this personal protective equipment is necessary.

FACE 89-15: Laborer Electrocuted as Boom of Bucket Truck Contacts a 7200-volt Power Line

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On January 11, 1989, a 31-year-old laborer was electrocuted while contacting an aerial bucket truck when the boom of the truck contacted a 7200-volt power line.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On January 26, 1989, a DSR research safety specialist conducted a site visit, met with representatives of the company, and discussed the incident with the Occupational Safety and Health Administration Compliance officer.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was one of 30 workers employed by a power line right-of-way clearance company. The company, which had been in operation for 6 years, had no safety policy, no safety program, and no written safe work procedures. All training was on-the-job. The victim had worked for the company for three days.

SYNOPSIS OF EVENTS

On the day of the incident, the victim and a truck driver (crew chief) were clearing a section of right-of-way for a single-phase 7200-volt power line in a wooded rural area located approximately one-quarter of a mile off the main road. Each time the truck was positioned, the victim would drop outriggers, and the driver would raise himself into position in the bucket and trim the trees with a chain saw or pneumatic clippers. When the driver had trimmed all branches within reach he would lower the boom to the truck. The victim would then raise the outriggers and reposition the truck. Once the truck was repositioned, the victim would stand near where the boom was mounted to the truck, in sight of the driver, until trimming was completed in that area. The truck was not grounded during this procedure.

In mid-afternoon the men decided to take a break. When they returned from the break the victim positioned the truck for the driver who began trimming branches. When the driver had finished trimming in that area, the victim repositioned the truck. When the driver saw the victim begin to drop the outriggers, he raised himself in the bucket to a position above the 7200-volt power line (the power line was approximately 22 feet above the ground). The driver assumed that the victim had returned to his position on the ground. As the driver repositioned the bucket he heard the victim groan and call out his name. The driver then noticed that the lower side of the uninsulated boom had contacted the power line and that the victim was lying on the ground beside the truck. He immediately lowered the bucket to the truck. As the driver exited the bucket he noticed that the victim was standing. As he approached, however, the victim collapsed. When he noticed that the victim was having difficulty breathing, the driver began "massaging" his chest. He looked up, saw three men in an adjacent field burning trash, and ran to them for assistance. One man left to summon the rescue squad while the others returned to the victim. When they arrived they noticed the victim had no vital signs. Once the rescue squad arrived, the physician's assistant pronounced the victim dead at the scene. The victim had apparently been in contact with the truck and the ground at the time the boom contacted the power line, allowing the electric current to pass through him to ground causing his electrocution.

CAUSE OF DEATH

The county coroner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Booms used in the vicinity of power lines should be insulated or adequate alternate means should be taken to protect workers.

Discussion: Booms used in proximity to power lines should be insulated to prevent the flow of current over the entire vehicle in case of inadvertent contact with the power lines. Safety measures such as those outlined in OSHA Standard 1910.180(j)(1)(i) should be utilized when uninsulated booms are used. Although this standard actually applies to cranes, the precautions are applicable to bucket trucks and other boomed vehicles as well. This standard states that "except where power lines have been deenergized and visibly grounded at the point of work, or where insulating barriers not a part of the crane have been erected to prevent physical contact with the lines, a minimum clearance of ten feet must be maintained between power line and machine for power lines rated 50 kV or less." If an insulated boom had been used or if a safe clearance distance had been maintained, this fatality may not have occurred.

Recommendation #2: The employer should develop a safety program designed to recognize and control hazards.

Discussion: The ever-present danger of overhead power lines appears obvious; however, contacts between booms and overhead power lines which result in occupational electrocutions continue to occur. OSHA Standard 1926.21 (b) (2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." The tasks performed by workers should be evaluated and the associated hazards identified. A safety program should then be developed that addresses the control of these hazards. The program should also stress hazard awareness training for all employees, especially new employees. The victim should have been made aware of all hazards associated with the performance of his task, including the hazards associated with working in proximity to power lines with boomed vehicles. If the victim had understood the hazards he may have known to watch and alert the driver that the bucket was too close to the power lines. Additionally, it was a poor safety practice for the driver to extend the boom of the truck over the power line. The truck should have been repositioned so that this action would not have been necessary. If the truck had been repositioned or if the victim had recognized the existing hazards, this fatality may have been prevented.

Recommendation #3: Employees who perform their duties in proximity to electrical energy should be certified in cardiopulmonary resuscitation (CPR).

Discussion: Although the majority of work performed by this company is in proximity to power lines the workers are not all certified in CPR. When the driver noticed that the victim was having difficulty breathing he began to massage the victim's chest. If the proper procedures for CPR had been immediately initiated, the victim's chances for survival would have been increased.

FACE 89-16: **Roofer Electrocuted When Ladder Contacts 7200-Volt Power Line**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On October 20, 1988, a 23-year-old male roofer was electrocuted when the 40-foot aluminum extension ladder he was positioning contacted an overhead 7200-volt power line.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On January 25, 1989, a DSR research safety specialist discussed the incident with the Occupational Safety and Health Administration compliance officer and the victim's partner.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim had been a partner with his uncle in a roofing company since his graduation from high school 5 years earlier. At the time of the incident, the company employed four workers. Although no written safety policy or program existed, it was standard company practice to avoid using aluminum ladders within 12 feet of overhead power lines. If a 12-foot clearance could not be maintained, it was standard practice to call the local utility company to request that protective sleeves be placed on the power lines.

SYNOPSIS OF EVENTS

On the day of the incident, the victim, his uncle, a cousin, and a fourth worker were replacing the asbestos shingles on a church roof. The crew had been working on the roof for 3 days, and was almost finished. It was late in the day when the victim suggested to his uncle that they stop and complete the job the following day. The uncle agreed and began to gather the tools on top of the roof. After telling his uncle that he would make sure that the cleanup work on the ground was completed, the victim descended one of the two 40-foot aluminum extension ladders that were used to access the roof of the church. The edge of the roof against which the ladders were placed was 27 feet above ground. The uncle estimated that the ladder was extended to about 30 feet in length. A 7200-volt power line was 15 feet from the side of the church against which the ladders were placed, and 35 feet above ground level.

After the victim descended the ladder, the uncle noticed that the ladder was being raised higher. Although the uncle could not see the workers on the ground, he heard the cousin tell the victim not to raise the ladder any higher and to watch the power line that ran parallel to the side of the church. As the uncle turned to face the edge of the roof, he again heard the cousin warn the victim. The victim replied that he knew what he was doing. The uncle saw that the ladder was still being raised, and was being moved in the direction of the power line. (It was standard company procedure to lower the ladder to the ground by sliding it to the left or right down the face of the building.) The uncle walked to the edge of the roof to see what was going on. As he reached the edge of the roof he saw the ladder contact the power line. The cousin attempted to pull the victim from the ladder, received an electrical shock, and lost consciousness. The ladder fell breaking contact with the power line and the victim collapsed on the ground. The uncle immediately descended the second ladder. He reached the cousin first and began to administer cardiopulmonary resuscitation (CPR). The cousin immediately responded and regained consciousness. The uncle then began CPR on the victim while the third worker summoned the rescue squad. The rescue squad transported the victim and the cousin to the hospital. The victim was pronounced dead by the attending physician, and the cousin was hospitalized. During interviews with the uncle it was learned that the victim had been "unusually distracted" for the two days prior to the incident. The uncle also stated that the victim was well aware of the electrical hazard presented by the power line since that was one of the hazards they addressed before beginning any new job.

CAUSE OF DEATH

The attending physician listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Aluminum ladders should never be used when the possibility of contact with overhead power lines exists.

Discussion: The workers believed that the 15-foot clearance between the power line and the church roof was sufficient to ensure their safety. They knew that the ladder, which was not fully extended, was not long enough to contact the power line. No one could explain why the victim raised the ladder and moved the ladder in the direction of the power line, especially after being warned, OSHA Standard 1926.450 (a) (11) states that "portable metal ladders shall not be used for electrical work or where they may contact electrical conductors." The aluminum ladder used in this incident was conductive. If a ladder constructed of non-conductive material had been used in this case the incident may have been prevented.

Recommendation #2: To ensure proper protection for anyone working near electrical power lines, arrangements should be made with the power company to cover the lines with insulating hoses or blankets.

Discussion: Energized power lines in proximity to a work area constitute a safety hazard. Extra caution must be exercised when working in the vicinity of energized power lines. A safe working distance between ladders and power lines should be maintained at all times. At least one state (California) requires that a 6-foot minimum clearance be maintained. The power company should be contacted and requested to place insulating hoses or blankets on any power lines in close proximity to a work area. This passively protects workers who are working near power lines.

Recommendation #3: The employer should develop a safety program designed to recognize and control hazards.

Discussion: The ever-present danger of overhead power lines appears obvious; however, contact with overhead power lines and the subsequent occupational electrocutions continue. OSHA Standard 1926.21 (b) (2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." The tasks performed by workers should be evaluated and the associated hazards identified. A safety program should then be developed that addresses the control of these hazards. Although, this company had standard safe work practices, these were not followed. If these practices had been followed it would have decreased the probability of a death occurring.

FACE 89-17: Electrical Foreman and Groundman Electrocuted When Guy Wire Contacts 13,200-Volt Power Line.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On October 12, 1988, a 45-year-old male electrical contractor foreman and a 30-year-old male groundman were electrocuted when a guy wire they were touching contacted a 13,200-volt power line.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On January 26, 1989, a DSR research safety specialist met with employer representatives, discussed the incident with the OSHA Compliance Officer, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim had been employed for 1 month by an electrical contractor that specializes in power line construction and maintenance. The contractor has been in operation for 53 years and employs 340 workers. The contractor has a written safety policy and a comprehensive safety program that requires training of all new employees and periodic retraining of all employees. Training is conducted both in the classroom and on the job. Tailgate safety meetings are conducted each day at the jobsite prior to work and the safety director makes periodic visits to all jobsites. All employees are required to be certified in cardiopulmonary resuscitation (CPR).

SYNOPSIS OF EVENTS

The employer had been contracted by the local utility to install a new three-phase 13,200-volt power system adjacent to an existing 13,200-volt system. The job required installing new power poles parallel to the existing poles and stringing three conductors for the new three-phase distribution system. The new conductors were to be attached to insulators mounted at 2-foot intervals on the sides of the new poles. When installed, the lowest of the new conductors would be 5 feet above the existing system. The new conductors were temporarily suspended at a distance of 36 inches from the new poles by individual roller brackets during stringing operations.

On the day of the incident the crew (two linemen, two groundmen, and the foreman) was assigned the tasks of permanently attaching the new conductors to the insulators on the poles and tensioning the new conductors (i.e., adjusting the amount of slack in the new power lines between the two power poles). To accomplish these tasks, two bucket trucks were used, one positioned at the front and one positioned at the back of each pole. The two linemen worked from the buckets while the groundmen and foreman offered assistance from the ground. Two guy-wire anchors had previously been installed in the ground approximately 12 and 15 feet in front of each power pole and guy wires had been attached to the new poles. Standard practice called for the guy-wire anchor farthest from the pole to be set deeper in the ground. Two guy wires would then be attached to that anchor while one guy wire would be attached to the anchor closest to the pole. However, because of an underground rock formation, standard practice could not be followed in this case. Instead, two guy wires were attached to the closest anchor and one was attached to the farthest anchor. The utility company was notified of this change in procedure and, after an inspection by their engineers, said that the modified procedure was acceptable.

As the linemen began to remove the new conductors from the roller brackets and attach them to the insulators, they noticed that the new conductors were coming close to the existing energized conductors. They notified the foreman of the problem. The foreman said he could take additional slack out of the new lines by tightening the guy wire on the farthest anchor, which would pull the new pole toward the guy wire anchor and away from the existing lines. Using a chain come-along (a portable ratcheting winch) the foreman began to tighten the guy wire. As the foreman tightened the single guy wire, the groundman (victim) loosened one of the guy wires on the other anchor. (The reason the groundman did this was unknown; neither the linemen nor the second groundman heard the foreman instruct the groundman to loosen the guy wire.) The foreman, who was facing away from the groundman while working the come-along and communicating with the linemen in the buckets, may not have noticed the groundman's actions.

The second groundman saw the groundman remove the guy wire from the anchor, walk toward the power pole, and bend over to place the guy wire on the ground. As the second groundman turned away, he heard the sound of an arc. When he turned back he saw both the foreman and the groundman lying on the ground near the anchors. The guy wire that the groundman was moving had contacted one of the energized power lines. Apparently both the foreman and groundman were touching the guy wire at the instant of contact. Cardiopulmonary resuscitation (CPR) was begun immediately on both men and the emergency rescue squad was summoned. The men were transported to the local hospital where the foreman was pronounced dead. The groundman died the following morning.

CAUSE OF DEATH

The coroner listed the cause of death in both cases to be electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers must stress the importance of adhering to established standard work procedures.

Discussion: Established employer standard work procedures require that insulating sleeves be placed on energized power lines when guy wires are installed in the vicinity. The groundman relocated a guy wire without following this procedure. None of the other workers heard the foreman instruct the groundman to relocate the guy wire, and it was possible that the foreman was not aware of the groundman's actions. In any case, had the company's standard work procedure of sleeving the energized power lines been followed, this fatal incident might have been prevented.

Recommendation #2: At tailgate safety meetings, the foreman should accurately detail the specific procedures to be followed to perform the designated tasks of the day, address all hazards associated with these tasks, and discuss how potential hazards will be controlled.

Discussion: Daily tailgate meetings should provide a forum to detail the exact procedures necessary to accomplish the assigned tasks for the day and to outline control measures for any hazards associated with these tasks. Supervisors must stress the importance of adhering to these procedures. Any modification to the procedures should be carefully considered before action is taken. Any potential new hazards created by modifying work procedures must be controlled. In this case, the procedures were altered when the victims began to work with the guy wires, thus creating the possibility that the guy wires could contact the existing energized lines. The job should have been delayed while the hazards were re-evaluated and controlled by covering the power lines with protective sleeves. If the newly created hazard had been addressed in this case the incident might have been prevented.

FACE 89-18: **Journeyman Electrician Electrocuted when Lockout Attempt Falls**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On December 17, 1988, a 39-year-old male journeyman electrician died when, after de-energizing one controlled access area, he mistakenly entered an identical energized area through a hatch with a defective lock, and made contact with an energized conductor.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. A research safety specialist discussed this case with state officials, and on February 2, 1989 met with company officials and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a large pulp and paper mill which has been in operation since 1961. The company employs approximately 500 individuals, including 19 electricians. The company has a full-time safety and health officer, a written safety policy, and detailed safety procedures. The victim had been employed by the company for the past 12 years as a journeyman electrician.

SYNOPSIS OF EVENTS

On the day of the incident the paper mill was in the middle of a "scheduled shutdown," an annual event that occurs when the mill ceases one of its two paper manufacturing operations, thereby reducing production by 50%. In order to return the idle unit to production as quickly as possible, maintenance crews work 12-hour shifts, 7 days a week until the task is completed. The victim had been working these extended shifts for 3 weeks prior to the incident.

At the time of the incident, the victim and a co-worker were engaged in routine maintenance and inspection of an electrostatic precipitator (a pollution control device designed to reduce emissions from the boiler's stack) in a large recovery boiler. This inspection can only be done when the boiler has been shut down for an extended period of time due to the high temperatures in the area during boiler operation.

The transformers controlling the precipitators are located inside two 25-foot by 37-foot by 7-foot-high "precipitator penthouses." The only access to these penthouses is through separate 24-inch-diameter access hatches located on the roof. The south penthouse (the unit to be inspected) was one of two identical units in the area which shared a common roof. Six transformers were located on the roof between the hatches leading to the north and south penthouses. Transformers 1, 3, and 5 controlled power to the south penthouse; transformers 2, 4, and 6 controlled power to the north penthouse.

The company utilizes a sophisticated "captive key" lockout system to control access to the penthouses. This procedure calls for a complex series of functions to be performed in exact sequence in order for access to be obtained. The normal sequence of events required to enter the penthouse are:

1. Shutdown the main breaker, located on ground floor.

2. Open the key control cabinet (ground floor) and obtain keys to power supply transformers (in this case, transformers 1, 3, and 5).

3. Go to the eighth floor and, using the keys from the control cabinet, shut down transformers 1, 3, and 5. As each transformer is locked out, the key used to lock out the transformer is retained and another key is released.

4. Take the three keys obtained from locking out the transformers back to the key control cabinet on the ground floor.

5. Insert the three keys into the control cabinet and turn them, thereby releasing one single key.

6. Take the single key obtained in step 5 back to the eighth floor. This key will unlock the hatch and allow access to the interior of the penthouse.

A few minutes after 1:00 a.m., the victim had completed the first three steps, locking out transformers 1, 3, and 5. As a result, the south transformer was de-energized. At this point the victim had the three keys needed to obtain the key to the penthouse from the key control panel. To obtain this key, the victim would have had to travel down the steps from the eighth floor to the first floor, obtain the required key from the key control cabinet, and return to the eighth floor to open the hatch to the penthouse.

The victim commented to his co-worker that the lock to the penthouse hatch was broken, and that they could save themselves a trip downstairs by entering the hatch. The victim then went over to the hatch of the (energized) north penthouse and pointed out the broken lock to his co-worker. The co-worker twice asked the victim if the area was secure and safe to enter . The victim replied "Yes," and proceeded to open the hatch and enter the penthouse while the co-worker waited outside the hatch. Shortly after the victim entered the penthouse the co-worker heard a "pop" and saw a flash. The co-worker called to the victim but received no reply.

The co-worker then went to the nearest phone and called the utilities supervisor. The supervisor immediately sounded an alarm summoning the plant emergency organization. The supervisor, four workers trained in first-aid, and a plant paramedic responded to the scene. Actual entry to the penthouse was delayed for several minutes as these individuals were required to go through the entire lockout procedure described above to de-energize the north penthouse.

Company rescue personnel entered the penthouse approximately 10 minutes after the incident. The victim was observed lying on the floor, with small third degree burns on his left arm and extensive burns on his right hand and forearm. Although the incident itself was not witnessed, it appeared that the victim had picked up a static ground cable with the intention of attaching it to a metal brace (standard procedure) when he made contact with the energized 50,000-volt transformer and was electrocuted.

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Company personnel immediately began cardiopulmonary resuscitation (CPR) and continued it until the local ambulance service arrived on the scene approximately 20 minutes after the incident. At this time defibrillation was performed twice, and CPR was continued. CPR was then discontinued for approximately 1 minute while the victim was removed from the penthouse and placed on a stretcher. The victim was transported to the local hospital where he was pronounced dead on arrival approximately 1 hour and 15 minutes after the incident.

CAUSE OF DEATH

The medical examiner gave the cause of death as cardiac arrest as a result of electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Periodic safety inspections should be made to ensure that unsafe conditions are identified and corrected. Conditions likely to result in serious injury or death should be assigned a high priority.

Discussion: In this case the company had an extremely sophisticated lockout system In place; however, the failure of one component of this system (the lock on the north hatch) permitted the victim to enter an energized area resulting in his electrocution. The broken lock had been reported 7 days prior to the incident and a work order to repair it had been submitted. This order, assigned to a contractor working on the site, had been returned marked completed; however, no one had followed-up to verify this. Proper follow-up of this work order would have detected the unrepaired lock, and could have prevented this fatality by correcting a flaw in the lockout system.

Recommendation #2: Employers must continue to stress the importance of following established safety procedures to all employees.

Discussion: In this case the employee disregarded two company safety policies. First, the employee failed to complete the standard lockout procedure for entering the penthouse. If he had followed company policy and obtained the key, he may have realized that he was preparing to enter the wrong area. Second, the employee disregarded company confined space entry procedures which require that an entry permit be obtained and that the air within the confined space be tested by a company technician. If this confined space procedure had been followed, at least one of the workers involved (the victim, co-worker, or technician) would probably have realized that the victim was planning to enter the incorrect hatch.

Recommendation #3: Auxiliary work lights should be available in all areas where maintenance work is routinely performed after dark.

Discussion: The site where the incident occurred had no lighting installed, and the victim entered the penthouse with only a flashlight for illumination. The area where the hatches are located is outdoors, and would normally be dark. Auxiliary lighting in this area might have helped the victim realize he was entering the energized north hatch.

Recommendation #4: A highly visible moans of identifying similar accessways or work areas should be used by the employer.

Discussion: The north and south hatches are identical in appearance. Working in the dark, after many days of long shifts, the employee became confused as to which hatch he was entering. Some easily recognized visible marking, such as a color coding or the letters S or N painted on the hatch covers, might have alerted the worker that he was entering the incorrect hatch.

Recommendation #5: Permanently installed safety equipment should be designed to minimize the possibility of accidental damage.

Discussion: In this case a complex and sophisticated lockout system was defeated by the failure of one small component (the lock on the hatch). This lock was subject to damage whenever the hatch was opened. A simple metal guard, installed to prevent the lock from striking other objects when the hatch was opened, might have kept the lock from becoming damaged and prevented this fatality.

Recommendation #6: Electric switch panels, key control panels, and similar units which have numerous identical or similar controls should have permanent, highly legible identification labels installed.

Discussion: The key control panel in this case contained numerous visually identical locks without any readily apparent means of differentiating between them. A simple, legible labeling system would help ensure proper identification of these units by involved workers.

Recommendation #7: Consideration should be given to the installation of an indicator light system on the hatches. Such a system would have a "green light" which would illuminate when the power to the penthouse was de-energized.

Discussion: An indicator light located in the hatch area would provide a ready check as to the state of the equipment inside the penthouse. Any failure to obtain a "green light" would serve to provide a visible warning to employees that the unit remained energized. Such a system could possibly have prevented this fatality.

FACE 89-19: Maintenance Mechanic Electrocuted While Touching Damaged Power Cord

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On December 22, 1988, a 37-year-old male maintenance mechanic was electrocuted when he grasped a power cord with damaged insulation and contacted an exposed energized conductor.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On February 8, 1989, a research team consisting of a safety specialist and an epidemiologist discussed this case with state officials, met with company officials, and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a meat-packing plant which has been in operation for 53 years and currently has 1500 employees. Ten workers are maintenance mechanics, whose work involves general mechanical repair of the various pieces of equipment used in the plant. The company has a formal safety program with written safety policies and procedures. Some specialized safety training in general safety and health and electrical safety is also provided to maintenance personnel. The victim had been employed by the company for 3 months at the time of the incident. He had received the general safety and health training but had not yet attended the electrical safety training program. The victim had completed a 4-year vocational mechanics program and had worked as a maintenance mechanic for several years prior to the incident.

SYNOPSIS OF EVENTS

At the time of the incident the plant was at the end of a normal production shift. Standard practice calls for personnel from the maintenance shop to go to the plant floor at the end of each shift, unplug two strapping machines (used for packaging meat), and move the machines to the maintenance shop for the night. The plant floor is then washed down and cleaned. The strapping machines are inspected the following morning and then returned to the plant floor for the following day's production.

Each strapping machine is a portable wheel-mounted stainless steel unit. Strapping material is fed to the machine from a fiberglass spool mounted on top of the machine cabinet. The strapping machine has a flexible power cord equipped with a twist-lock male plug which plugs into a receptacle at the end of a flexible cord extending down from the ceiling. These cords supply 480 volts to the machine.

On the day of the incident the strapping machines had been taken from the maintenance shop and placed in use at approximately 6:00 a.m. The machines were used throughout the day. Apparently the power supply cord on one machine repeatedly came in contact with the edge of the rotating fiberglass spool on top of the machine. The point of contact was approximately 2 1/2 inches from the male plug. Friction from the constant rotation of the spool gradually wore a small 1/2-inch-long hole through the outer cover of the flexible cord and through the insulation on one of the inner conductors, exposing a small section of energized wire. The floor of the room where the machine was located was wet from both the brine solution used in the packing operation and from water used periodically throughout the day to clean the area. The damage to the power cable went unnoticed as the non-conductive fiberglass spool, which caused the damage, served as an insulator and kept the machine from becoming energized and the operator from receiving electrical shock.

At approximately 5:00 p.m. the victim entered the room to unplug and move the strapping machine to the maintenance shop. The victim, wearing a damp pair of worn leather work boots, was standing in water when he reached out to unplug the strapping machine.

As he grasped the male plug, the ring finger of his right hand made contact with the damaged section of the cable and the bare 277-volt conductor. A "path to ground" was established from the victim's right hand through his body to his feet in contact with the wet floor, resulting in his electrocution.

A foreman and four workers from the department where the incident occurred were in the area and observed the victim in contact with the power cable. The foreman, who had received electrical burns 2 years previously, recognized that the victim was in contact with electricity and attempted to free the victim's hand from the cord with a plastic scoop. When this failed, the foreman struck the electrical plug above the victim's hand, knocking it loose from the cable. The supervisor and the workers in the area helped the victim to a chair in a nearby office and summoned both the company nurse and the local rescue squad. The victim then lost consciousness. The company nurse initiated cardiopulmonary resuscitation (CPR) on the victim. Upon their arrival, members of the rescue squad attempted defibrillation but were unsuccessful.

The victim was pronounced dead at the scene approximately 1 hour and 15 minutes after the incident.

CAUSE OF DEATH

The medical examiner gave the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Permanent fixed wiring should be used wherever possible. When such wiring is not practical, armored or protected cable should be used when the potential for contact between the cable and any moving parts exists.

Discussion: In this case both the power supply cable and the machine power cord had only a standard plastic covering over the insulated conductors. When the plastic covering on the power cord was exposed to friction from contact with the rotating spool of the strapping machine, it wore through, exposing the energized conductors. If permanent wiring (with a short power supply cord for the machine located where it could not contact any moving parts) or armored cable had been used, this incident might have been prevented.

Recommendation #2: Strain relief should be provided where connections on power cords are subject to being pulled apart.

Discussion: The wiring and equipment cords used in the facility had no form of stress relief as required by the National Electrical Code (NEC) 400-10. The constant strain during the operation of the strapping machine and the repeated connection and disconnection could easily result in damage to these cords, with the potential for exposing workers to an electrical hazard.

Recommendation #3: Disconnect devices should be located close to equipment. If the possibility of confusion exists, the disconnects should be marked to indicate which devices they control.

Discussion: The electrical disconnect for the strapping machine was located in a room remote from the work floor instead of being readily accessible as required by NEC 380-8. The disconnect was part of a large bank of circuit breakers which were not labeled to identify what area or equipment they served as required by NEC 110-22. As a result power to the involved machine could not be quickly disconnected, and the victim was freed from electrical contact only after the twist-lock connection was physically knocked from the energized line. This created a delay which could have contributed to the fatality, while at the same time endangering the co-workers attempting to rescue the victim. A company policy which calls for de-energizing equipment prior to unplugging it could prevent future incidents like this from occurring.

Recommendation #4: Electrical safety training should be provided to all employees likely to be exposed to energized equipment.

Discussion: While company policy calls for electrical safety training for all maintenance mechanics, the victim had not received the training in the 3 months he had been with the company.

Recommendation #5: Periodic safety inspection of all electrically-powered equipment should be performed to detect and correct any problems.

Discussion: Although the strapping machine was "inspected" by mechanics at the start of each shift, a visual examination of the damaged power cord revealed places where the outer covering had been previously abraded. Although no injury or serious damage to the cord had resulted from this previous damage, the problem should have been detected and investigated. Action could then have been taken which may have prevented this death.

FACE 89-26: Apprentice Lineman Electrocuted while Upgrading a Power Distribution System

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On March 6, 1989, a 21-year-old male apprentice lineman was electrocuted when he contacted a 13,700-volt power line while upgrading a power distribution system.

CONTACTS/ACTIVITIES

State OSHA officials notified DSR concerning this fatality and requested technical assistance, On March 23, 1989, a safety engineer and safety specialist interviewed company officials, met with the assistant coroner and the emergency medical service director, and obtained photographs of the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The victim was employed by a small power line construction company with 18 employees that has been in operation for 11 years. Two other employees are apprentice lineman. Although the company president serves as the company safety officer, the company does not have a formal safety program and relies upon on-the-job training. The company has a set of written safety rules that all employees are required to read and sign to verify that they understand them.

The victim had formerly been employed with the company for 20 months but in late 1987 he left to work for another company as a lineman. He rejoined the company as an apprentice lineman in October 1988.

SYNOPSIS OF EVENTS

The victim was working as part of a four-person crew upgrading a single-phase power distribution system to a three-phase system. The crew consisted of a foreman, the victim (apprentice lineman), a truck driver, and a groundman.

Using a "standoff," the crew moved the energized, 13,700-volt power line to a position, on the road side of the pole, which was approximately 2 feet away from where they would be working. (A standoff is a wooden arm with an insulator used to position a hot line away from the work area). The first phase (the line closest to the energized line) had been pulled into place, secured, and grounded. At the time of the incident, the crew was working on the second line, which had been pulled off a reel to the pole where it was to be "dead-ended." (Dead-ended means that the lines ended on insulators attached to a cross-arm.) After the line had been properly sagged, the victim in the bucket of an insulated bucket truck began to secure the line in a dead-end clamp. A 14-foot-long "tail" extended beyond the clamp, probably because this was what had been left on the reel. The groundman was providing tools and equipment as needed. The foreman and truck driver were replacing the empty reel in preparation for stringing the next line.

The groundman heard a "zip" and then heard a part of the clamp hit the ground. He called to the victim, who was still in the bucket, but got no response. After a few attempts to contact the victim with no response, he called the foreman to come over. They lowered the bucket to the ground and found the victim unconscious and not breathing. After removing the victim from the bucket, the groundman and the foreman initiated cardiopulmonary resuscitation (CPR). The foreman instructed the truck driver to call for an ambulance. The truck driver left the site to use a telephone because there was no radio in the truck. He was able to contact the emergency medical service (EMS) about 5 minutes after leaving the site.

Two nurses driving past the site saw the crew giving CPR, stopped, and helped continue CPR until the EMS personnel arrived at the scene. The EMS team transported the victim to a local hospital where he was pronounced dead on arrival.

When removed from the bucket, the victim was wearing only light leather gloves. His insulated rubber gloves and leather overgloves were on the floor of the bucket. The gloves had small burn holes in the palms of the gloves and there were burns on the victim's palms. Although there were no eyewitnesses, the victim apparently violated company safety policy by removing his insulated gloves and overgloves and placing them in the bucket.

The victim, holding the clamp in his left hand, may have pushed a cable off of the bucket with his right hand. In doing so, he could have come into momentary contact with the energized line, thus completing a circuit to ground from his right hand, across his chest to his left hand. This would account for the burn marks on both hands and the dropped clamp.

CAUSE OF DEATH

The emergency room physician listed cause of death as high voltage electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer needs to enforce employee compliance with established safety rules.

Discussion: The employer has a safety rule requiring that workers wear insulated gloves while working around energized lines. It is also necessary for the employer to be certain that his employees follow these rules. One way of doing this would be to conduct unannounced inspections of the work crews and take progressive disciplinary action when employees are found not using the proper protective equipment. This would inform the employees that the company takes safety seriously and will take action when necessary to be certain that the rules are obeyed. The employer was cited for a violation of 29 CFR 1926.28(a) which makes the employer responsible for requiring the wearing of personal protective equipment when there is exposure to hazardous conditions.

Recommendation #2: The crew should do a hazard survey prior to working on a pole.

Discussion: Each pole may have different potential safety problems that could be identified in a brief discussion between crew members. A line hose was installed on the energized line at the involved pole but was not positioned to prevent contact from being made. A review of the worksite should have shown a potential for contact with the energized line while working in the immediate vicinity. This review might have resulted in the movement of the line hose or installation of additional line hose on the energized line, thereby preventing the fatal contact. The employer was cited for failure to comply with 29 CFR 1926.416(a)(1) which requires the employer to guard live lines by insulation when an employee must work near them and the power cannot be disconnected.

Recommendation #3: A review of the clamps used in power line installation should be conducted.

Discussion: It appears that the victim may have removed his protective equipment to install some small nuts on the clamping device. Such clamps should be designed to enable workers to easily install them while wearing essential protective gloves and other required personal protective equipment.

FACE 89-27: Distribution Line Technician Dies after Contacting Energized Conductor

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On January 20, 1989, a 37-year-old male distribution line technician received third-degree burns to his leg and back when he contacted an energized conductor while repositioning a bucket to perform maintenance on a power line. He died 37 days later as a result of a secondary infection.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On March 22, 1989, a DSR research team consisting of a research safety specialist and a safety engineer, met with company officials, and visited and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a power line construction and maintenance corporation with 325 employees, 90 of whom are employed as distribution line technicians. The corporation has been in operation for 70 years, and serves as the prime contractor for a major utility company. The corporation has a comprehensive safety program with safety meetings held each Monday morning. In addition, "tailgate" meetings are held daily before work to review the planned tasks and to address any unusual situations likely to be encountered. The company employs a safety consulting firm and obtains additional safety consulting services and inspections from their insurance carrier. Periodic unannounced safety inspections of every crew are conducted at different times by corporation supervisory personnel, utility company supervisors, safety consulting personnel, and insurance company personnel. An observed violation of company safety policies results in immediate cessation of work and a 3-day suspension for the involved employee. Subsequent safety violations by the employee may result in dismissal.

Traditionally, the corporation has trained all employees by starting them as groundmen and entering them in a 6-year apprenticeship program. However, due to a recent increase in work load the corporation hired 6 "journeyman" line technicians who received training elsewhere. These line technicians were assigned to work with other line technicians trained by the corporation. The victim was one of these new employees, and had been with the corporation for 4 months at the time of the incident. However, he had 18 years' previous experience in power line construction.

SYNOPSIS OF EVENTS

On the day of the incident the victim was working as a member of a two-person crew replacing power line fuses to match an anticipated increased load on a line.

The power lines they were working on comprised a three-phase circuit with a phase-to-phase potential of 12,470 volts. In order to prevent power outages and surges affecting customers, this work had to be performed while the lines were energized. The first step in the normal procedure involved positioning and grounding the bucket truck. Then one of the crew would use the bucket to access the power lines, where a second ground would be installed from the bucket unit to the neutral wire. Next, a jumper wire would be installed around the fuse holder, the fuse would be replaced, and the jumper would be removed. This process would then be repeated on the other two phases of the circuit.

The crew had been working since 7:30 a.m. on power line poles beside side streets with a minimum amount of traffic. At 2:30 p.m. the crew was "spot checked" by a utility company supervisor, who found that they were following all policies and procedures, and were using all appropriate personal protective equipment. Shortly after 3:00 p.m. the crew moved to a pole located along a major two-lane highway. Because of the heavy volume of traffic on this road, the crew positioned the bucket truck they were using in a parking lot adjacent to the power line pole.

The victim, following the procedure outlined above, had changed the fuse on the first phase of the circuit; i.e., the power line closest to the bucket truck. He then repositioned the bucket to obtain access to the center of the three phases. Two sections of line hose for covering the energized conductor were in the bucket with the victim, but he did not use them. The victim attached one end of the jumper wire to the center phase, and placed the other end of the now energized jumper inside the fiberglass bucket with him. (This was a violation of company policy.) The uninsulated end of this jumper came into contact with the victim's right thigh. The victim repositioned the bucket to obtain access to a second point on the center phase conductor, where he planned to attach the free end of the jumper prior to changing the fuse. As he moved the bucket his upper back came into contact with the conductor he had previously worked on. A phase-to-phase path was established between the victim's right thigh and his back which resulted in extensive third-degree burns to his right leg and back.

The victim's co-worker, on the ground below, heard a noise and looked up, where he observed the victim's body smoking and saw the victim collapse within the bucket. The co-worker jumped onto the truck and began lowering the bucket while he summoned help via the onboard two-way radio. (A standard company distress signal serves to automatically call both a second crew and Emergency Medical Services (EMS) to the scene of an incident.) This distress signal was received by the EMS squad at 3:30 p.m. A unit was immediately dispatched, arriving at the scene of the incident at 3:33 p.m. A second crew also arrived on the scene shortly after the bucket had been lowered to the ground. The victim, who remained conscious, was removed from the bucket via a backboard by members of the EMS squad. He was transported to a local hospital, where he was treated and transferred by helicopter to a trauma center. He arrived at the trauma center less than 3 hours after the incident.

The victim lived for 37 days before dying as a result of an infection secondary to the third-degree burns he had received.

CAUSE OF DEATH

The medical examiner's report was pending at the time of this report. The presumed cause of death is infection subsequent to third degree burns.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Guarding or shielding should be used whenever the potential for contact with energized conductors exists.

Discussion: While the victim in this case was wearing all appropriate personal protective equipment, including rubber gloves, sleeves, hard hat, eye protection, safety belt and lifeline, he still contacted two live energy sources (the end of the jumper and the adjacent conductor). A fiberglass clip, attached to the outside of the bucket for holding the end of the jumper, was not used. In addition, two sections of line hose for covering the energized conductor were in the bucket, but also were not used. Company policy required workers to use both the clip and the line hoses. Both were being used when the crew was observed 1 hour prior to the incident. Had either of these protective devices been used at the time the incident occurred, this death might have been prevented.

Recommendation #2: Bucket trucks should always be positioned to provide the best access to the power lines being serviced.

Discussion: While the traffic on the two-lane highway was heavy and could not have been controlled by the two-person crew on the scene, additional help to direct traffic could have been requested. Corporation policy called for the use of an additional crew whenever a traffic problem was encountered. Nevertheless, this crew chose to access the conductors by positioning the truck in the adjacent parking lot, resulting in increased difficulty in reaching the conductors. The additional maneuvering of the bucket truck required to reach the conductors was a contributing factor in this fatality.

Recommendation #3: Power lines should be de-energized prior to working in their vicinity.

Discussion: Prior to the beginning of any task involving work on power transmission lines, de-energizing these lines should be considered. Although de-energizing the lines might have been impractical in this case due to the customer power outages which would have resulted, in some cases it may prove to be a feasible action. When lines are de-energized the probability of being exposed to an electrical hazard is decreased and worker safety is increased.

Recommendation #4: When clearance between a worker and energized lines is likely to be minimal, a ground-based observer should watch the operation from below and advise the line technician in the bucket of potential problems.

Discussion: While a co-worker (groundman) was present on the ground in this case, he was not observing the line technician operating the bucket at the time of the incident. Had the groundman been watching, he may have observed the potential for contact with the energized line, and warned the victim, thereby preventing this fatality.

FACE 89-36: **Distribution Line Technician Electrocuted by Conductor in Contact with 7200-volt Power Line**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On April 20, 1989, a 44-year-old male distribution line technician was electrocuted and a second distribution line technician received severe electrical burns when a new conductor they were installing contacted an existing, energized 7200-volt power line.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On May 16, 1989, two safety specialists evaluated pictures, line drawings, and the circumstances of the incident with the company's president, regional manager, and supervisor of power line construction. The circumstances of the incident were also reviewed with the county coroner and the county police. Investigative reports were obtained from the county police and the company.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The victim was one of 100 distribution line technicians employed by an electrical contractor. The contractor has been in operation for 43 years and employs 550 workers. The contractor has no written safety policy or safety program but adheres to the safety practices of any company for which they do contract work. The contractor does have an unwritten policy that requires linemen's gloves and rubber overshoes be worn when line work is being performed. Daily safety tailgate meetings are held at the job site, and weekly safety meetings are held at the office. The company maintains a video library of safety films dealing with all aspects of power line construction. These films are shown both in the office and in the field. Supervisors are required to complete a daily safety checklist for each job completed. Since this incident, the company has begun to develop a comprehensive written safety program and has reaffirmed with each worker its position on the use of rubber gloves and rubber overshoes.

SYNOPSIS OF EVENTS

The company was under contract to assist the local utility in converting an existing single-phase 7200-volt distribution system into a 3-phase system by installing two new conductors. The new conductors were to be located just 15 inches below the existing conductors, which were attached to pole-top insulators located at opposite ends of the 8-foot crossarms on each pole. At the time of the incident the job was nearly completed. One new conductor had been installed. Three 2-man crews (one crew from the utility company and two from the contractor) at the site were preparing to sag (adjust the amount of slack) the last four spans (one span is the distance between two power poles) of the second new conductor, an overall distance of 1,058 feet.

The two utility company employees were located in a bucket at the top of the pole at the end of the fourth span preparing to "dead-end" (attach) the second new conductor to an insulator on the final crossarm (see Figure 1). One contractor crew (the victim and co-worker) was located at the base of the pole, at the end of the fourth span, preparing to pull the slack out of the new conductor by hand. The second contractor crew was directing traffic near the first pole of the fourth span, which was 216 feet from the end pole.

The victim, because of his seniority, was the supervisor of the contractor employees. When the utility company employees were ready to dead-end the conductor to the crossarm, they called down to the victim to take up the slack. The victim grasped the conductor and began to pull but was not able to take up any slack. The co-worker, seeing that the victim was having a difficult time, grasped the conductor behind the victim and also began to pull. At this time one of the crewmen directing traffic saw that the conductor had become snagged in the topped-out cedar trees in the first span. Before he could yell for the victim to stop pulling, he heard a loud buzz and saw a flash at the midpoint of the first span above the topped-out cedar trees. The two workers had pulled on the new conductor with enough force to cause it to flip up into the energized conductor. The crewman also noticed the new conductor swaying back and forth. The utility company employees heard the victim and his co-worker yell and turned to see both men fall to the ground. They immediately lowered themselves to the ground and began to administer cardiopulmonary resuscitation (CPR) to the victim. The co-worker received electrical burns to his left arm and right side. Two nurses passing in a car stopped and assisted with CPR until the emergency medical service (EMS) rescue squad arrived. The EMS personnel transported the victim and co-worker to a local hospital where the victim was pronounced dead by the attending physician. The injured co-worker was transferred to a burn center where he was listed in serious condition. At the time of the NIOSH investigation, the co-worker had been released from the burn center, but had not returned to work.

Investigation revealed that neither man was wearing the required rubber gloves or rubber overshoes at the time of the incident. The victim and co-worker had been seen wearing their protective equipment by the field supervisor during several daily inspections, and had been seen wearing their gloves and overshoes earlier on the day of the incident. At the time of the incident, the co-worker was wearing leather gloves and the victim was working bare-handed. The fact that the co-worker was wearing leather gloves, and was standing behind the victim who may have received most of the electrical charge, might explain why there was only one fatality in this incident.

CAUSE OF DEATH

The attending physician listed cardiac arrest due to electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should stress the importance of strictly following established safe work procedures including wearing required personal protective equipment.

Discussion: The victim, the contractor supervisor at the job site, had worked for the contractor for 13 years, and was aware of safety procedures requiring the wearing of rubber gloves and overshoes. The two workers had been observed at various times, including earlier on the day of the incident, wearing the required protective equipment. They were not wearing their equipment at the time of the incident. Employers must ensure that all workers understand the importance of following established safe work procedures at all times.

Recommendation #2: Non-conductive drag lines should be attached to the conductors being installed for use by employees during sagging operations, especially when performing these operations by hand.

Discussion: The protective equipment required for these operations, if worn, would probably have reduced the severity of the outcome of this incident. To further protect the safety of workers, non-conductive drag lines could be attached to the conductors and pulled by workers during sagging operations. In this instance the energized lines were located only 15 inches above the new conductor. This would eliminate the need for the workers to directly contact the conductors during these operations.

Recommendation #3: A job site survey should be conducted prior to beginning work to identify existing or potential hazards.

Discussion: A job site survey performed prior to beginning work may have identified the topped-out cedar trees as a potential hazard. Once this hazard was identified, a lookout could have been posted near the tree to alert the other workers if the conductor became snagged in the trees. Additionally, the feasibility of placing protective sleeves over energized conductors during stringing operations should be considered.

Recommendation #4: The employer should design, develop, and implement a comprehensive safety program which includes specific written procedures for all work near energized power lines.

Discussion: The employer should design, develop, and implement written procedures for specific tasks such as line stringing and sagging. These procedures should include, but not be limited to:

1. Worker training
2. Electrical hazard recognition
3. Use of personal protective equipment
4. Supervisory job site surveys prior to the start of work
5. First aid cardiopulmonary resuscitation (CPR) certification training.

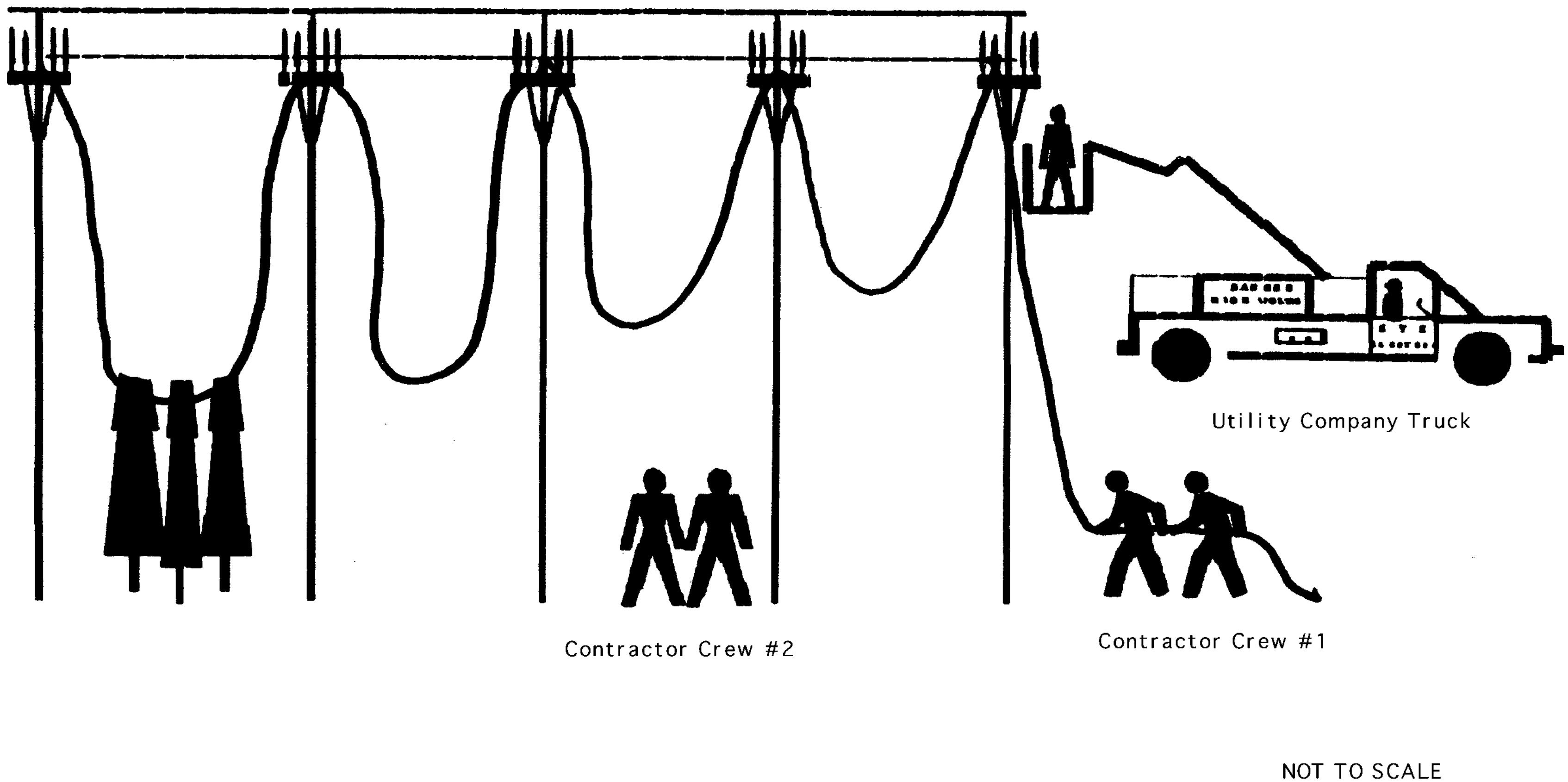
Utility Company Truck
Contractor Crew #2
Contractor Crew #1
NOT TO SCALE

Figure 1.

FACE 89-37: Laborer Electrocuted When He Contacts 4160-volt Power Line on Rooftop

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 1, 1989, a 21-year-old male laborer was electrocuted when his hand contacted a 4160-volt power service line.

CONTACTS/ACTIVITIES

State officials of the occupational safety and health program notified DSR of this fatality and requested technical assistance. On June 21, 1989, a research team consisting of a research industrial hygienist and a medical officer met with company officials and state OSHA compliance personnel to gather information, and traveled to the site of the incident to conduct an investigation.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The employer is a painting contracting company which has been in operation for 15 years and currently has approximately 50 employees. The majority of the work performed by the employer is sandblasting and painting on the outside of buildings. Most of the employees are painters and general laborers. The victim in this incident was a general laborer (doing sandblasting) and had been employed for 1 month. The company has no written safety program. However, the owner conducts weekly safety meetings with all employees. He also conducts a hazard communication program on chemicals used in paint, and training in the use of respirators for spray painting and sandblasting. Material safety data sheets (MSDS) are available to employees from the employer's office. All workers are required to report to the office at the beginning of each workday to receive their assignments and a briefing before going out to various job-sites. At the time assignments are given, the owner briefly reviews individual work crew progress, and discusses safety information and concerns specific to the job being performed.

SYNOPSIS OF EVENTS

The employer had been contracted by a large textile manufacturing company to sandblast and paint several air conditioning units on the roof of a 35-foot-high textile plant building. The roof is flat and has a 2-foot-high, 8-inch-wide parapet wall border. Electrical power to the building is provided by a three-phase, 4160-volt service line. The service line is anchored 5 feet above the roof surface to two galvanized pipes, which are located 2 feet apart on the top of the roof, and 2 feet in from the edge. The power lines and anchorage are guarded on all sides (except the roof edge) by a 6-foot-high chain link fence forming an 8-foot by 20-foot enclosure. The fence has a locked access gate and a 10-inch by 12-inch sign on the gate which states "DANGER - HIGH VOLTAGE - KEEP OUT."

Two days before the incident, the owner and two workers (the victim and a painter) who had been assigned to the job, met at the office and then at the jobsite. While at the site, the owner discussed the job with the two workers, cautioning them to stay away from the edge of the roof and not to enter the power service enclosure.

On the day of the incident, the victim was sandblasting the air conditioning units. The painter was spray painting each unit after it had been sandblasted. The victim was wearing a dust/mist respirator, sandblasting hood, and leather gloves. At 11:40 a.m., the victim completed the sandblasting work. Noting this, and that it was almost lunch time, the painter told the victim to sit down and "cool off" (due to the heat of the day) while he finished spray painting. Five minutes later, the painter ran out of paint and decided to break for lunch. When he turned around to look for the victim, he saw him inside the power service enclosure. The victim's legs were wrapped around one of the anchor poles with his back arched over the edge of the parapet wall.

The painter ran to the roof access door and yelled to a textile company employee to call the emergency medical service (EMS). The painter then entered the fenced-in enclosure by climbing around the end of the fence on top of the parapet wall. He pulled the victim away from the anchor pole into the middle of the enclosure and began administering cardiopulmonary resuscitation (CPR). He was assisted by the textile plant engineer who arrived at the scene within a few minutes of the incident. Personnel from the local EMS arrived approximately 15 minutes after the painter called for help. Efforts by the EMS crew to resuscitate the victim were unsuccessful, and the victim was pronounced dead at the scene.

There were no eyewitnesses to the incident. However, evidence indicates that the victim removed his respirator, sandblasting hood, and leather gloves and then, for unknown reasons, entered the enclosure either by climbing over the fence or by walking around on the parapet wall. Presumably the victim sat down on the roof under the power line, and contacted one of the energized power line conductors with his left hand. The victim's body provided a path to ground for the current and the victim was electrocuted. The medical examiner's report indicated deep thermal burns on the victim's right hand and the inside of his right thigh.

CAUSE OF DEATH

The medical examiner listed accidental electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Owners of buildings should ensure that electrical installations are adequately guarded to prevent unauthorized access.

Discussion: The building in this incident did have a fenced enclosure around the power service entrance in accordance with the National Electric Code (NEC), Article 110-31. Yet, an unauthorized worker entered the power service entrance enclosure, contacted an uninsulated conductor, and was electrocuted. Therefore, the building owner should consider an additional or alternate means for guarding service entrance conductors in accordance with the NEC Articles 110-31 and 230-202.

Recommendation #2: The employer should develop a safety program designed to recognize and control hazards.

Discussion: The ever-present danger of overhead power lines appears obvious; however, contact with overhead power lines and subsequent occupational electrocutions continue. OSHA Standard 1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." The tasks performed by workers should be evaluated and the associated hazards identified prior to beginning any work. A safety program should then be developed that addresses the control of these hazards. Although the employer had conducted weekly safety meetings and had given verbal safety instructions to workers, there was no written safety program, and in this incident verbal safety instructions were not followed. Admittedly, a written safety program is no guarantee that worker fatalities will not occur. However, a written safety program does help to establish the fact that the employer has initiated the process of taking reasonable measures to protect workers.

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FACE 89-39: **Apprentice Lineman Dies after Contacting 7200-volt Primary Wire**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On May 2, 1989, a 20-year-old male apprentice lineman died after making direct contact with a 7200-volt primary wire.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. DSR personnel discussed this case with state compliance personnel. On June 26, 1989, a safety specialist and a safety engineer from DSR reviewed the incident with company officials, visited and photographed the accident site, and met with responding EMS personnel.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this case is a large, multistate utility services contractor. The company has been in operation for more than 70 years and employs more than 10,000 employees. The company has a multifaceted safety program that specifically addresses the hazards employees in each of the various subdivisions (i.e., electrical distribution, gas line distribution, and telephone line distribution) are likely to encounter. The company employs full-time professional safety personnel in each division, a ratio of approximately one safety professional for every 250 employees. Periodic refresher training courses are provided to all employees. In addition, in the electrical distribution division (which was involved in this incident), all service personnel go through a training and classification system sponsored by the local electrical union. The victim was classified by the union as a fifth step (highest level) apprentice lineman at the time he was hired by the company. The victim had worked for the company for 7 months at the time of the incident.

SYNOPSIS OF EVENTS

The victim was employed as an apprentice lineman on one of six powerline construction crews working near a large metropolitan area. These crews consist of a crew leader, a journeyman lineman, and in some cases an apprentice lineman. The victim's father was the crew leader on the victim's crew.

Company procedure for apprentice work on utility poles requires the journeyman to ascend the pole and install all needed guards (line hoses, etc.) before the apprentice ascends the pole. After work is completed, the apprentice descends the pole first. The journeyman then removes the guards and descends.

On the day of the incident, the journeyman lineman for the crew had called in sick, leaving just the apprentice and crew leader at work. Since the crew was short a journeyman, and since it was raining, the company superintendent informed the crew leader the first thing in the morning that the crew would not be working any lines that day. Instead, the crew leader was instructed to complete some outstanding paperwork and deliver it to two area offices. He was also to pick up materials that the crew would be using during the following days.

The rain stopped at approximately noon, and the crew leader and the apprentice decided to go look at an area where they would be working the following day. The work to be done at this site involved transferring one primary and three secondary lines from an old utility pole to a new pole, less than 18 inches away.

After looking at the worksite, the apprentice and his father (the crew leader) discussed performing the job while they were at the site rather than coming back the following day (with the journeyman). The crew leader, in direct violation of company safety policy, agreed to allow the apprentice to perform the job by himself.

The pole was in the backyard of a private residence, and could not be accessed from the crew's bucket truck. Therefore, the apprentice put on his climbing equipment, rubber sleeves (as required by company policy), and a set of leather "protectors" (leather gloves designed to be worn over a pair of rubber lineman's gloves), and climbed the pole. As the apprentice prepared to install a line hose over the primary wire prior to moving this wire to the new pole, the crew leader left the area to go to the crew's truck and obtain a "baker board" (a portable platform linemen erect on a pole to provide a stable platform to work from). As he was approaching the truck, approximately 50 yards from the pole, he heard the apprentice scream. When the crew leader turned around, he saw the apprentice in contact with the 7200-volt primary line. The apprentice collapsed and fell away from the line, still secured to the pole by his climbing belt. The crew leader asked a nearby resident to call for help while he began trying to remove the victim from the pole.

Local fire department and emergency medical services (EMS) personnel were on the scene approximately 6 minutes after the incident. The crew leader assisted rescue personnel in removing the apprentice (his son) from the pole. Cardiopulmonary resuscitation (CPR) was begun immediately by EMS personnel.

The victim had burns on the little finger of each hand and on each shin where his metal climbers were strapped on. It appears that the victim, wearing only his leather overgloves, was attempting to install a section of line hose when the little fingers of both hands made contact with the energized primary wire. A path to ground was established from the victim's hands, through his body, to the metal climbers strapped to his legs, with the new pole serving as "ground."

<u>NOTE</u>: The victim had his rubber gloves and a second pair of leather overgloves in a tool pouch on his hip at the time of the incident. The victim had previously requested and been issued a pair of rubber guards for his climbers. These were in the crew's truck when the incident occurred.

The victim was transported to a nearby hospital where he was pronounced dead approximately 1 hour and 30 minutes after the incident.

CAUSE OF DEATH

The medical examiner's report lists the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Established company safety procedures must be followed at all times.

Discussion: In this incident the company has a comprehensive safety program in place. This plan specifically prohibits apprentice linemen from climbing a pole without a journeyman first climbing the pole and installing all needed guards. The policy also calls for the use of both rubber lineman's gloves and leather protectors to be worn at all times when a lineman is off the ground. Had either of these policies been followed, this incident probably would not have occurred.

Recommendation #2: Line crews should obtain management approval prior to making changes in work assignments or operational procedures.

Discussion: In this case the crew decided to visit a site and perform a task without the knowledge of management. The superintendent was unaware the crew was even in the town where the incident occurred, much less that they were engaged in line work. Had the crew leader contacted his supervisor he probably would have not been permitted to attempt the task which resulted in this fatality.

Recommendation #3: Management should consider the possible consequences of permitting family members to work together when one is serving as a "trainee" under the other's supervision.

Discussion: When relatives work together, the potential exists for either individual to exert personal influence on the other. For example, the son may have convinced his father to "give him a chance" or, the father may have "pushed" the son to accomplish a task for which he was not adequately trained. In any case, the apprentice attempted, and the crew leader condoned, a task which would ordinarily have been prohibited. Management must stress the fact that company safety policies apply to all individuals, regardless of relationships between individuals.

FACE 89-40: **Service Operations Technician Dies after Contacting 7680-volt Switch.**

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On May 13, 1989, a 40-year-old male service operations technician died after contacting an energized 7680-volt switch while observing a service operations technician trainee operating the switch.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. DSR personnel discussed this case with state compliance personnel. On June 28, 1989, a safety specialist and a safety engineer from DSR reviewed the case with company officials, visited and photographed the incident site, and met with responding Emergency Medical Service (EMS) personnel to obtain information about the sequence of events leading up to and following this incident.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The employer in this incident is a large utility company which has been in operation for more than 140 years. The company employs 8,600 employees, including full-time safety and industrial hygiene personnel at both the corporate level and at field operations locations. The company has a comprehensive, multifaceted safety program which addresses all hazards to which employees may be exposed. Scheduled safety training programs are held on a regular basis. In addition, specialized training is provided whenever operations or equipment change, and all employees receive periodic refresher training in their areas of expertise.

The victim was one of 106 service operations technicians employed by the company. Service operations technicians routinely perform such tasks as streetlight repair and switching operations. In order to become a service operations technician, an individual must first become a journeyman lineman and must then complete an additional 6 weeks of classroom training and a 6-month "trainee" period under the direction of an experienced service operations technician. The victim had worked for the company for 19 years prior to the incident, serving as a journeyman lineman for 14 years prior to becoming a service operations technician 2 years ago.

SYNOPSIS OF EVENTS

On the day of the incident, the victim was working the third shift. Although normally he would be working alone, for the month preceding the incident the victim had been training a service operations technician trainee.

The two men began work at midnight on the day of the incident performing a variety of routine tasks. Near the end of their shift, at approximately 7:15 a.m., they were assigned the task of restoring power to a large shopping mall. Construction crews from the company had been working at the mall all night in response to a power outage which occurred the previous evening. In order to restore normal power to the mall, the crew had to unlock and open a pad-mounted cabinet and throw a knife switch. The interior of the cabinet contained three sections, each of which contained a vertical knife switch flanked by nonconductive panels.

Standard procedure for opening or closing one of these switches called for an employee to use a "load-buster" (a device designed to contain electrical arcing) attached to a fiberglass "hot stick" (a non-conductive extension tool designed to allow a lineman or technician to work safely with or around energized conductors). The end of the load-buster fits into a socket on the hot stick, with a spring-loaded button from the load-buster protruding through a hole in the hot stick to secure the connection. The opposite end of the load-buster has a hook which is used to grasp and pull the knife switch to the desired position. Company policy calls for the employee using a hot stick, and anyone working with him, to wear rubber lineman's gloves, rubber sleeves, goggles, and a hardhat. This operation is typically accomplished by a service operations technician working alone.

When the service crew reached the incident site, they met a two-man construction crew which had been working in the area. While the victim was talking to the men on this crew, the trainee attached the load-buster to the hot stick, put on his required personal protective equipment (PPE), and walked over to the cabinet. A trench, approximately 2 feet wide and 4 inches deep, ran the length of the cabinet face. (This trench had been made by the construction crew during their work.) The trainee opened the cabinet and prepared to throw the knife switch. At this time, the victim told the construction crew that he had "better go over and watch the trainee throw the switch." He walked over to the cabinet and stood in the trench directly in front of the open cabinet and to the right of the trainee. The technician was not wearing any of the required PPE, with the exception of his hardhat. This was in violation of a company policy that requires an employee to wear the required protective equipment when within 3 feet of an open cabinet.

Due to the construction work that had been done, the trainee had to stand to the left of, rather than directly in front of, the knife switch. While the trainee was attempting to throw the switch, the spring-loaded button on the load-buster became disengaged from the hole in the hot stick. This allowed the hot stick to rotate freely instead of turning the load-buster. As the trainee attempted to realign the hole in the hot stick with the button on the load-buster, the technician reached out with his bare right hand to assist him. It is not known whether his bare hand touched the energized switch or the load-buster, or came close enough (within a quarter inch of an energized surface) to establish contact with the current. In any case, the current followed a "path-to-ground" from the energized equipment to the victim's right hand, through his body, and out his feet. The victim straightened into an upright position. Flames were observed coming from the victim's right hand. The victim, still conscious, fell away from the cabinet.

The two-man construction crew observed this incident. One member of the crew immediately used the vehicle radio to call for an Emergency Medical Service (EMS) ambulance while the other ran to the victim. As the trainee and the men of the construction crew attempted to help him, the victim told them "I'll be O.K., just leave me alone for a minute." The victim then lost consciousness.

The construction crew members, who were trained in Cardiopulmonary Resuscitation (CPR), immediately began to administer CPR to the victim. They were unable to detect any vital signs. The EMS crew was on the scene approximately 5 minutes after the incident. They continued CPR on the victim, but were not able to detect any vital signs. They initiated transport of the victim to a local hospital; however, when they were unable to detect any vital signs, the victim was pronounced dead and they were instead routed to the county morgue.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The design of the system for attaching the load-buster to the hot stick should be reviewed.

Discussion: While problems with the attachment system had not been previously recorded, this incident clearly shows that the potential for such problems exists. The design of this system should be reviewed and consideration given to the practicality of installing guards to prevent the locking button from being inadvertently depressed.

Recommendation #2: Periodic spot checks of worksites by management/supervisory personnel should be conducted to verify that established safe work practices are being followed.

Discussion: A program of periodic spot checks conducted at random intervals and times by supervisory personnel would have the twofold effect of providing management with knowledge of whether or not established safe work practices are being followed by field personnel, while at the same time providing an incentive to field staff to follow the practices.

Recommendation #3: Safety rules and practices must be followed at all times by all employees.

Discussion: In this case company policy requires the use of appropriate personal protective equipment when working around energized equipment. The policy of using the fiberglass hot stick and rubber gloves and sleeves provides redundant protection; i.e., two "layers" of protection for the worker. In spite of this policy, the victim, an experienced employee, entered an area known to contain energized electrical equipment without his PPE. When the problem developed, he reacted without thinking, contacted an energized piece of equipment, and was electrocuted. This momentary lapse in adherence to known safe work practices cost him his life.

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FACE 89-42: Television Cable Installer Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 21, 1989, a 24-year-old male television (TV) cable installer was electrocuted when he came in contact with a 7280-volt powerline running 5 feet above the roof of a house.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. DSR personnel discussed this case with state compliance personnel. On July 19, 1989, a safety engineer from DSR conducted an investigation, reviewed the case with company officials, visited and photographed the incident site, and met with responding emergency medical service (EMS) personnel to obtain information about the sequence of events surrounding this incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is an electrical contractor with 90 employees who has been in business for 12 years. The company president serves as the safety officer and each supervisor is responsible for the safety and training of his crew. The company does powerline work, TV cable installation, and other electrical contracting. Safety information is primarily conveyed via on-the-job training, which is supplemented with safety materials provided by the utility companies for whom the contractor works. The company does not have a formal safety program.

The victim had started working for the company just 2 days before the incident as part of a crew of 10 employees. None of the crew members had been with the company for more than a few weeks.

SYNOPSIS OF EVENTS

The employer had a contract to install TV cable in a semirural area. Existing power poles were being utilized to secure the TV cable. The employer stated that two safety evaluations of the installation project had been conducted. The power company whose poles were being used conducted one of these evaluations, and did not identify any serious hazards. Power company officials had informed the employer of these findings prior to initiation of the installation work. The second evaluation was conducted by a private concern.

The victim, who had a ground job, was working as part of the 10-person crew installing the cable. The crew was divided into four, two-man teams of cable installers or groundmen. The groundmen on these teams were responsible for controlling the cable reel, pulling the cable into position along the route, and keeping the cable clear of obstacles. Additionally, two polemen with the crew were responsible for any pole work that might be required, and a single supervisor was present to oversee the entire job.

A hanger wire had been installed on the power poles to facilitate installation of the TV cable. A cable dolly (a device that rides on the hanger wire, and to which the cable is attached) was being used to pull the TV cable into position. While the cable dolly was being pulled along the hanger wire, it fell off onto the roof of a house which was under the path of both the TV cable and the powerline. A co-worker boosted the victim onto the roof of the single-story house so that he could place the cable dolly back on the hanger wire line. While the victim was on the roof, his head contacted a 7280-volt powerline that was approximately 5 feet above the roof. The victim had his hands on the hanger wire at the same time his head contacted the powerline, providing a path to ground through his body and the hanger wire. The victim then fell approximately 15 feet from the roof onto a concrete surface.

Initially, the victim was conscious and was attended to by co-workers. By the time the EMS arrived 10 minutes later, the victim had lost consciousness. The victim was treated by EMS personnel, who initiated cardiopulmonary resuscitation (CPR). Although they were initially able to detect a pulse, the EMS personnel could not obtain a blood pressure reading. The victim was transported to the local hospital where he died approximately an hour after the incident occurred. The victim had burns on the top of his head and on both hands.

CAUSE OF DEATH

The coroner's report stated that the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Code violations should be corrected within a reasonable time period to ensure the safety of all individuals who might encounter the hazards created by these violations.

Discussion: The powerlines involved in this incident were already in place when the house was built 12 years earlier. The state laws in this jurisdiction require that powerlines be at least 6 feet (horizontally) away from, and 12 feet above, the rooftops of buildings. The power company had notified the house owner approximately 6 months prior to the incident that they would be moving the powerlines. The state or local government body that establishes a code should establish a specified period of time for code violations to be corrected, and enforce compliance. In this case, a house was built within 5 feet of an energized line. It is not known if special precautions were taken at the time the house was built. Extended time delays in correcting these types of violations may result in injury or death as this case clearly demonstrates.

Recommendation #2: Safety training should be a part of new employee orientation.

Discussion: New employees need to be made aware of all the potential hazards that they could encounter in performing their job tasks. In companies that primarily use on-the-job training, new employees might encounter a hazardous situation before he or she can be trained to recognize and avoid such situations. It is a challenging task for small companies to inform new employees about hazards that they will typically encounter, as well as hazards they may rarely encounter. Untrained employees may not recognize even the routine hazards that they will typically face every day. The employer is responsible for informing employees of the hazards they might encounter in a realistic and informative manner. This training is needed to ensure that employees understand the hazards and corrective actions that can be taken to control or eliminate the hazards. In this case, a man who was expected to work on the ground, got onto a roof and contacted an energized line. Strict enforcement of a requirement that ground workers not work on elevated structures without supervision might have prevented this incident. When on-the-job training is used to provide safety instruction, experienced workers with safe work habits should be assigned to work with new employees. This should help to train the new workers in safe, effective work practices while they learn how to do the work.

Recommendation #3: Safety evaluations should address all potential hazards.

Discussion: Although two safety evaluations were made to identify potential hazards prior to the initiation of any cable installation, the powerline/roof hazard was not identified. The individuals preparing the safety evaluations either did not realize the proximity of the powerline to the roof, or did not consider the possibility of contact as a significant hazard. A neutral line was located a few feet above the energized line. Today, energized lines are commonly installed in the upper position, above the neutral lines. The safety evaluators, the victim, and the co-workers may not have realized that the lower line was energized. After this incident, the power company de-energized the powerline, and had the contractor remove the TV cable from the power poles. The power company then installed two new poles and rerouted the powerlines, bringing them into compliance with state code. The old poles and powerlines were still in place, but de-energized at the time of the investigation. The reliability of any safety evaluation depends upon the reliability of the information supplied to the individuals doing the evaluation. Whether they were aware of the hazard presented by the powerline location with respect to the roof is unknown.

Recommendation #4: If TV cable lines are installed on power poles, procedures should be taken to protect the cable installers from the energized lines.

Discussion: Cable lines should be installed on separate poles if practical. This eliminates the hazards associated with working below high voltage lines. If this is not feasible, then the powerlines should be de-energized or covered with protective sleeves to prevent contact while the cable lines are being installed or maintained. The company should ensure that any work performed in proximity to powerlines be performed by the polemen who are trained to do such work. Cable lines should be located at least 40 inches below powerlines per American National Standard C2-1984, Table 235-5.

FACE 89-43: Foundry Laborer Electrocuted While Loading Electric Induction Furnace

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On June 5, 1989, a 22-year-old male foundry laborer was electrocuted when a piece of scrap metal he was loading into a damaged electric induction furnace became energized.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On July 21, 1989, a DSR Research Industrial Hygienist met with company officials, conducted an investigation, and discussed the incident with state industrial commission personnel.

OVERVIEW OF EMPLOYER’S SAFETY PROGRAM

The employer is a foundry with 30 employees (mostly furnace tenders and laborers). The foundry belongs to a larger parent company with 1,000 employees. The victim was a foundry laborer who had been hired just 2 weeks before the incident. The foundry has a written safety program, and the manufacturing manager conducts safety meetings (shop talks) once a week. The parent company has a full-time safety manager and a corporate safety committee that meets regularly. The safety committee consists of the safety manager, a manufacturing manager from each plant, and union representatives.

SYNOPSIS OF EVENTS

The foundry uses electric induction furnaces for melting aluminum, brass, stainless steel, and iron. The furnaces are powered by a 3-phase, 1250-volt electrical system. The outside dimensions of the furnaces are 32 inches in diameter by 4 feet high. The inside of the furnaces are lined with a ceramic material which leaves a mold cavity (i.e., the space in which the metals are melted; also called a rammed refractory) that is 12 inches in diameter by 3 feet deep. A copper tube (electric induction coil) is coiled around the outside of the ceramic refractory. Water circulates inside the copper tube for cooling. The frame and sides of each furnace are constructed of steel. A dead air space exists between the induction coil and the furnace frame. The inside of the refractory is electrically grounded with a metal probe which protrudes up through the base of the refractory. The probe is attached to a flexible grounding wire directly under the furnace that leads to a steel grounding rod. The furnace frame is also grounded (see Figure).

Company standard operating procedures require that after approximately 100 to 120 furnace heats, the ceramic refractory and grounding probe be replaced (due to expected wear on the refractory after repeated heatings). One month prior to the incident, the refractory on one of the furnaces was replaced and the old grounding probe removed, but a new grounding probe was inadvertently left out. The furnace was heated approximately 100 times during the weeks that followed. As a result the refractory began to wear, and developed cracks. (A certain amount of wear is considered "normal." However, the cracks which developed in this instance are not considered normal wear). Molten metal seeped through cracks between the coil and gradually solidified in the space between the coil and furnace frame. A mound of the metal formed and was in contact with the frame, but not in contact with the coil.

On the day of the incident, the furnace tender (co-worker) was manually loading stainless steel scrap into the open top of the furnace refractory while the furnace was energized and in operation. One scrap metal piece to be loaded was about 3 feet long, 8 inches in diameter, and weighed about 150 lbs. Unable to lift the piece by himself, the co-worker called for the victim to help him. The co-worker was wearing leather gloves and the victim was wearing cotton gloves. Both workers were perspiring profusely. The victim and co-worker both grasped the scrap piece and began lowering it into the furnace refractory, which already contained about 12 inches of molten stainless steel (heated to about 2,600^o F). In doing so, the victim had his thighs, just above the knees, resting against the top edge of the furnace frame. The co-worker was not in contact with the furnace frame. The furnace was jarred as it was being loaded, which presumably resulted in further cracking of the ceramic refractory. This caused molten metal to flow through the cracks in the refractory, making contact with the induction coil and metal mound, thus energizing the molten metal, scrap metal piece, and furnace frame. Since the victim's hands were in contact with the scrap metal piece, and his thighs were in contact with the grounded furnace frame, his body provided a path to ground and he was electrocuted. The victim's hands "froze" to the piece of scrap metal he was loading. The co-worker, who was also holding the scrap metal piece, felt a slight "tingle" of electric current.

The co-worker immediately turned around and hit the power switch at the furnace control panel 8 feet from the furnace. (Whether the co-worker actually shut off the power at the control panel or the furnace breaker switch had already tripped, is not known.) The victim fell backward to the concrete floor. The co-worker and other foundry workers who were summoned by the co-worker immediately began to administer cardiopulmonary resuscitation (CPR). A local volunteer emergency medical service (EMS) unit was notified and they arrived at the scene in 18 minutes. The EMS personnel continued to administer CPR as the victim was transported to a local medical center. He was pronounced dead on arrival by the attending physician.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution. Electric burn marks were noted on the victim's hands (entry wounds) and thighs (exit wounds).

RECOMMENDATIONS/DISCUSSION

Recommendation #1: The employer should ensure that all electrically powered equipment is adequately grounded (according to the National Electric Code 250-112).

Discussion: Although the company had a written procedure for changing out furnace refractories (which included installing a new grounding probe with each new refractory), the installation of the new grounding probe after removing the old grounding probe in this instance had been omitted. This resulted in an ungrounded furnace refractory. If it had been properly grounded, when the molten metal leaked through the crack in the refractory and came in contact with the energized coil the current would have gone to ground, causing the breaker to trip, thus greatly reducing the possibility of electric shock to the workers.

Recommendation #2: The employer should ensure that furnace refractories are maintained in good condition.

Discussion: Repeated molten pourings began to cause the furnace refractory to wear prematurely and ultimately crack. The employer and furnace manufacturer should therefore re-evaluate the manufacturer's recommended number of furnace heats (of 100 to 120). It may be prudent to specify a reduced number of furnace heats before a new refractory and a new grounding probe must be installed.

Recommendation #3: Electric induction furnace manufacturers should develop specific procedures for furnace refractory installation.

Discussion: Although the manufacturer's operators manual includes a furnace refractory change-out procedure, it does not specifically address the need or importance of installing a new electric ground probe after installing a new refractory. This information should be added in the next revision of the manual, and highlighted as an electrical hazard warning in the written procedures.

Recommendation #4: The electric induction furnace should be re-evaluated to identify possible electrical safety design modifications.

Discussion: Electric induction furnace manufacturers should evaluate whether a built-in solenoid or other type of device that would automatically de-energize (or prevent from energizing) the induction furnace if a ground fault developed within the electrical system of the furnace is feasible. If so, such protection should be incorporated into the design of newly manufactured furnaces. Electric induction furnaces presently in use without this type of device should be retrofitted to prevent this type of incident.

Recommendation #5: The employer should establish a maximum scrap metal size and weight for manual loading into this type of induction furnace.

Discussion: Because of the small interior size of the induction furnaces, each is basically a one-man loading operation. The scrap metal piece being loaded into the induction furnace in this incident weighed approximately 150 lbs. The co-worker was therefore unable to load it into the furnace by himself, so he was assisted by the victim. Since the scrap piece was so large and heavy, it jarred and damaged an already weakened refractory as it was lowered into the furnace. Therefore, such large scrap pieces should be cut into smaller pieces that one worker can easily handle. The employer should determine and specify a maximum scrap metal weight and dimension for manual loading into this type of induction furnace.

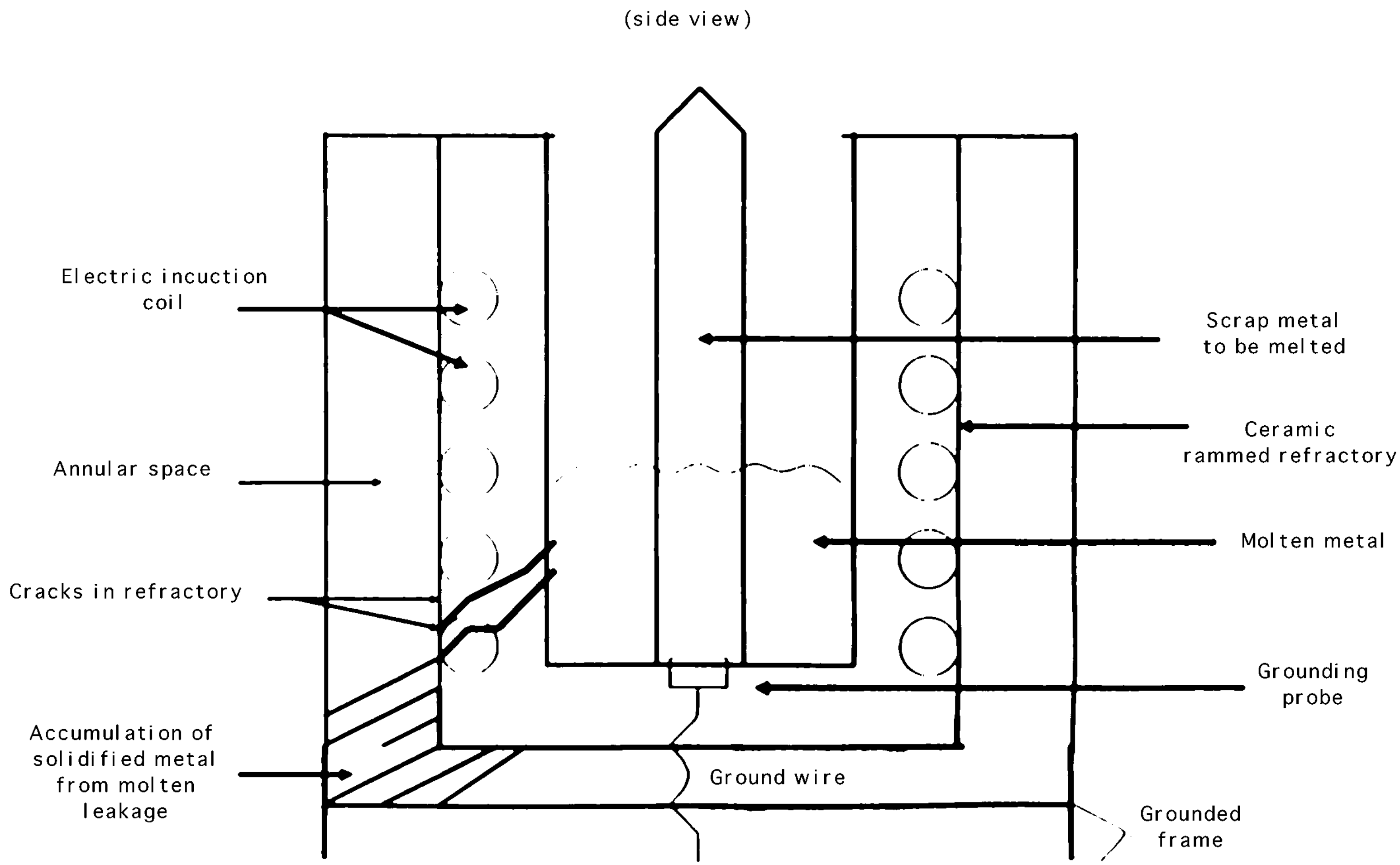

Figure. *Electric Induction Furnace*

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FACE 89-48: Truck Driver Dies When Crane Boom Contacts Powerline

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On August 22, 1989 a 43-year-old male truck driver died when the boom of the truck mounted crane he was operating contacted a 14,400-volt overhead powerline.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. Prior to the investigation, DSR personnel reviewed this case with state officials. On September 19, a DSR safety specialist and an epidemiologist conducted an investigation of this incident. They met with local officials and company representatives, and visited and photographed the incident site.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is a large building materials supply company. The company has been in operation for more than 80 years and presently employs 1,726 individuals. The victim was one of 52 drivers who deliver concrete products. The company has a full-time safety officer, a written safety policy, and a procedures manual which includes safety information. Both formal and on-the-job training are provided to all employees. The victim had been employed by the company for 5 1/2 years. During the first 2 1/2 years he worked as a dump truck driver. For the past 3 years he worked as a concrete products delivery truck driver.

SYNOPSIS OF EVENTS

On the morning of the incident, the victim began work at 8:00 a.m. He made one delivery and returned to the concrete block plant for a second load. He left the plant at 11:05 a.m., and drove to a construction site where a new church was being erected. The concrete blocks were to be used for the foundation of the church building. The victim had delivered an identical load to the same location the previous day.

The victim unloaded blocks on three sides of the building site, and then moved the crane truck to the fourth side of the site to unload the last pallet of blocks. A driveway ran parallel to the new building at this location. Also parallel to the new building, but across the driveway, ran an overhead powerline. On the building side of the driveway another powerline ran to a security light at the rear of the property. (See Figure). The victim positioned his truck in the driveway between these lines and lowered the outriggers of the truck to stabilize it. Then, standing at the rear of the truck the victim began to raise the crane boom to a vertical position using a remote control device attached to the truck by a 15-foot-long umbilical cord. As the boom crane was raised, it contacted the uppermost wire of the powerlines across the driveway from the building site. When the boom contacted this energized 14,400-volt line, the truck-mounted crane, the umbilical cord, and the remote control device became energized. A "path to ground" was established through the victim's body, entering his hands (holding the remote control device) and exiting his feet to ground. The victim collapsed clutching the remote control device to his chest. By the time the automatic disconnect device in the powerline deenergized the circuit, the victim had received massive electrical burns over most of his body.

Construction workers in the area reported hearing an "arcing" sound and observed the victim lying on the ground and the tires of the truck on fire. One of the workers called the local emergency services, including fire, rescue, and police personnel, along with employees of the electric utility company, who responded to the scene within minutes of the incident. The fire department extinguished the fire. The victim was pronounced dead at the scene by the assistant medical examiner.

CAUSE OF DEATH

The medical examiner gave the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: In accordance with current OSHA regulations, cranes should not be operated within 10 feet of energized powerlines.

Discussion: Existing OSHA standards (29CFR 1926.550(a)(15)) prohibit the operation of a crane within 10 feet of overhead electrical distribution and transmission lines except where those lines have been deenergized and visibly grounded. This standard also requires that a person be designated to act as observer when it is difficult for the operator to maintain the required clearance by visual means. Had these requirements been followed this fatality could have been prevented.

Recommendation #2: Consideration should be given to adaptation of electrically isolated remote control systems.

Discussion: The remote control system used on this crane was electrically connected to the crane. This system provided the "path to ground" which resulted in this fatality. A remote control system which is electrically isolated from the crane would provide protection to a crane operator if contact with an energized overhead powerline occurs. Electrical isolation could be accomplished by radio controls, fuse equipped control lines, fiber optic controls, insulated control boxes, etc. Manufacturers of crane systems should evaluate these options and incorporate an electrically isolated remote control system in the design of newly manufactured truck-mounted cranes. Manufacturers and their customers should cooperate in an effort to retrofit existing truck-mounted cranes with these systems, as well.

Recommendation #3: Boomed vehicle drivers/operators should be trained in the safe operation of these vehicles.

Discussion: The victim in the incident had received no formal training in the hazards associated with boomed vehicle operations. At minimum, such training should address:

1. all OSHA standards applicable to cranes

2. recognition of hazards associated with loading/unloading of materials

3. selection of sites for offloading materials that are level and firm, and located away from overhead powerlines

4. proper use of outriggers in accordance with the manufacturer's guidance

5. use of established procedures in emergency situations [Example - In the event of contact with an electrical powerline, never contact a vehicle or allow anyone else to contact a vehicle, and keep all unauthorized personnel away from the area.]

Recommendation #4: When circumstances are such that no alternative to operating a crane in close proximity to a powerline exists, the local utility company should be contacted to de-energize or insulate the powerlines prior to the start of work.

Discussion: De-energizing or insulating powerlines in a work area serves to provide a measure of protection to crane operators should contact with powerlines occur. While obvious drawbacks exist to pursuing this course of action (time involved to get utility company personnel to the scene, disruption of customer service, etc.) in cases where no alternative to operating a crane near a powerline exist, this procedure does provide a viable option which could prevent injuries or fatalities.

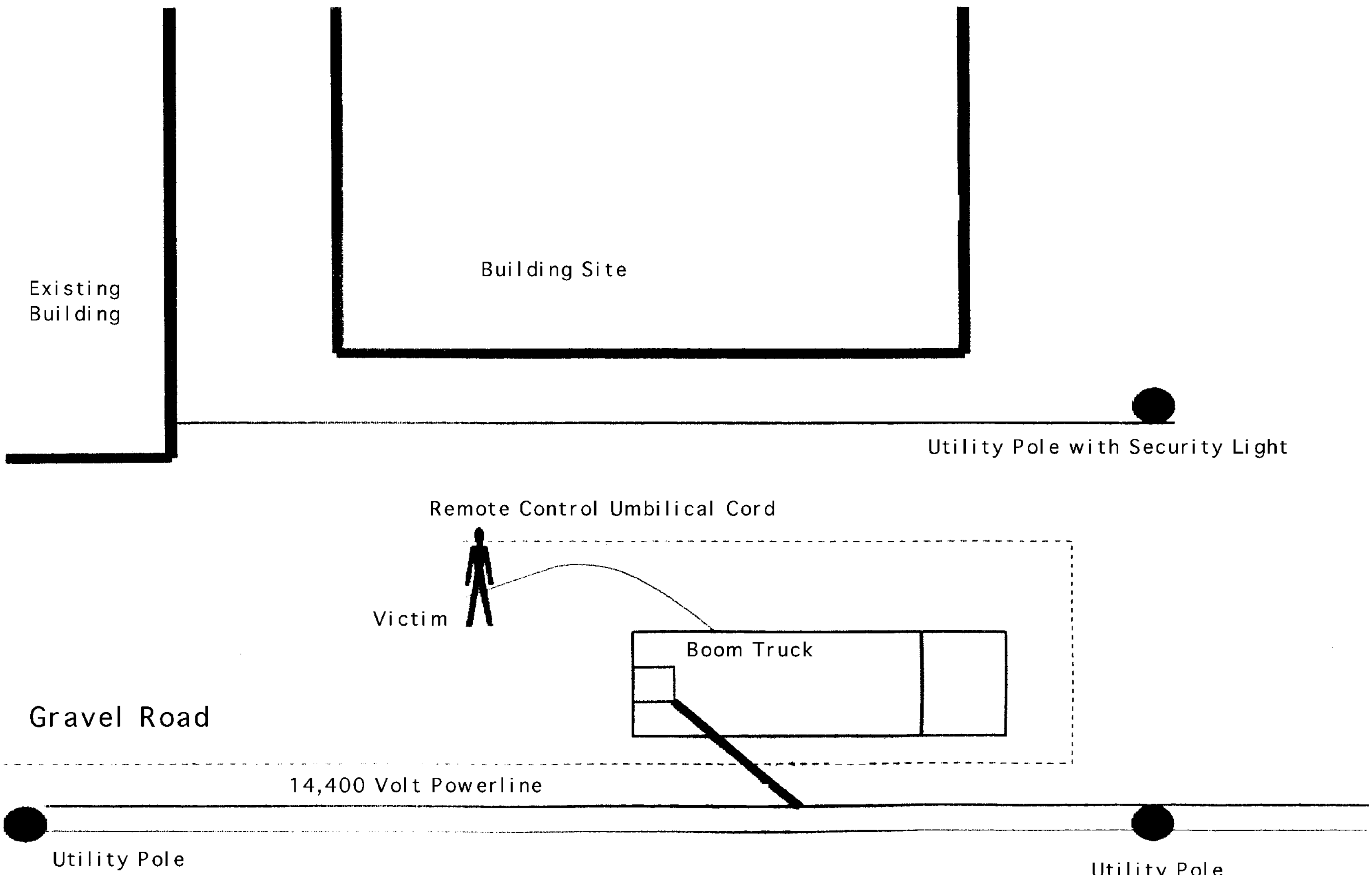
Existing
Building
Building Site
Utility Pole with Security Light
Remote Control Umbilical Cord
Victim
Boom Truck
Gravel Road
14,400 Volt Powerline
Utility Pole
Utility Pole

***Figure*.**

FACE 89-50: Apprentice Electrician Electrocuted

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to 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.

On August 23, 1989, a 23-year-old male apprentice electrician was electrocuted while making a connection for a light fixture in a junction box.

CONTACTS/ACTIVITIES

State officials notified DSR of this fatality and requested technical assistance. On September 14, 1989, a safety engineer from DSR traveled to the site and conducted an investigation, reviewed the case with company officials, photographed the incident site, and met with state compliance officials to obtain information about the events surrounding this incident.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer, an electrical contractor with 40 employees, has been in business for 15 years. The company has a designated part-time safety officer, but has no formal safety program. The company does a wide range of electrical work in construction, remodeling, and home repairs. Safety is handled through on-the-job training, observation of work practices by supervisors, and printed handouts of safety topics that management deems appropriate.

The victim had previously worked for the company for 2 years. He left the company for about 2 years and returned to work at the beginning of 1989. While working for another employer the victim received electrical burns on his hands. The victim had recently taken the examination to be classed as a journeyman electrician but had not received the results.

SYNOPSIS OF EVENTS

The employer had a contract to install wiring and fixtures in an office complex that was located behind a new shopping mall. The third floor of the office complex was being hurriedly prepared for a tenant. The off-site designer made daily changes (e.g., fixture locations) to electrical system blueprints, and transmitted the revised drawings to the jobsite via a facsimile transmission (fax) machine.

The lighting system is a 3-phase, 4-wire, 277/480-volt system. The wires for two circuits (three hot wires and one neutral wire per circuit) were run in one conduit down a central hall with junction boxes installed for branch circuits to individual lights. The lights are mounted in a metal gridwork, flush with ceiling tiles. System grounding is achieved through the metal conduit. Work had been completed on one side of the hall and the victim was installing conduit and fixtures on the other side.

At the time of the incident, the victim was wiring in a light fixture at a junction box and was in contact with the gridwork. During the work, he received a shock, came down from the fiberglass ladder, said "cut the juice," and collapsed. Two co-workers immediately started cardiopulmonary resuscitation while another worker called the emergency service number. The phone call was made from an elevator which had the same number as other elevators in the mall-office complex. The person at the emergency service answering location asked if the call was coming from the place where the victim was located. (The number and location were available to the emergency service person.) The caller replied that it was, neither one realizing that the mall was the listed address for the phone number. The emergency rescue team went to the mall searching for the victim, while the co-workers waited with the victim for assistance in the office complex. Approximately 20 minutes elapsed before the rescue team reached the victim. The victim was then transported to a local hospital where he was pronounced dead-on-arrival.

Work was stopped for that day and the area secured until an investigation could be made by the company. The next day no energized lines could be detected in the junction box where the victim was working when he received the fatal shock. The panel box was in a closet, but was not locked. After work in the area was finished, further investigation revealed that the two neutral conductors in the same conduit run had been cross-wired at a junction box. That is, the neutral wire in the de-energized circuit was mistakenly connected to the neutral wire of an energized circuit back at the junction box. Company officials believe that the victim had previously, inadvertently cross-wired the neutral conductors, which subsequently allowed electricity to flow from the live circuit on the completed side of the building through a light fixture, to the circuit on which the victim was working. When he handled the energized neutral conductor to make the connection, his body provided a path to the metal gridwork he was touching, which was connected to the building structural steel.

The Figure on page 5 demonstrates how it could be possible for the victim to be electrocuted due to the crossed neutral wires. The circuit breaker had to be closed and the light switch in the "on" position on the live circuit to allow current to flow through the light fixture to the neutral line wire of the parallel circuit.

CAUSE OF DEATH

The medical examiner ruled that the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should limit panel box access to electricians and lock it (if possible) or tag out circuits being actively worked on.

Discussion: The preferred method to control access would be to lock out the circuits where possible. However, the individual twenty-amp circuit breakers such as those used on this project are not designed to be locked out. The front of the panel box, which can be locked, was not in place because wires were still being installed in the panel. At a minimum, electricians should open the circuit breakers for the circuits they will be working on, and tape across the circuit breakers. Then a tag should be located at the circuit breakers to inform other workers who is working on those circuits. Additionally, secure temporary barriers should be considered that would keep unauthorized people out of the panel box area. This could be a temporary gate or door with a lock that only the electricians have the key to open. This would limit access to the panel box to electricians. The electricians should also be trained in lockout/tagout procedures so that any circuits being worked on are either locked out or tagged. These procedures need to be used and compliance enforced.

Recommendation #2: All conductors in the immediate work area should be tested by the worker to verify that they are de-energized before starting to work.

Discussion: An ohm meter or a voltage indicator meter should be used by the electrician to determine that all lines are de-energized before starting work. This simple test should detect problems such as incorrect wiring or unsuccessful de-energization. The instruments required to do this are inexpensive and easy to carry, and would not impose a significant burden on the worker. In a job such as this, where changes were being made on a regular basis, the extra precaution of testing the circuit might have prevented the incident.

Recommendation #3: Wiring done by apprentice electricians should be checked by a journeyman.

Discussion: The victim was an apprentice electrician with 4 to 5 years of experience. Due to the rush nature of the job (3 weeks after the incident the offices were occupied) and the fact that changes were being made regularly on the electrical blueprints, it would have been good practice to have a journeyman electrician check the apprentices' work.

Recommendation #4: The company should develop and implement a comprehensive safety training program.

Discussion: The company, at present, has an informal safety training program, which covers areas of concern as management becomes aware of them. There is no plan to cover various safety hazards on a formal basis. The company does have a good inspection program for ladders. A formal safety training program to inform employees of potential hazards needs to be developed and implemented.

Recommendation #5: The jobsite supervisor should evaluate all revisions to the original blueprints to identify potential hazards that these revisions might create.

Discussion: Since the revisions to the blueprints were being sent directly to the jobsite, the contractor did not have a chance to review the modifications. For this reason, the supervisor at the jobsite should review all the revisions to the system to identify potential hazards. The changes were being made on blueprints, with small sections of the marked-up blueprint being sent by FAX machine to the jobsite. Some of these changes involved rewiring connections in various junction boxes. As a result of the rush nature of the job and the many design changes, the potential for error was increased. The evaluation of the changes by the jobsite supervisor might have identified areas where potential electrical hazards could exist, such as areas where connections were to be rewired. Once these areas were identified, they should have been carefully inspected to ensure proper wiring techniques.

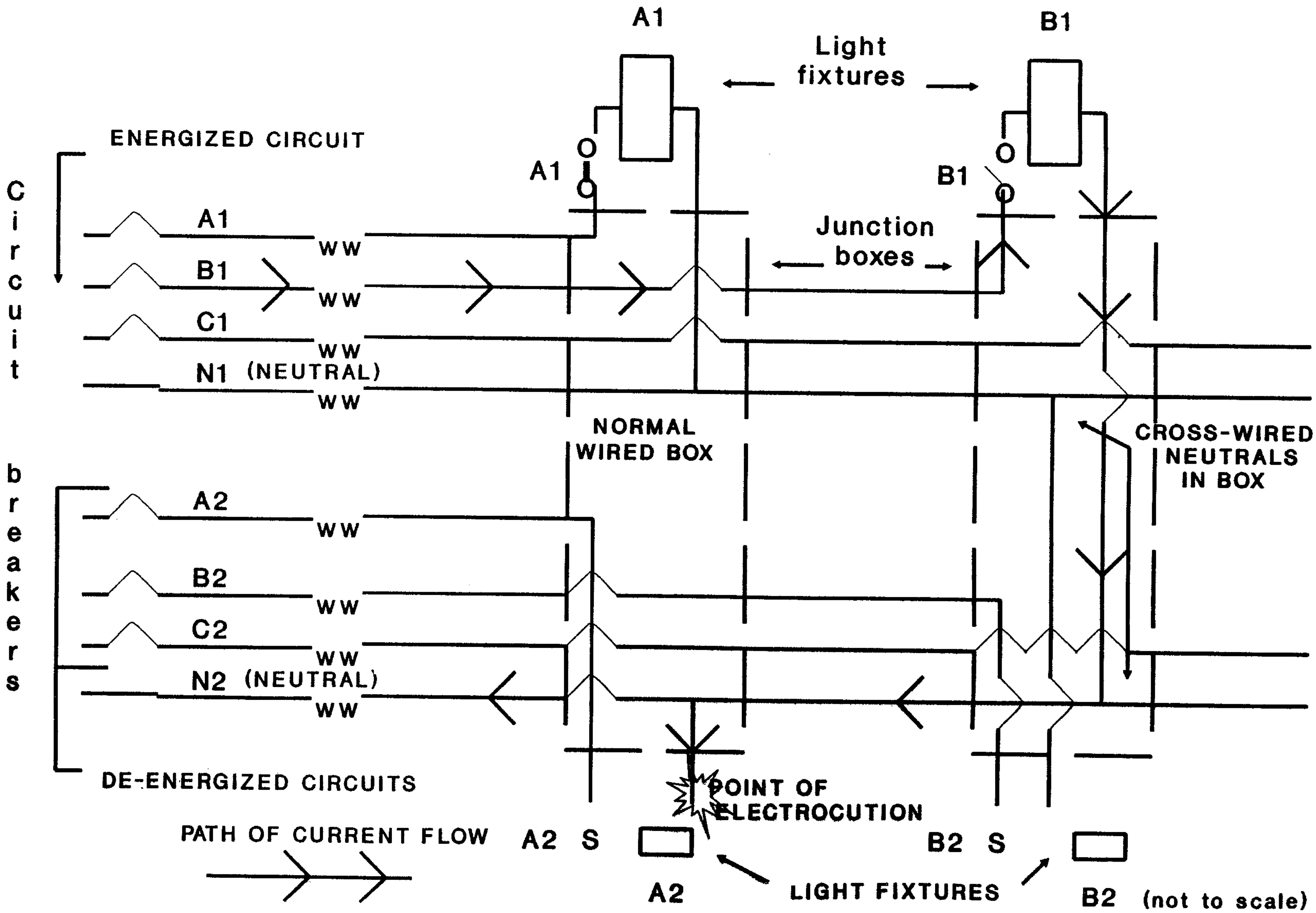

Figure. *Cross-wired Neutrals*

FACE 90-01: **One Laborer and Two Steel Workers Electrocuted when an Elevated Work Platform Contacts 69,000-volt Powerline in Ohio**

SUMMARY

Three construction workers were electrocuted, and three others wore seriously burned, when the mobile elevating work platform they were moving contacted the bottom phase of a 69,000-volt overhead powerline. This occurred as the crew was installing aluminum siding to one side of a 25-foot warehouse under construction. The three-phase powerline, which ran parallel to the warehouse, is 7-feet lower on the north end of the warehouse than on the south end. On the south end, the powerlines were attached to the horizontal crossarm of a utility pole so that all three phases were 34 feet off the ground. The powerlines twist 90 degrees from the horizontal orientation to a vertical orientation, and were attached directly to the utility pole on the north end of the warehouse, where the bottom phase is only about 27 feet off the ground. The six crew members were working from the south end of the warehouse, where adequate clearance for the 25 foot 6 inch platform existed, toward the north end. They moved the platform under the lowest part of the powerline at a point where the ground sloped upward to meet the existing roadway. The platform's top guardrail contacted the bottom phase of the powerline, and current passed to ground through the platform and the workers who were touching it. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and employees must:

- conduct initial jobsite surveys to identify overhead electrical hazards and develop job specific methods of controlling them, and follow up with scheduled and impromptu safety inspections to ensure that safety procedures are being followed

- lower mobile elevating work platforms to ensure that adequate clearance exists before moving them into close proximity to overhead powerlines

- follow company and equipment manufacturer safety procedures (both include prohibitions against moving such platforms into close proximity to overhead powerlines)

- consult with local electric utility company officials to discuss preventative measures to be taken before initiating work under, or around overhead powerlines.

INTRODUCTION

On September 25, 1989, officials of a State Industrial Commission of Ohio notified the Division of Safety Research (DSR), of three construction workers (30-year-old male laborer and two male steel workers, 34- and 38 years-old, respectively, who were electrocuted on September 25, 1989, when the mobile elevating work platform they were moving contacted a 69.000-Volt powerline. Technical assistance was requested by the State Industrial Commission, and on October 12, 1989, a safety specialist from DSR traveled to the site to conduct an investigation. The safety specialist reviewed the incident with a company representative, State personnel, an electric utility representative, and the OSHA compliance officer assigned to this case. Photographs and diagrams of the site were obtained during the investigation.

The employer in this incident is a general construction company that has been in operation for 9 years. The company employs 180 full-time employees, including a safety director. The company has a comprehensive, multifaceted safety program and provides on-the-job training to the employees.

Additionally, the company conducts monthly safety meetings with all employees. Also, weekly "toolbox" meetings are hold to discuss safety matters for the specific jobsite.

INVESTIGATION

The company had been contracted to construct a large (300-foot-long by 150-foot-wide by 25-foot-high) steel-framed and aluminum-siding warehouse. The three victim were members of a six-man crew assigned to install aluminum siding on the warehouse. The crew was using a mobile elevating work platform to install 3-foot by 20-foot sections of aluminum siding. The work platform, mounted on inflated rubber tires, measured 25 feet, 6 inches from ground level to the top guardrail. Parallel to the warehouse (approximately 30 feet away) was a 69,000-volt three-phase overhead powerline. At the south end of the warehouse, the powerlines were 34 feet of f the ground. However, toward the north and of the warehouse, one of the lines was only 27 feet off the ground. This difference was due to the methods of attaching the lines to the utility poles at opposite ends of the warehouse. The lines on the utility pole at the south end were attached to a horizontal crossarm, while the lines on the pole at the north end (327 feet away) were attached vertically, directly to the pole. This configuration required the power lines to twist from a horizontal to a vertical orientation between the poles.

The crew had been installing siding on the long (300-foot) side of the warehouse for 7 days prior to the incident. The crew had started working on the south end of the warehouse and was moving northward. On the morning of the incident, the crew had progressed to a point where relocating the platform was necessary due to a raised driveway curb that extended to the north end of the warehouse. Although details are still incomplete, crew members may have assumed that clearance between the top guardrail of the mobile platform and the powerlines was the same at both the north and south ends of the warehouse. However, the lowest powerline was 7 feet lower at the north end of the warehouse. When the six-man crew moved the platform under the powerline at a point where the ground sloped upward to meet the existing roadway, the top guardrail contacted the powerline. Three crew members were electrocuted and three were seriously burned.

A security guard and another construction employee heard the arcing, observed a fireball, and ran to the incident site. After seeing what had happened, the security guard telephoned for help. A fire truck arrived in approximately 5 minutes and firemen then removed the workers from contact with the energized platform by using a "dead man stick" (i.e., 10-foot fiberglass rod equipped with a hook on one end). Two emergency medical service (EMS) units arrived concurrently 2 minutes after the arrival of the fire truck, and transported three severely burned workers to a nearby hospital. The three other workers were pronounced dead by the county coroner approximately 2 hours later at the incident site.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Established company safety procedures should be followed at all times.

Discussion: This company has a comprehensive safety program in place. The plan specifically prohibits moving a mobile elevating work platform to within 10 feet of energized power lines. Had this policy been followed, this incident would not have occurred.

Recommendation #2: Scheduled and impromptu safety inspections should be conducted by upper management personnel at each jobsite.

Discussion: The company has a comprehensive safety plan which includes monthly safety contacts and toolbox meetings. Apparently, however, the enforcement of the safety program is incomplete. Upper management personnel should conduct or appoint competent personnel to conduct scheduled and impromptu safety inspections at each jobsite to ensure that safety procedures are being followed.

Recommendation #3: The employer should follow equipment manufacturers' general and operating rules for safe practices.

Discussion: The manufacturer of the mobile elevating work platform provides a list of general and operating rules which governs the safe operation of the equipment. These rules specifically address the hazards of operating equipment near energized power lines. The employer should read, understand, and follow these rules provided by the manufacturer. Had the manufacturer's rules been followed, this incident may have been prevented. Also, the mobile elevating work platform is designed and constructed to be raised and lowered via two manual winches. Had the crew recognized the height of the powerline, the platform could have been lowered approximately 9 feet prior to moving it. If the crew would have taken the time to lower the platform, the top rail would have passed approximately 8 feet beneath the powerline.

Recommendation #4: The employer should comply with 29 CFR 1926.416 (a)(1) and (a)(3)(1), which establish requirements for the protection of employees exposed to electrical hazards.

Discussion: Employers should not permit employees to work in such proximity to energized powerlines that the employee could make contact in the course of work, unless the employee is protected against electric shock by de-energizing and grounding or by effective guarding. The employer should comply with the aforementioned regulations governing this activity.

Recommendation #5: The employer should contact the appropriate utility company before moving mobile elevating work platforms near energized power lines.

Discussion: The policy of the electric utility company is to send a representative to the jobsite and discuss preventive measures to be taken with the requesting company. The company neglected to request this service and continued work near the energized powerlines which ultimately resulted in three deaths. The company should contact the appropriate utility company and make arrangements to have the appropriate preventive measures taken.

Recommendation #6: The employer should conduct initial jobsite surveys to identify all hazards associated with the specific jobsite.

Discussion: The jobsite had numerous associated hazards: 1) energized powerlines located adjacent to the warehouse (work area) 2) varying heights of the powerlines and 3) uneven ground surrounding the warehouse. Recognition and consideration through jobsite surveys may have prompted the employer to have the powerlines de-energized or the platform lowered or dismantled before it was moved. Employers should conduct jobsite surveys, identify all hazards, and apply appropriate preventive measures.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 162. July 1989.

FACE 90-02: Tree Trimmer Crew Leader Dies When He Contacts Energized Powerline in Puerto Rico

SUMMARY

A tree trimming crew was en route to a jobsite when they noticed that trees had fallen over a 4,000-volt powerline in front of a radio tower. The damage had been caused by Hurricane Hugo. Since all the powerlines in the area had been de-energized, the crew leader decided to clear the area in front of the radio tower. The crew cut and pruned the trees to clear the area, and upon finishing, returned to the truck while the crew leader made a final inspection of the work area. Crew members heard their leader cry out and ran to the worksite, where they found him lying on his back. No vital signs could be detected. Investigation revealed that although the powerlines had been de-energized, a gas station was using a portable gas-powered electric generator to supply electrical power to the gas pumps. Since the main circuit breaker at the gas station had not been opened, electrical current from the generator flowed back through the transformer and energized the powerline at the work area. When the victim contacted the powerline, his body provided a path to ground and he was electrocuted. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and employees must:

- ensure that workers assigned the task of clearing debris from downed powerlines identify and treat all downed powerlines and any debris in contact with these lines as energized, unless these lines have been tested and grounded on both sides of the work area by qualified workers

- institute a comprehensive electrical safety program for both company workers and members of the general public regarding the hazards of feedback electrical energy from portable electric generators

- in addition, state and local governments should consider legislation that would require electrical disconnect devices to be present at all locations where portable electric generators are used.

INTRODUCTION

On September 29, 1989, Commonwealth of Puerto Rico officials notified Division of Safety Research (DSR), of a 35-year-old male tree trimmer crew leader who was electrocuted when he backed into a fallen powerline while inspecting an area after the completion of a trimming job. Technical assistance was requested by Commonwealth officials and during the week of October 2-6, 1989, a DSR research team (two occupational safety and health specialists, a safety engineer, and an epidemiologist) conducted an investigation, and met with the Commonwealth Epidemiologist and his staff, the Secretary of Health, representatives of the Medical Examiner's office, and power company officials to obtain information concerning the circumstances surrounding the incident. Videotape and photographic documentation of hurricane damage to the electrical transmission and distribution system was taken. This investigation was one of five separate investigations (90-02 through 90-06) conducted by DSR staff. All five of the investigations involved workers who were electrocuted while restoring electrical power to the island of Puerto Rico as a result of damage caused by Hurricane Hugo (1).

The employer is a major utility company with more than 10,500 employees. The company has been in existence for the past 41 years. The company has a comprehensive safety program with written policies and procedures for all routine operations. The corporate safety staff consists of a supervisor of industrial safety, six safety engineers, and seven safety advisors. Classroom and on-the-job training for all workers is provided. All workers receive periodic retraining. Workers that perform line work are certified in cardiopulmonary resuscitation (CPR).

INVESTIGATION

A tree trimming crew was assigned the task of clearing fallen trees in an area where a 4000-volt powerline had been knocked down during Hurricane Hugo. The men arrived at the site and began to prune and cut the trees away from the downed line. Upon finishing the job, the crew gathered their tools and returned to the truck. The crew leader inspected the jobsite to ensure that all work had been completed, and returned to the truck to contact his supervisor for further instructions. Upon receiving new work orders, the crew began to travel to the next worksite when the crew leader noticed that trees had fallen over the same 4000-volt powerline in front of a radio tower. Since all the powerlines in the area had been de-energized, the crew leader decided to clear the area in front of the radio tower before traveling to the assigned worksite. The crew cut and pruned the trees and cleared the area in front of the radio tower. Upon finishing, the crew gathered their tools and returned to the truck while the crew leader gave the area a final inspection.

Crew members heard their leader cry out and ran to the worksite, where they found him lying on his back. When vital signs could not be detected, crew members initiated CPR and continued CPR while they transported the crew leader to the hospital. The victim was pronounced dead on arrival at the hospital.

Investigation by power company officials revealed that the lines had been de-energized a day prior to the incident when power company linemen had opened the breaker for the line on an emergency generator which was in use to supply power to the city's public works department. However, on the day of the incident, a gas station between the public works department and the worksite was using a portable gas-powered electric generator to supply electrical power to the gas pumps. Since the main circuit breaker at the gas station had not been opened, electrical current from the portable generator flowed back through the transformer and energized the powerline at the work area. When the victim contacted the powerline, his body provided a path to ground and he was electrocuted. The medical examiner's report identified an entrance wound in the lower left back region which indicated where the victim contacted the line (Figure). Tests performed on the powerline by power company workers indicated that the powerline contacted by the victim carried 2400 volts.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Workers assigned the task of clearing debris from downed power lines should be instructed to inspect their worksite to identify all downed powerlines prior to the start of work. These powerlines and any debris in contact with these powerlines should be treated as energized until these lines are tested and grounded on both sides of the work area by qualified workers to control the hazard of feedback electrical energy.

Discussion: Workers should be instructed to conduct an inspection of the entire jobsite prior to the start of work to identify all downed power lines. These lines, and any debris in contact with these lines, should be treated as energized. Because of the ever-present danger of feedback electrical energy, these powerlines should be grounded on both sides of the work area and tested by qualified personnel, even though they have been verified as de-energized (1). These precautions are especially important during restoration operations, when the use of portable electric generators is very likely. If these precautions had been taken in this instance, this fatality might have been prevented.

Recommendation #2: A comprehensive electrical safety education program for both company workers and members of the general public should be instituted.

Discussion: A comprehensive electrical safety program should be instituted to instruct both power company workers and members of the general public of the hazards posed by feedback electrical energy, the use of portable electric generators during power outages, and downed power lines. This information could be distributed to workers at safety meetings. Additionally, a public awareness campaign should be initiated by the power company to alert the general public regarding the hazards to linemen from feedback electrical energy from portable electric generators. At a minimum, this awareness campaign should inform the public to move the main breaker in their home to the "off" position or to pull the main fuse link whenever a portable electric generator is in use. This public awareness campaign could utilize all forms of media including newspapers, radio and television.

Recommendation #3: To prevent electrocutions from feedback electrical energy, disconnect devices (device which prevent electrical energy from leaving a location) should be present at all locations where portable electric generators are used.

Discussion: Electrical disconnect devices, preferably of the automatic type, should be installed in all locations where portable electrical generators are used. The feasibility of legislation (such as enacted in the State of California (2)) to ensure the use of such devices should be reviewed by state and local governments.

REFERENCES

1. Morbidity and Mortality Weekly Report, October 27, 1989/Vol.38/No. 42 Update: Work-Related Electrocutions Associated with Hurricane Hugo - Puerto Rico.

2. DHHS (NIOSH) Publication 88-104, Request for Assistance in Preventing Electrocutions by Undetected Feedback Electrical Energy Present in Powerlines.

3. State of California Electrical Safety Orders. Section 2940.9 Labor Code Section 142.3 1988 California Labor Code.

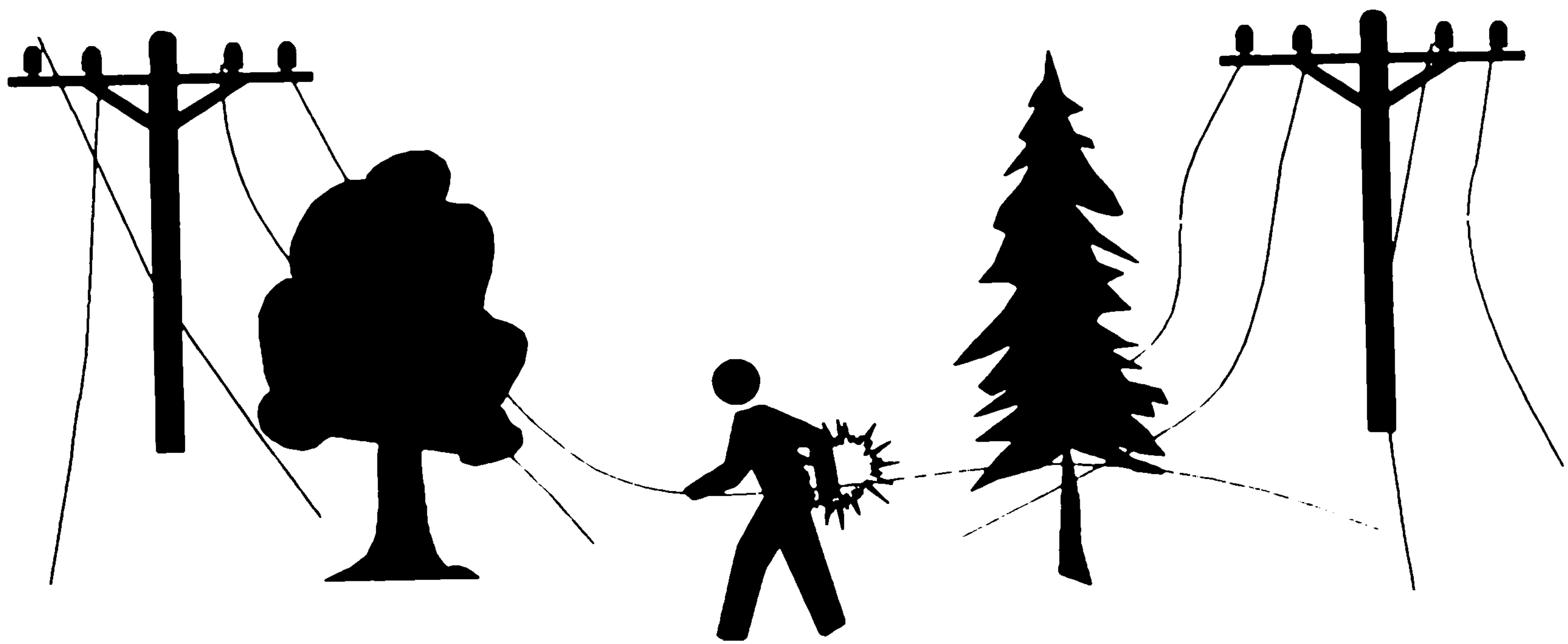

Figure. *Tree Trimmer Electrocution*

FACE 90-03: **Lineman Dies When He Contacts Energized PowerLine in Puerto Rico**

SUMMARY

A line crew, assigned the task of restoring power to secondary service lines at night, determined that a switch had to be opened on a pole-mounted transformer to de-energize the line on which repairs were to be made. The powerline repairs were needed as a result of damage caused by Hurricane Hugo. A co-worker lifted a hot stick to open the switch. As the victim walked toward the co-worker, his right arm contacted a powerline that was dangling from the pole. He fell backward and landed on his back on top of the powerline. The dangling phase was aluminum, while all other phases attached to the pole were copper. A guy wire anchor was buried in the ground approximately 20 feet from the pole, but no guy wire was attached. It is assumed that the victim either did not see the wire because of the darkness or thought that it was a guy wire (because of its color) and believed, therefore, that it was not energized. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and employees must:

- treat all powerlines as energized unless verified de-energized
- perform a site inspection prior to the start of work to identify any potential hazards present at the jobsite
- provide and utilize adequate lighting while performing line work at night
- ensure that all conductors in a given system are constructed of the same material to eliminate confusion.

INTRODUCTION

On September 29, 1989, Commonwealth of Puerto Rico officials notified the Division of Safety Research (DSR) that a 38-year-old male lineman was electrocuted when he contacted, then fell upon, a downed 4800-volt powerline in a wooded area. During the week of October 2-6, 1989, a DSR research team (two occupational safety and health specialists, a safety engineer, and an epidemiologist) conducted an investigation, and met with the Commonwealth Epidemiologist, the Secretary of Health, representatives of the Medical Examiner's office, and electric power company officials to obtain information concerning the circumstances surrounding the incident. Videotapes and photographs were taken to document storm damage to the electrical transmission and distribution system. This investigation was one of five separate investigations (90-02 through 90-06) conducted by DSR staff. All five of the investigations involved workers who were electrocuted while restoring electrical power to the island of Puerto Rico as a result of damage caused by Hurricane Hugo (1).

The employer, is a major utility company with more than 10,500 employees. The company has been in operation for the past 41 years. The company has a comprehensive safety program with written policies and procedures for all routine operations. The corporate safety staff consists of a supervisor of industrial safety, six safety engineers, and seven safety advisors. Apprentice linemen undergo a 6-month training program during which they spend half of each day in the classroom and the other half day on the job. At the end of this 6-month period, apprentices are classified as first, second, or third (highest) class linemen, depending on their level of competence. Classroom as well as on-the-job training is also provided for workers in other occupations. All workers receive periodic retraining. Workers who perform line work are certified in cardiopulmonary resuscitation (CPR).

INVESTIGATION

The crew was assigned the task of restoring power to secondary service lines as a result of damage caused by Hurricane Hugo. Upon arriving at the worksite on the evening of the incident, the crew determined that a switch had to be opened on a pole-mounted transformer to de-energize the line on which repairs were to be made. The transformer was mounted on a pole that was located in a heavily wooded area, 150 feet from the roadside worksite. The victim and a co-worker removed a telescoping hot stick from the truck and walked to the utility pole to open the switch. When they arrived at the pole, the co-worker lifted the hot stick to open the switch. The victim, who was the senior lineman, decided that he should open the switch. As the victim walked toward the co-worker, his right arm contacted a powerline that was dangling from the pole. He fell backward and landed on his back on top of the powerline. The co-worker used a piece of wood to pull the powerline away from the victim, and then began CPR. The victim was transported to the hospital by co-workers where he was pronounced dead on arrival.

Examination of the incident site revealed that six 4800-volt phases were attached to the crossarm above the transformer, three phases on each side of the pole. On one side, however, the middle phase was dangling down from the crossarm to the ground. The phases on both sides of the pole were connected by wire jumpers. The dangling phase was aluminum, while all other phases attached to the pole were copper. A guy wire anchor was buried in the ground approximately 20 feet from the pole, but no guy wire was attached (Figure). It is assumed that the victim either did not see the wire because of the darkness or thought that it was a guy wire because of its color (and therefore not energized).

CAUSE OF DEATH

The medical examiner listed the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All powerlines should be treated as energized unless verified de-energized.

Discussion: Linemen must be instructed to treat all powerlines as energized unless they personally verify that the lines have been de-energized. Lines should be de-energized by establishing a visible open point between the load and supply sides of the lines, and installing proper grounds on the lines. These grounds should be installed within sight of the worker whenever possible. Because of the threat of feedback electrical energy (especially during power outages), a powerline should be grounded on both sides of the work area to be considered de-energized.

Recommendation #2: A site inspection should be performed prior to the start of work to identify any potential hazards present at the worksite.

Discussion: A jobsite inspection should be performed prior to the start of work to identify any potential safety hazards present at the jobsite. In this instance, had the workers determined the origin point of the dangling phase, they would have discovered that the phase was attached by wire jumper to a phase on the other side of the pole and, therefore, was energized. Had the dangling phase been treated as an energized conductor, this fatality would have been prevented.

Recommendation #3: Adequate lighting should be provided and utilized while performing line work at night.

Discussion: Adequate lighting for the entire work area should be provided and utilized when performing line work at night. In this instance, in which it was impossible to use spotlights from the truck, hand-held lanterns could have provided adequate illumination. Adequate illumination would have made the dangling phase readily visible and may have assisted in identifying the dangling phase as an energized conductor.

Recommendation #4: To eliminate confusion, all conductors in a given system should be constructed of the same material.

Discussion: Although the rest of the current-carrying conductors in the electrical system were copper, the conductor that was dangling from the crossarm to the ground was aluminum. The guy wires used to stabilize power poles in the system are also aluminum. For this reason, the victim may have mistaken the dangling, current-carrying conductor for a guy wire. This confusion may have been compounded by the fact that a guy wire anchor was in place in the ground 20 feet from the power pole without a guy wire attached. To avoid confusion and to aid in the identification of current-carrying and non-current-carrying conductors, the material from which these conductors are constructed should remain consistent throughout an electrical system.

REFERENCES

1. Morbidity and Mortality Weekly Report October, 27, 1989/Vol. 38/No. 42/ Update: Work-Related Electrocutions Associated with Hurricane Hugo, Puerto Rico.

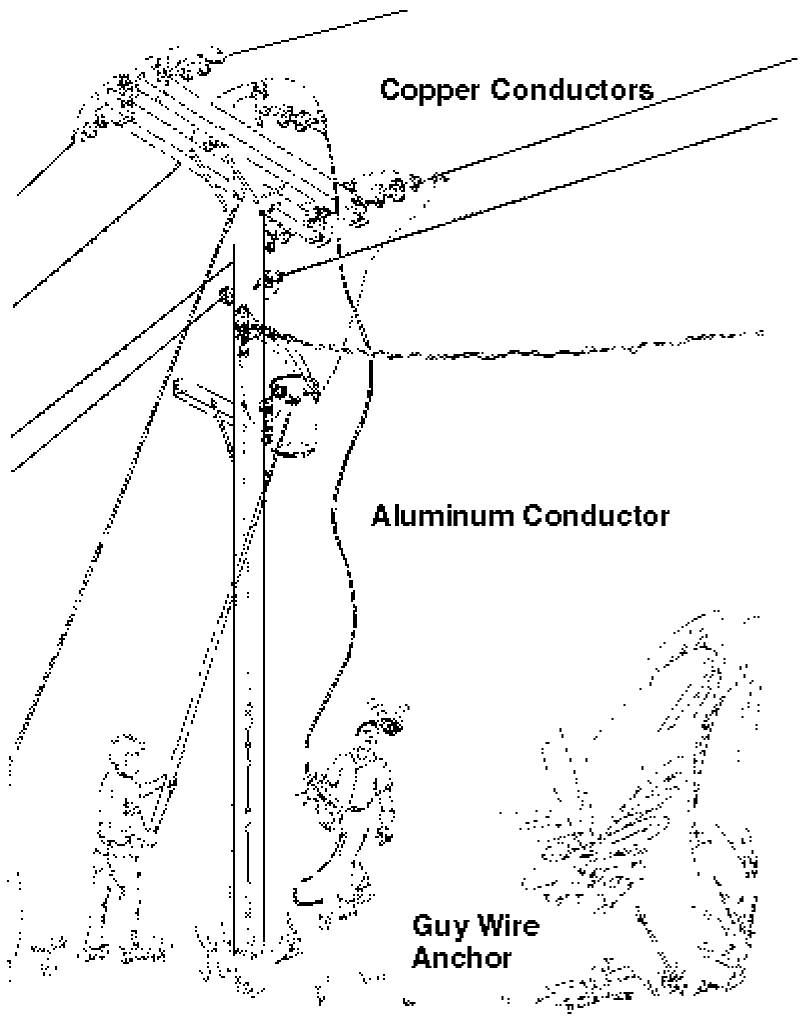

Figure.

FACE 90-04: Meter Reader Dies When He Contacts Energized Clothesline Wire in Puerto Rico

SUMMARY

A power company crew (a supervisor, a lineman, and two meter readers) was assigned the task of restoring secondary service to residences in an area that had been damaged by Hurricane Hugo. When the crew arrived at the jobsite after dark, the supervisor decided that two phases of an existing three-phase drop service needed to be reattached to a pole-mounted transformer near a residence. When the lineman had completed reattaching the two phases, one of the meter readers (the victim) went to the residence to tell the occupants that their power had been restored. As the victim stepped over a chain-link fence into the yard of the residence, he lost his balance and grabbed a wire clothesline in an effort to regain his balance. Co-workers noticed the victim was being shocked and knocked him away from the clothesline and fence. The wire clothesline was attached to a metal pole that supported the tin roof of the residence. An energized secondary service from a nearby residence had been torn loose from its connection and was lying across and energizing the tin roof, metal pole and clothesline at 110 volts. When the victim grabbed the wire clothesline, his body provided a path to ground, causing his electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and employees must:

- conduct a comprehensive jobsite survey prior to the start of work to identify all potential hazards that workers might encounter during the performance of their duties

- provide and utilize adequate lighting while performing work place safety inspections prior to the start of work and during powerline repair work at night

- instruct all workers to treat all conductive components in their work area with extreme caution, especially when the electrical system in their work area has suffered extensive damage, and wear appropriate personal protective equipment when necessary.

INTRODUCTION

On September 28, 1989, officials of the Commonwealth of Puerto Rico notified the Division of Safety Research (DSR) that a 28-year-old male meter reader was electrocuted when he grasped an energized clothesline wire to regain his balance while crossing a chain-link fence. Technical assistance was requested by officials of the Commonwealth and during the week of October 2-6, 1989, a DSR field team (two occupational safety and health specialists, a safety engineer, and an epidemiologist) conducted an investigation, met with the Commonwealth Epidemiologist and his staff, the Secretary of Health, representatives of the Medical Examiner's office, and power company officials to obtain information concerning the circumstances surrounding the incident. Videotape and photographic documentation of storm damage to the electrical transmission and distribution system was taken. This investigation was one of five separate investigations (90-02 through 90-06) conducted by DSR staff. All five of the investigations involved workers who were electrocuted while restoring electrical power to the island of Puerto Rico as a result of damage caused by Hurricane Hugo (1).

The employer is a major utility company with more than 10,500 employees. The company has been in operation for the past 41 years. The company has a comprehensive safety program with written policies and procedures for all routine operations. The corporate safety staff consists of a supervisor of industrial safety, six safety engineers, and seven safety advisors. Training for all workers is provided in the classroom as well as on the job. All workers receive periodic retraining and workers that perform line work are certified in cardiopulmonary resuscitation (CPR).

INVESTIGATION

On the day of the incident, the crew members (a supervisor, a lineman, and two meter readers) were assigned the task of restoring secondary electrical service to residences in an area that had been damaged by Hurricane Hugo. The two meter readers were being utilized as part of this crew because of the manpower shortage created by the extensive utility line damage from the hurricane. The crew worked at this task throughout the day and at the time of the incident were restoring power to the last residence scheduled for that day (after dark). When the crew arrived at the last jobsite the supervisor decided that some tree trimming was necessary and that two phases of an existing three-phase drop service needed to be reattached to a pole-mounted transformer near the residence. The lineman prepared the two phases for reattachment on the ground while the meter readers did the required tree trimming. When the lineman had completed his preparations, he raised himself in the bucket of a bucket truck and attached the two phases to the transformer while the meter readers collected the tools that had been used and placed them on the truck. When the lineman had completed the connections, one of the meter readers (the victim) went to the residence to tell the occupants that their power had been restored. As the meter reader stepped over a chain-link fence into the yard of the residence he lost his balance and grabbed a wire clothesline in an effort to regain his balance. After a period of minutes co-workers noticed the victim was being shocked and knocked him away from the clothesline and fence. The co-workers initiated cardiopulmonary resuscitation and transported the victim to the local hospital where he was pronounced dead one-half hour after arrival.

Investigation of the incident site by power company officials revealed that the wire clothesline was attached to a metal pole that supported the tin roof of the residence. An energized secondary service line from a nearby residence had been torn loose from its connection and was lying across and energizing the tin roof at 110 volts (Figure). This action, in turn, energized the metal pole and clothesline at 110 volts. When the victim grabbed the wire clothesline, his body provided a path to ground, causing his electrocution.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: A comprehensive jobsite survey should be conducted prior to the start of work to identify all potential hazards that workers might encounter during the performance of their duties.

Discussion: A comprehensive jobsite survey should be conducted by the supervisor or worker in charge prior to the start of any work to identify all potential hazards that may confront the workers performing the task at that given site. This type survey is particularly necessary in incidents where extensive damage has been inflicted by a natural disaster, e.g., a hurricane. The possibility of potential electrical hazards is greatly increased by the presence of conductive components and multiple powerlines being downed. These hazards include these that might be present both at ground level and at any level above ground where conductive components might be physically connected to conductive components at ground level, such as the metal pole and wire clothesline in this instance. This situation is compounded further since work was being performed in the dark, making identification of existing and potential hazards even more difficult. Had an inspection been conducted it is possible the downed live conductor on the conductive roof would have been identified, and this fatality would have been prevented.

Recommendation #2: Adequate lighting should be provided and utilized while performing work place safety inspections prior to the start of work and during powerline repair work at night.

Discussion: Adequate lighting should be provided and sufficient time taken to thoroughly inspect the entire worksite for hazards prior to the start of electrical repair work. If adequate lighting had been used during an inspection of the roof, the downed powerline in contact with the roof could have been discovered and properly repaired, preventing the fatality. In addition, adequate lighting must also be provided when powerline work is performed after dark.

Recommendation #3: Workers should be instructed to treat all conductive components in their work area with extreme caution, especially when the electrical system in their work area has suffered extensive damage, and wear appropriate personal protective equipment when necessary.

Discussion: Workers should be instructed to exercise extreme caution when working with or near an electrical system which has suffered extensive damage, especially in a work area that contains conductive components. In the presence of multiple downed powerlines and conductive components, workers should be extremely cautious, and wear appropriate personal protective equipment when necessary.

REFERENCES

1. Morbidity and Mortality Weekly Report, October 27, 1989/Vol.38/No. 42 Update: Work-Related Electrocutions Associated with Hurricane Hugo - Puerto Rico.

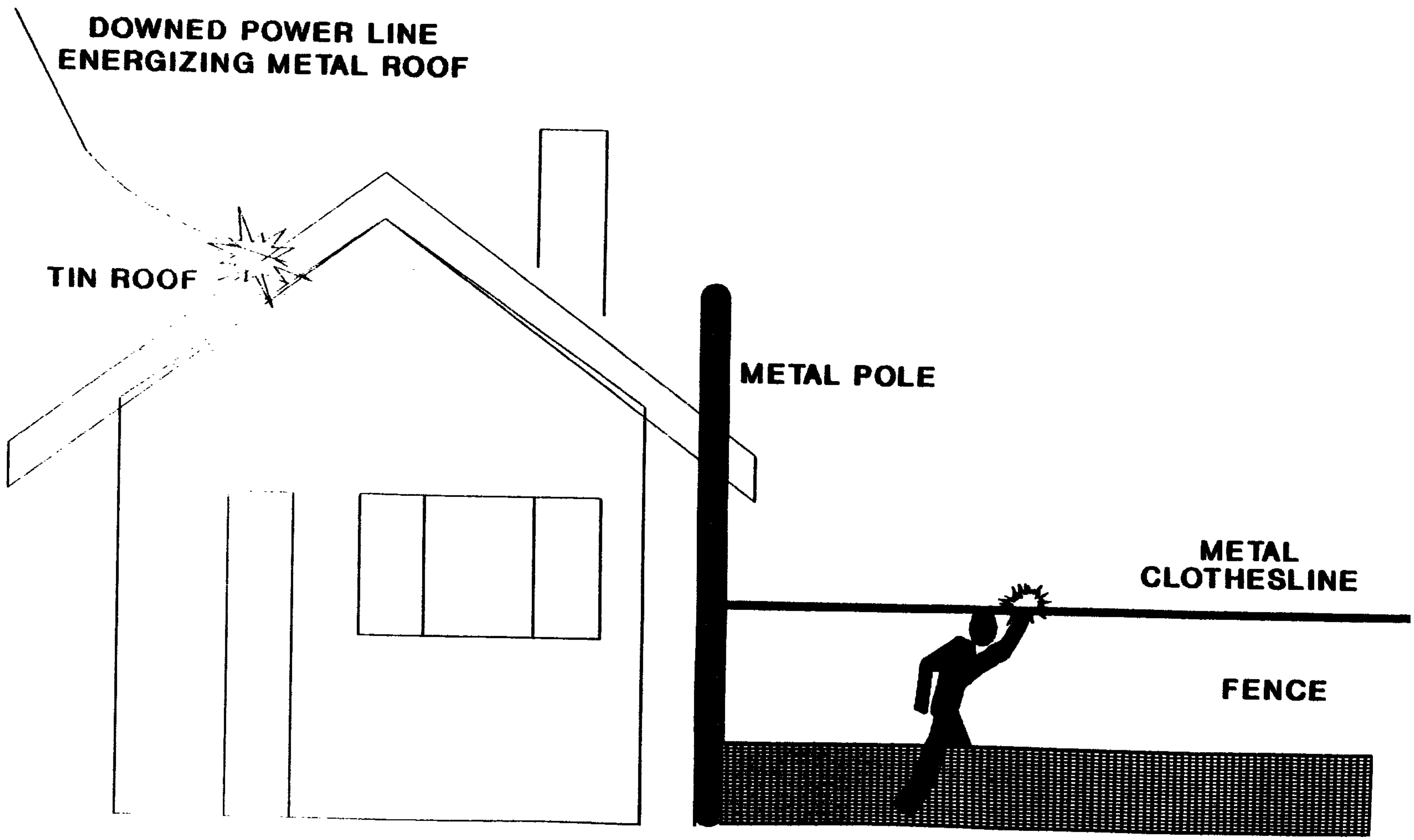

Figure. *Meter Reader Electrocution*

FACE 90-05: Lineman Dies When He Contacts Energized Power Line in Puerto Rico

SUMMARY

A construction crew consisting of a supervisor, three class A linemen (including the victim), a first class lineman, a groundman, and two truck drivers were assigned the task of correcting a malfunction in a de-energized three-phase powerline. When the crew arrived at the worksite, they found that one of the three phases had broken and fallen to the ground. The supervisor instructed the victim to relocate the damaged phase on the crossarm of the pole to better balance the load on the crossarm. As the victim began to climb the pole he was assured by the supervisor that the powerlines had been de-energized. When he attempted to relocate the damaged line he contacted another phase, was shocked, and slumped backwards, prevented from falling by his safety belt. The powerlines at the worksite had been energized by backfeed electrical energy from a portable gas generator being used on the circuit. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and employees must:

- ensure that established procedures for powerline maintenance work are followed at all times

- take special precautions to guard against feedback electrical energy, including testing and grounding powerlines prior to the initiation of work.

INTRODUCTION

On September 29, 1989, Commonwealth of Puerto Rico officials notified the Division of Safety Research (DSR) of a 42-year-old male lineman with 19 years of experience that was electrocuted while attaching a 2400-volt powerline to a pole-mounted insulator. The powerline had been de-energized two days earlier and the supervisor assured the lineman that the powerline was still de-energized. During the week of October 2-6, 1989, a DSR research team (two occupational safety and health specialists, a safety engineer, and an epidemiologist) conducted an investigation, met with the Commonwealth Epidemiologist and his staff, the Secretary of Health, representatives of the Medical Examiner's office, and power company officials to obtain information concerning the circumstances surrounding the incident. Videotapes and photographs were taken to document storm damage to the electrical transmission and distribution system. This investigation was one of five separate investigations (90-02 through 90-06) conducted by DSR staff. All five of the investigations involved workers who were electrocuted while restoring electrical power to the island of Puerto Rico as a result of damage caused by Hurricane Hugo(1).

The employer is a major utility company with more than 10,500 employees. The company has been in operation for the past 41 years. The company has a comprehensive safety program with written policies and procedures for all routine operations. The corporate staff consists of a supervisor of industrial safety, six safety engineers, and seven safety advisors. Apprentice linemen undergo a 6-month training program in which they spend half of each day in the classroom and the other half day on the job. At the end of this 6-month period, the apprentice transmission and distribution linemen are classified as first, second, or third (highest) class linemen, depending on their level of competence. Apprentice construction linemen are classified as either class A (highest), B, or C linemen. All workers receive classroom and on-the-job training, and periodic retraining. Workers that perform line work are certified in cardiopulmonary resuscitation.

INVESTIGATION

On September 17, 1989, the day before the area was struck by Hurricane Hugo, a malfunction occurred in a main electrical feeder line that served one region of the Commonwealth. Power company engineers identified a group of three phases of powerline that branched off of the feeder line as the cause of the malfunction and decided to de-energize these phases and repair them at a later date. The hurricane struck the island the following day causing massive damage to the electrical utility network and power company workers did not return to correct the malfunction at the feeder line until September 21, 1989. A crew consisting of a third class lineman, a first class lineman, and a cable splicer were assigned the task of identifying and correcting the cause of the malfunction. When they arrived at the site, the crew found that one of the three phase lines had broken and fallen to the ground. The crew decided to temporarily eliminate the broken phase and restore power to the other two phases in an attempt to restore electrical service to their customers.

A construction crew in the area, consisting of a supervisor, three class A linemen (including the victim), one groundman, and two truck drivers arrived at the site. The supervisor decided to relocate the damaged phase on the crossarm of the pole located before the damaged portion of the phase to better balance the load on the crossarm. The victim was to attach the damaged phase to an insulator located at a position on the crossarm that was congested with other conductors and communication lines.

As the victim climbed the pole to relocate the damaged phase, he asked the supervisor if the lines had been de-energized. The supervisor assured him that the lines had been de-energized 2 days earlier. The victim was wearing his work gloves when he grasped the line and began to position it on the insulator. The victim contacted one of the other lines, received a shock, and slumped backward. He was prevented from falling by his safety belt. One of the construction linemen climbed the pole and brought the victim to the ground. Co-workers immediately initiated cardiopulmonary resuscitation (CPR), and continued to administer CPR as they transported the victim to the hospital. The victim was pronounced dead on arrival at the hospital.

Power company investigators discovered that the lines had been de-energized at a pole-mounted service transformer. However, incorrect connections at this transformer established a path for current energy from another circuit to travel back (backfeed) through the transformer, energizing the line that the victim had contacted. Tests determined that 2400 volts were present on the line.

CAUSE OF DEATH

The medical examiner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers must ensure that established safety procedures are followed at all times.

Discussion: Company policy requires linemen to verify that powerlines are de-energized, grounded, and tested before starting work on the lines. The victim accepted the word of his supervisor that someone else had de-energized the lines. The supervisor allowed the victim to proceed without following established procedures. Had the victim or the supervisor verified that the lines were de-energized, grounded, and tested, this incident might have been prevented.

Recommendation #2: Special precautions should be taken to guard against feedback electrical energy.

Discussion: The potential for electrocution due to feedback energy should not be underestimated. This is especially true in this case, where massive damage was inflicted on the area's electrical system by the hurricane. To protect against the hazard of electrical feedback energy, linemen must verify that powerlines have been de-energized. De-energized lines must also be properly grounded to the system neutral. Grounds must be attached to the system neutral first and removed from the system neutral last. If work is being performed on a multi-phase system, grounds must be placed on all lines, and should be grounded in sight of the work area, with work being performed between the grounds whenever possible. If work is to be performed out of sight of the point where the line has been de-energized, an additional ground should be placed on the source side of the work area. Unless a power line is effectively grounded on both sides of a work area, it must be considered energized even though the line has been de-energized. Linemen should also be instructed to always wear the appropriate personal protective equipment (NIOSH 88-104).

REFERENCES

1. Morbidity and Mortality Weekly Report October 29, 1989/Vol. 38/No. 42 Update: Work-Related Electrocutions Associated with Hurricane Hugo - Puerto Rico.

2. DHHS (NIOSH) Publication No. 88-104, Request for Assistance in Preventing Electrocutions by Undetected Feedback Electrical Energy in Powerlines.

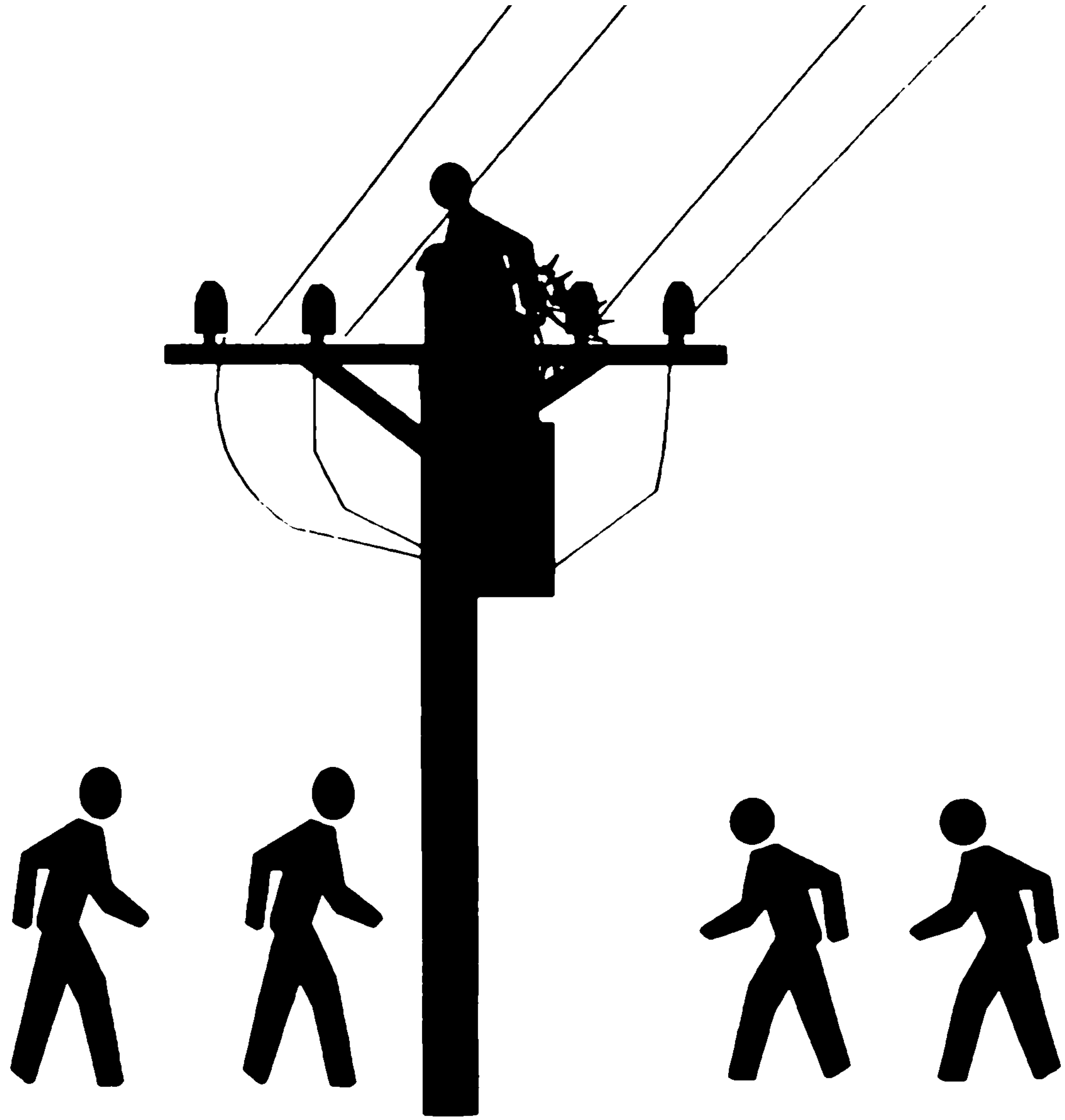

Figure. *Lineman Electrocution*

FACE 90-06: Electrical Lineman Electrocuted by Contact with Energized Powerline in Puerto Rico

SUMMARY

A journeyman lineman working to restore electrical power in the wake of Hurricane Hugo was electrocuted when the boom and bucket of the bucket truck in which he was working rotated into an energized 4800-volt powerline. Just prior to the incident, the lineman noticed that a plastic tool basket, mounted on the side of the bucket with copper-wire hooks, was full of water. He removed the basket from the side of the bucket, and emptied it. When the lineman attempted to reinstall the tool basket in the dark, one of the hooks caught on the lever which controlled boom rotation, and engaged it, causing the boom to swing into the powerline. The victim's body made contact with an energized 4800-volt powerline and a secondary fuse box. The jolt of the bucket striking the lines caused the victim to be thrown from the bucket to the ground 30 feet below. NIOSH investigators concluded that, in order to prevent similar incidents in the future, employers must ensure that:

- standard safe operating procedures, such as grounding bucket trucks and using insulated line hoses and blankets, are followed at all times

- portable lighting, which enables the worker to see the worksite clearly, is provided whenever employees are required to work in darkness

- comprehensive inspections of each worksite are conducted prior to the start of each job to identify potential hazards, including damaged equipment. Damaged equipment should then be removed from service.

INTRODUCTION

On September 28, 1989, a 30-year-old male lineman third class was electrocuted when the boom and bucket of the bucket truck in which he was working rotated into an energized powerline and a secondary fuse box.

Commonwealth officials notified DSR of this fatality and requested technical assistance. During the week of October 2-6, 1989, a DSR field team consisting of two occupational safety and health specialists, a safety engineer, and an epidemiologist conducted an investigation. Members of the DSR team met with the Commonwealth Epidemiologist and his staff, the Secretary of Health, representatives of the Medical Examiner's office, and power company officials to obtain information concerning the circumstances surrounding this incident. Videotape and photographic documentation of storm damage to the electrical transmission and distribution system was taken. This investigation was one of five separate investigations (90-02 through 90-06) conducted by DSR staff. All five of the investigations involved workers who were electrocuted while restoring electrical power to the island of Puerto Rico as a result of damage caused by Hurricane Hugo (1).

The employer is a major utility company with more than 10,500 employees. The company has been in operation for the past 41 years. The company has a formal safety program with written policies and procedures for all routine operations. The corporate safety staff consists of a supervisor of industrial safety, six safety engineers, and seven safety advisors.

All workers receive periodic retraining and workers that perform work on electrical lines are certified in cardiopulmonary resuscitation (CPR).

INVESTIGATION

The victim, a third class (highest level) lineman with 6 years' experience, was a member of an electric utility work crew that for 10 days prior to the incident had been working extremely long hours to restore electric service to an area devastated by a hurricane. On the day of the incident, the crew had been working since early morning. At approximately 8:30 p.m., the crew decided to restore power to one more area before quitting work for the night. The victim went up in a bucket truck to open a two-phase line on a transformer and install a jumper between that line and another two-phase line on a second transformer. As the victim prepared to start work in the bucket, he noticed that a plastic tool basket mounted on the side of the bucket was full of water. The mounting bracket for this basket had broken and had been replaced with two copper wire hooks which slipped over the edge of the bucket to hold the basket in place (Figures 1 and 2).

The victim removed the plastic basket from the bucket to empty the accumulated rainwater. When he attempted to reinstall the basket in the darkness, one of the copper hooks became caught on one of the three bucket-mounted control levers (Figure 3). This lever controlled the horizontal rotation of the boom. The weight of the tool basket engaged the control lever and caused the boom to begin to move toward the powerlines. (Had the original mounting bracket been in place, the basket could not have engaged the control lever.) The victim tried in the darkness to manipulate the controls and stop the rotation. A ground crew worker, who observed the bucket moving toward the powerlines, attempted to reach the master control panel on the truck, but slipped and fell before reaching the controls. The victim made contact with an energized 4800-volt powerline and a secondary fuse box. The bucket hit the line with such a jolt that the victim was thrown from the bucket to the ground approximately 30 feet below.

Co-workers administered cardiopulmonary resuscitation (CPR) to the victim and transported him to a local hospital where he was pronounced dead. The victim had second and third degree burns on his abdomen and right thigh.

CAUSE OF DEATH:

The Medical Examiner listed the cause of death as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers must insure that existing company safety procedures are followed at all times.

Discussion: Company standard operating procedures require the grounding of all bucket trucks and the use of insulating line hoses and blankets when working around energized lines. Neither of these required practices was being followed when this incident occurred. Compliance with these existing safe work practices might have prevented this fatality.

Recommendation #2: Employers must provide portable lighting for workers required to work during periods of darkness.

Discussion: Adequate lighting of the worksite is vital if workers are to function in a safe manner. Darkness can obscure obvious hazards and thereby dramatically increase worker exposure to these hazards. Truck-mounted spotlights and portable lanterns must be available and utilized to minimize risks. The use of such lighting might have prevented this incident.

Recommendation #3: Employers should conduct a comprehensive inspection of each worksite prior to the start of each job to identify all potential hazards at the worksite, including any damaged equipment. Damaged equipment should be removed from service.

Discussion: Failure to inspect both the worksite and the equipment to be utilized can result in unnecessary worker exposure to hazards. Equipment which has been damaged must be either repaired to factory specifications or replaced. Makeshift, on-site repairs, such as the repair of the plastic tool basket in this case, can create hazardous conditions. Had the tool basket been properly replaced, this incident might have been prevented.

REFERENCE

1. Morbidity and Mortality Weekly Report, October 27, 1989/Vol.38/No. 42 Update: Work-Related Electrocutions Associated with Hurricane Hugo - Puerto Rico.

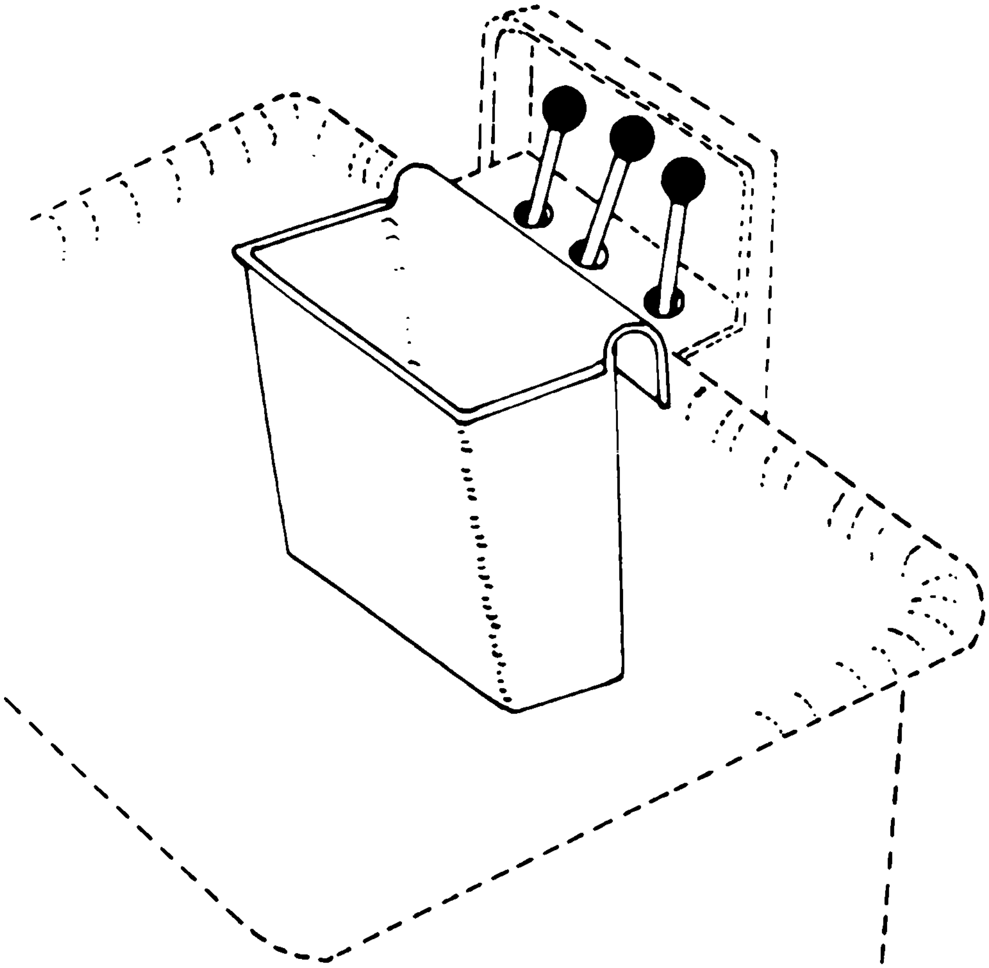

***Figure 1**. Tool Basket as Originally Installed*

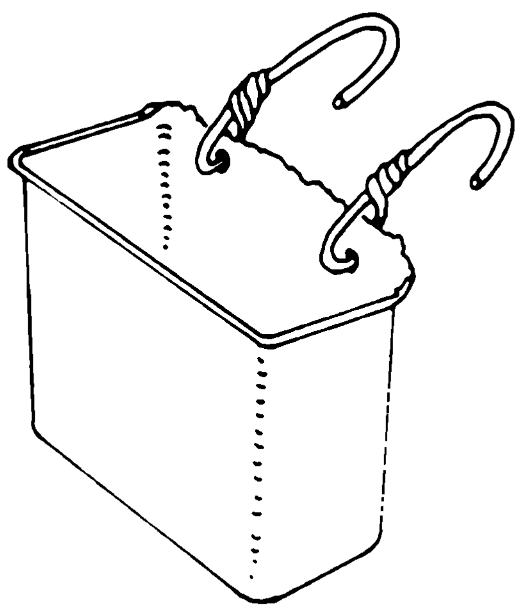

***Figure 2**. Tool Basket Showing Wire Hooks Used for Installation*

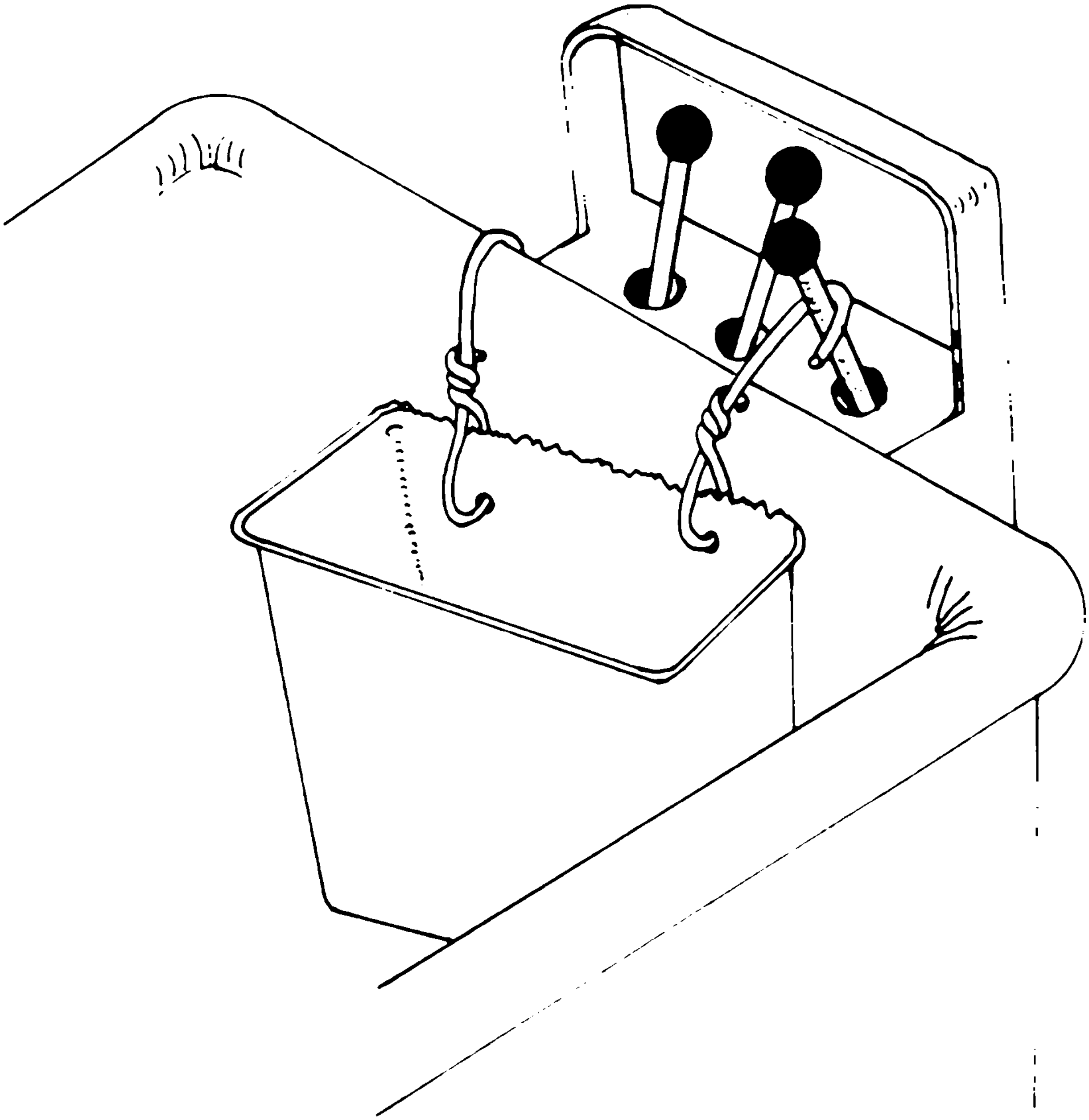

Figure 3. *Position of Tool Basket at Time of Incident*

FACE 90-08: **Line Technician Electrocuted During Power Restoration Following Hurricane Hugo in South Carolina**

SUMMARY

A utility company line technician was electrocuted while working to restore electrical service that had been interrupted by Hurricane Hugo. The victim and a co-worker had been clearing debris from a pole-mounted three-phase 7200-volt powerline. When they thought the line was clear of debris, the victim asked substation workers to energize the three phases. However, the recloser (an automatic switch or circuit breaker that reestablishes an electrical circuit after an interruption of service) on the middle phase opened indicating that a problem with that phase still existed. The workers, who started to look for the problem without requesting that the powerlines be de-energized, found that the middle phase had been pulled down into a guy wire by storm debris. The victim climbed the pole to cut the middle phase, and called to his co-worker to throw him a pair of pliers. The co-worker asked the victim whether he wanted his hardhat tossed up as well, but the victim declined. While he was maneuvering between the powerlines, with his feet on the neutral wire, the back of the victim's head contacted an energized jumper wire and he was electrocuted. In order to prevent similar deaths in the future, NIOSH suggests that:

- extra emphasis be placed on strict adherence to all company safety procedures during emergency operations

- the company change its procedures to require that substation workers de-energize powerlines when notified that problems exist

- workers inspect an entire circuit that has been de-energized for maintenance to ensure the circuit is clear of debris and free from physical damage prior to re-energizing that circuit.

INTRODUCTION

On October 11, 1989, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the electrocution of a line technician on September 22, 1989. The victim was electrocuted while working to restore electrical service interrupted by Hurricane Hugo. The state requested an investigation of the circumstances involved with this fatality and on October 20, 1989, a DSR safety engineer conducted an investigation. The DSR investigator met with company officials to discuss the circumstances of the incident, and examined and photographed the incident site. The incident was also reviewed with state compliance personnel.

The employer, a utility company with approximately 20,000 employees, has a comprehensive safety program that includes detailed, job-specific procedures. Safety training is accomplished through on-the-job training, as well as by manuals and classroom sessions. Safety procedures are discussed regularly so that employees are aware of procedures to follow in various situations. Monthly safety meetings are held, and toolbox meetings are conducted on site to discuss job-specific safety measures. During the time that restoration work was being performed after the hurricane, company safety personnel were out in the field observing the workers and verifying that safety procedures were being followed.

According to local management and company safety personnel, the victim, a 58-year-old male, had been with the company for over 20 years and had a good safety record. He was the secretary of the local safety committee.

INVESTIGATION

Hurricane Hugo began to affect the area on the morning of September 22, 1989. The utility company workers had assembled at the area office, waiting for the storm to pass before going out to work. At 10:00 a.m., work to restore electrical service began.

The victim and a co-worker were working along a road to restore service and were clearing debris from the area of a three-phase 7200-volt powerline. The co-worker was a meter reader assigned to assist the victim on the ground. At 6:00 p.m., believing that the lines were clear, the workers radioed substation workers requesting them to energize the three phases. Upon re-energization, however, the recloser on the middle phase opened, indicating that a problem still existed on that phase. The victim notified the substation workers that a problem still existed on one of the phases, and that he was going to find it. He and the co-worker drove along the road until they identified that the middle phaseline had at one site been pulled down by storm debris and was in contact with a guy wire causing a fault.

The victim climbed the pole to cut the middle phase and he then called to the co-worker to toss him a pair of pliers. The victim was wearing lineman boots, insulated gloves, and fall protection as required by company policy. He was not wearing his hardhat, also required by company policy. The co-worker told the victim that he would toss him his hardhat, but the victim declined. The victim climbed the pole to the neutral wire and commented that he was tired. While attempting to maneuver into position to cut the middle phase, the back of his head contacted an energized jumper wire while his feet were on the neutral wire. The current passed through his body, and he was electrocuted. The co-worker immediately radioed the dispatcher from the truck to summon the Emergency Medical Service (EMS). A supervisor who had arrived at the scene, radioed the substation and instructed them to de-energize the three phases. The supervisor climbed up the pole to assist the victim, and he could not find any vital signs. A bucket truck arrived at the scene, and the victim was removed from the pole. The victim was transported by the EMS to a local hospital, where he was pronounced dead.

While restoring service after the hurricane, the company worked daylight hours to minimize hazards posed by working in the dark. Also, the company required the workers to be off duty for at least 8 hours each day, to minimize the effects of fatigue.

CAUSE OF DEATH

The coroner ruled that the cause of death was electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: During emergency operations, extra emphasis should be placed on strict adherence to all safety procedures.

Discussion: In this instance, the victim, who had a good safety record, violated safety procedures. Employers must emphasize strict adherence to safe work procedures, especially during emergency operations. The company discussed safe work procedures daily with the workers during these emergency operations. Safety staff were in the field observing the work habits of the workers, and were taking corrective action where safety rules were not being followed. The company safety procedures state that a worker cannot climb a pole with energized lines. The worker is to work on energized lines from an insulated bucket truck or an insulated platform, and the lines must be covered by mats, line hoses and/or blankets. When climbing a pole, a worker must wear a hardhat, insulated rubber linemen gloves, boots, and fall protection. If these established safety procedures had been followed, this fatality might have been prevented.

Recommendation #2: The company should re-evaluate its procedures pertaining to the de-energization of powerlines.

Discussion: The company should re-evaluate its procedures and policies regarding the de-energization of powerlines prior to the start of maintenance work in emergency situations. Company policy prohibits working on energized powerlines from a pole. However, the company should institute a policy that requires de-energizing an entire circuit prior to starting maintenance. In this case, the powerlines should have been de-energized by substation personnel as soon as word was received that trouble still existed and that additional work would be performed. Once the powerlines are de-energized, substation personnel should then inform the workers that work can proceed. Had such practices and established safe work procedures been followed in this case, this fatality would have been prevented.

Recommendation #3: Company policy should require workers to visually inspect an entire circuit that has been de-energized for maintenance prior to energizing that circuit.

Discussion: The company should require that workers visually inspect an entire circuit that has been de-energized prior to energizing that circuit. In this case, the victim had substation personnel energize the circuit before performing a visual inspection of the entire circuit to ensure that all lines on that circuit were clear. Had a visual inspection been performed, the trouble might have been identified before the powerlines were energized, thereby preventing this incident.

FACE 90-09: **Painter Electrocuted while Repositioning an Aluminum Extension Ladder in Virginia**

SUMMARY

A painter was electrocuted and his co-worker injured, when a portable aluminum extension ladder contacted a 7,200-volt powerline. This incident occurred as the two workers were painting a two-story aluminum-sided house. The powerline was located parallel to, and approximately 10 feet from, one side of the house. The powerline was 22 feet off the ground. The victim was using a 30-foot aluminum extension ladder to paint the upper part of the house, while his co-worker was using a stepladder to paint the window trim on the first floor. The victim had progressed to a point where repositioning the ladder was necessary to continue painting. He descended the ladder, placed the paint brush and bucket on the ground, and proceeded to move the ladder. The ladder tipped backwards and contacted the powerline. The current passed through the ladder and victim to ground while he was still in contact with the energized ladder. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and employees should:

- use ladders made of non-conductive materials when working near energized powerlines

- contact the local electric utility company for assistance in de-energizing or sleeving powerlines if work is to be done near energized powerlines

- develop a safety program designed to recognize and avoid hazards (e.g., overhead electrical powerlines)

- conduct initial jobsite survey to identify all hazards associated with the specific jobsite.

INTRODUCTION

On October 16, 1989, a 24-year-old male painter was electrocuted when a portable aluminum extension ladder he was using contacted a 7,200-volt powerline. On October 25, 1989, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR), of this fatality, and requested technical assistance. On November 6-7, 1989, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with the OSHA compliance officer assigned to the case, EMS personnel, police personnel, and an electric utility representative. Photographs of the incident site and various reports of the incident were obtained.

The employer in this incident is a small painting contractor that has been in operation for 5 years. The company employs three full-time employees. The company had no written safety program and provides no safety training beyond verbal instructions to work safely. Also, the victim worked for the employer 4 weeks, and had only been in this country for 6 weeks and could not read or speak English.

INVESTIGATION

The company had been contracted to paint a two-story aluminum-sided house. Two employees had been working at the jobsite for 3 days prior to the incident. The employees were using a portable 30-foot aluminum extension ladder and two aluminum stepladders to paint the upper part of the house. A 7,200-

volt overhead powerline is located parallel to, and approximately 10 feet from, one side of the house. The powerline is 22 feet off the ground.

On the day of the incident, the victim was painting on the side of the house nearest the powerline, while his co-worker was working around the corner of the house. The victim was working from the extension ladder painting window trim and soffit and facia on the second floor. The co-worker was using a stepladder to paint the trim around the windows on the first floor. The victim had progressed to a point where repositioning the ladder was necessary to continue painting. The victim descended the ladder, placed the paint brush and bucket on the ground, and proceeded to move the ladder. The ladder, which had been previously raised to a height of approximately 24 feet 6 inches, tipped backwards and contacted the powerline (Figure). The ladder in contact with the powerline provided a path for the electrical current through the victim to ground. The co-worker, confused as to what had happened, rushed to aid the victim and also contacted the ladder which was still in contact with the powerline. The co-worker, victim, and ladder were all knocked to the ground. An off-duty policeman saw the incident, and radioed for help. Prior to the arrival of an emergency medical service (EMS) vehicle, the policeman checked for injuries. Noting that the victim had stopped breathing, the policeman began administering cardiopulmonary resuscitation (CPR). An EMS vehicle arrived in 4 minutes and EMS personnel attended to the two workers. A second EMS vehicle arrived 2 minutes later. The victim received advanced cardiac life support, and was then transported to the hospital, where he was pronounced dead on arrival. The co-worker was treated for burns, transported to the hospital, and released the following day.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Ladders used near energized powerlines should be made of nonconductive materials.

Discussion: OSHA Standard 1926.450(a)(11) states that "portable metal ladders shall not be used for electrical work or where they may contact electrical conductors." The portable 30-foot aluminum extension ladder used in this incident was conductive. If a ladder made of nonconductive material had been used in this case, the fatality might have been prevented.

Recommendation 2: If work is to be done near energized overhead powerlines, the employer should notify the local electric utility company for assistance.

Discussion: If work is to be done near energized overhead powerlines, particularly work involving ladders, scaffolds, boomed vehicles, large pieces of conductive materials, or long-handled tools, the employer should notify the local electric utility company. The utility company can de-energize the powerlines, insulate the powerlines with insulating blankets or hoses, or advise employers and employees of procedures to avoid contact. Most electric utility companies will consult with employers on matters pertaining to worker safety.

Recommendation #3: The employer should develop a safety program designed to recognize and avoid hazards (e.g., overhead electrical powerlines).

Discussion: The danger of overhead powerlines appears to be obvious; however, deaths resulting from contact with overhead powerlines continue to occur. OSHA Standard 1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." The company does not provide training in safe work procedures and does not have written safety rules. The tasks performed by workers should be evaluated and the hazards identified. A safety program should be developed which addresses these hazards.

[Note: The victim had only been in this country for 6 weeks prior to the incident and could not read or speak English. Therefore, the safety program should have provisions ensuring that non-English-reading/-speaking employees fully understand the safety program.]

Recommendation #4: The employer should conduct an initial jobsite survey to identify all hazards associated with the specific jobsite.

Discussion: Two characteristics of this jobsite combined to produce a very serious hazard: 1) energized powerlines located 10 feet away from the house being painted, and 2) the use of a portable 30-foot aluminum extension ladder. Recognition of this potential hazard through a jobsite survey may have prompted the employer to contact the local utility company to have the powerlines covered with insulating hoses or blankets, or provide the employees with non-conductive ladders. Employers should conduct jobsite surveys, identify all hazards, and apply appropriate preventive measures prior to the start of any work.

REFERENCES

1. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 171. July 1, 1989.

2. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 20. July 1, 1989.

An employer should conduct a jobsite survey prior to initiating work at each site. Hazards, such as potential contact between an aluminum ladder and an overhead powerline depicted below, can be identified and controlled.

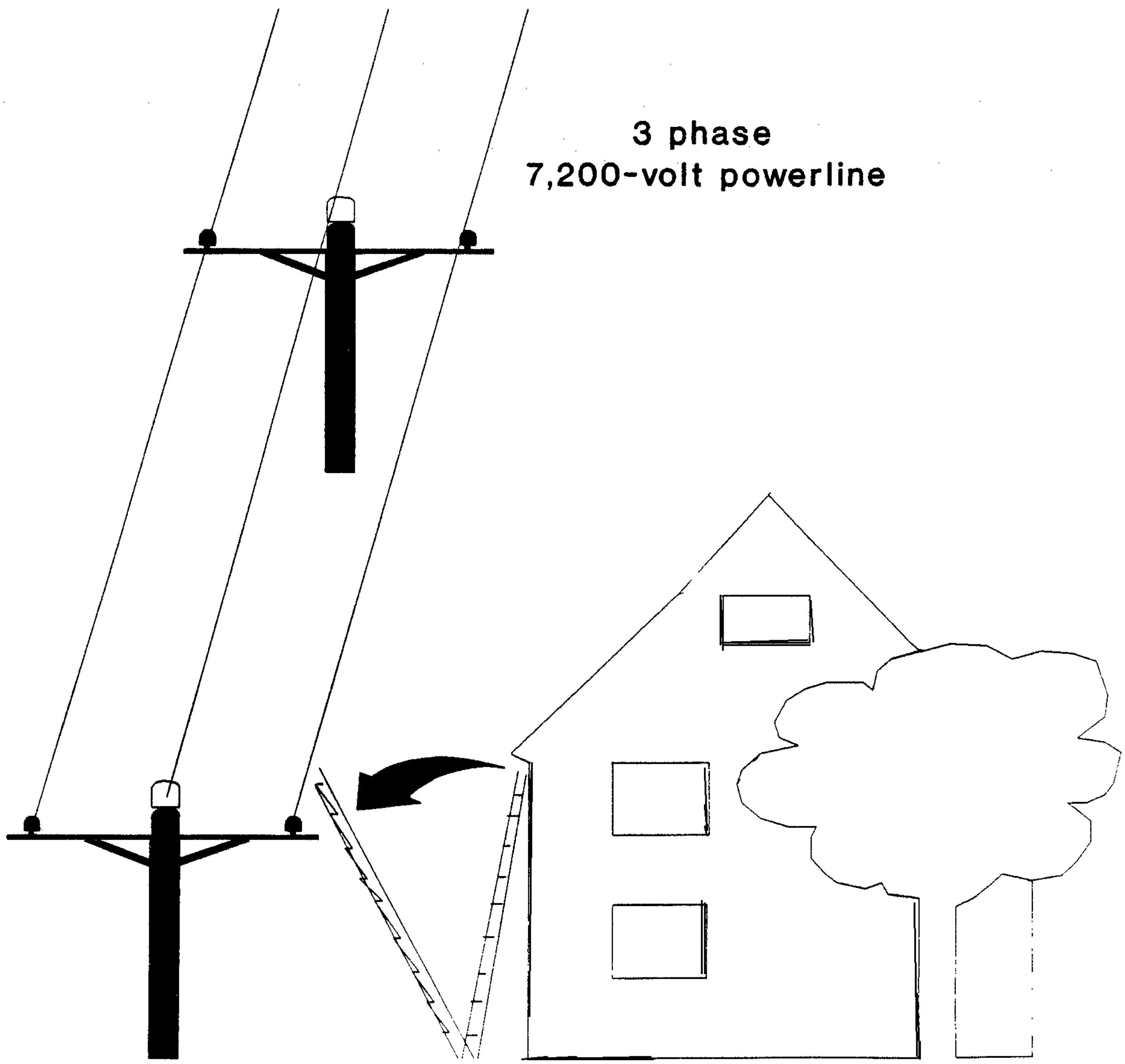

***Figure*.**

FACE 90-10: **Carpenter Electrocuted in Pennsylvania when Aluminum Edging Contacts Powerline**

SUMMARY

A carpenter was electrocuted when a strip of aluminum drip edging he was installing contacted a 7,200-volt powerline located behind and above him. The victim was working on replacing the roofing on a 45-year-old house. The powerlines were located 6 feet away from the house and 5 feet above the edge of the roof. The victim was working from an aluminum ladder jack scaffold when a segment of edging he was apparently placing in position contacted the powerline, allowing the current to pass through his body to ground. The NIOSH investigator concluded that, in order to prevent future similar occurrences, employers should:

- contact the local utility company to insulate the powerlines in proximity to any work area prior to the initiation of work
- use non-conductive ladders when working near powerlines
- require employees to wear fall protection.

INTRODUCTION

On October 28, 1990, a 31-year-old carpenter was electrocuted when a strip of aluminum drip edge he was positioning contacted a 7200-volt powerline. On November 2, 1989, officials of a county coroner's office in Pennsylvania notified the Division of Safety Research (DSR), of this fatality, and requested technical assistance. On November 15, 1989, a DSR safety engineer conducted an investigation, reviewed the case with a company official, discussed the incident with personnel familiar with the incident site and photographed the site.

The employer is a general contractor with 3 employees who has been in business for 9 years. The company has no safety officer and no written safety policy or program. Each job is reviewed for potential hazards by the owner. Specific hazards such as the location of powerlines are discussed with employees at the jobsite. For this particular job, the powerline location was discussed with the workers. Training is done on-the-job. The victim worked for the employer for 4 months and had 10 years' experience as a carpenter.

INVESTIGATION

The victim was involved in replacing the roofing on a 45-year-old private dwelling. A three-phase 7,200-volt powerline was located parallel to the front of the house and 5 feet above the edge of the roof. The nearest of these lines was 6 feet horizontally away from the house. The victim was installing fascia and aluminum drip edge from an aluminum ladder jack scaffold about 12 feet above the ground. (Drip edge is a "T"-shaped metal strip that fits on the edge of the roof covering the joint between the fascia and the roof board to prevent water from entering that joint.) The victim had been handed two pieces of 12-foot long drip edge by a co-worker. He installed one piece of long drip edge and then finished installing the fascia board. At this time someone pulled up in a car at the house and started talking with the co-worker. Although the incident was not witnessed, it appears that the victim took the other strip of drip edge and was maneuvering it into position when it contacted the powerline behind and above him. The victim fell from the scaffold to the ground. The emergency rescue squad was summoned while the co-worker initiated cardiopulmonary resuscitation. The victim was pronounced dead at the scene by an assistant county coroner.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution. The victim had entry wounds on his hands and exit wounds on his toes.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should contact local utility companies and request that they insulate all powerlines in proximity to a work area.

Discussion: Once employers identify the hazards associated with powerlines they should contact the local utility and request that the powerlines in proximity to the work area be insulated with line hoses until work is completed. Most utility companies provide this service when requested.

Recommendation #2: Employers should consider replacing the conductive components of a work platform with components made of a non-conductive material, such as fiberglass, for use around electrical conductors.

Discussion: The victim was standing on a metal surface (i.e., an aluminum ladder jack scaffold) that was connected to metal ladders in contact with the ground. When the drip edge made contact with the powerline, the victim's body provided a path to ground for the current. The use of non-conductive work platforms helps to reduce the possibility of electrocutions should a worker contact an energized conductor.

Recommendation #3: Workers should wear fall protection equipment when working at elevations.

Discussion: Employers should ensure that workers who are exposed to falls from elevations wear a safety belt and lanyard fastened to a life line which is secured to an anchor point.

FACE 90-22: Electrician Electrocuted after Contacting an Energized 480-volt Bus Bar in South Carolina

SUMMARY

An electrician was electrocuted when he and a co-worker attempted to perform electrical maintenance in a main service disconnect breaker panel at a South Carolina hotel. This incident occurred as an indirect result of Hurricane Hugo, which caused extensive damage to the beachfront hotel. The victim was part of a crew that had been contracted to make repairs throughout the hotel. The victim and a co-worker had been assigned to clear a ground fault that repeatedly tripped a 400-amp breaker in the main service disconnect breaker panel. Initially, the victim switched the main breaker to the off position. The victim and his co-worker then removed the panel covers from the breaker panel. As the co-worker turned away from the victim to lay one of the panel covers on the floor, the victim, for unknown reasons, switched the breaker back to the on position. When the co-worker turned around, he observed the victim in contact with the bus bar and a conductor. The victim died approximately 1 hour later as a result of his contact with the energized electrical conductor. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- develop, implement, and enforce a comprehensive safety program which includes worker training in recognizing and avoiding hazards, especially electrical hazards

- de-energize electrical systems prior to any work being performed on them, implement lockout/tagout procedures, and test the system to verify that it has been de-energized before working on the system.

INTRODUCTION

On January 17, 1990, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) that a 30-year-old male electrician was electrocuted on January 8, 1990, when he inadvertently touched an energized 480-volt bus bar in a main service disconnect breaker panel. Technical assistance was requested by the South Carolina Occupational Safety and Health Administration, and on January 30, 1990, a safety specialist traveled to the incident site to conduct an investigation. The safety specialist reviewed the incident with a company representative, the victim's co-worker, and a private electrical consultant. Photographs of the incident site and a police report regarding the incident were obtained during the investigation.

The employer in this incident is an employee leasing company that has been in business for 7 months. The company provides workers to perform maintenance, janitorial, and small construction jobs. The company, which employs 2,000 employees (i.e., carpenters, electricians, plumbers, and laborers), has no written safety program or safety director. The foremen is responsible for jobsite safety. The victim in this incident, who had worked for this employer for 7 months, was a licensed electrician with 6 years of experience.

INVESTIGATION

On Friday September 22, 1989, Hurricane Hugo battered the coast of South Carolina causing considerable property damage. A 9-story beachfront hotel sustained extensive damage during the hurricane. An employee leasing firm was contracted to make carpentry, masonry, plumbing, and electrical repairs to the hotel.

On the day of the incident, a crew of fifteen contract employees were performing various tasks throughout the hotel. The victim and a co-worker had been assigned the task of identifying and eliminating a ground fault that repeatedly tripped a circuit breaker in the main service disconnect breaker panel. The two employees proceeded to the maintenance room where the main breaker panel was located. The main breaker panel contained six separate circuits (three 480-volt and three 277-volt circuits) with accompanying breaker switches. The problem was determined to be a 400-amp breaker in one of the 480-volt circuits.

The two employees switched all of the breakers, including the main breaker, to the off position, and then removed the breaker panel covers. The next phase was to check the continuity of the conductors leading to a branch circuit panel located in another room. As the co-worker turned away from the victim to place one of the panel covers on the floor, he heard what sounded like the click of a breaker being switched on/off. He then heard a spitting sound and turned around to see the victim's right hand in contact with a conductor and his left hand in contact with a bus bar (Figure). The co-worker kicked the victim causing him to fall and break contact.

The foreman, who had been on his way to the maintenance room to check on the workers' progress, heard the commotion and immediately rushed to the area. After realizing what had happened, the foreman instructed another worker to call the local police, fire, and emergency medical service (EMS) departments. Approximately 2 minutes after the incident, the victim stopped breathing and the foreman began cardiopulmonary resuscitation (CPR), continuing it until the police arrived. The police arrived approximately 4 minutes after the incident and continued CPR. The EMS arrived 55 minutes after being called, provided advanced cardiac life support, and transported the victim to the hospital where he was pronounced dead approximately 1 hour later.

Note: For unknown reasons, the victim switched the main breaker from the off position to the on position and then inadvertently contacted the energized bus bar, which remains energized even though the other breakers were switched off. A subsequent investigation by a local electrical consultant confirmed that the main breaker switch had been in the on position at the time of the incident.

CAUSE OF DEATH

The medical examiner's office reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop, implement, and enforce a comprehensive safety program which includes worker training in recognizing and avoiding hazards, especially electrical hazards.

Discussion: In this incident the victim switched the main breaker from an on position to an off position, removed a panel box cover, and for unknown reasons switched the main breaker back to the on position. This procedure exposed an energized bus bar, which the victim contacted. Employers should evaluate the tasks performed by workers; identify all potential hazards; and then develop, implement, and enforce a comprehensive safety program addressing these issues as required by OSHA standard 1926.21. (1) This safety program should include, but not be limited to, worker training in electrical hazard recognition.

Recommendation #2: An electrical system should be de-energized, and tested to verify that it has been de-energized, prior to any work being performed on it.

Discussion: The breaker panel was not de-energized before the repair work was attempted. The circuitry may have been left energized in order not to inconvenience the other repair workers. A job of this type should be scheduled at a time (a weekend or before or after hours) when the incoming power could be de-energized without disrupting operations. Employers should develop specific job procedures for tasks that are performed by employees, including de-energizing electrical circuits before beginning to work on them, and verifying that the system has been de-energized. These procedures should detail the various safety hazards associated with each task. Once these specific procedures have been developed, employers should ensure that they are implemented and enforced by a qualified person at each jobsite. Additionally, when employees need to work away from the control point (i.e., the breaker panel in this incident), lockout and tagout procedures should be implemented (2).

REFERENCES

(1) Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 20. July 1, 1989.

(2) Federal Register: Part IV, Department of Labor, 29 CFR Part 1910. pp. 36644-36696. September 1, 1989.

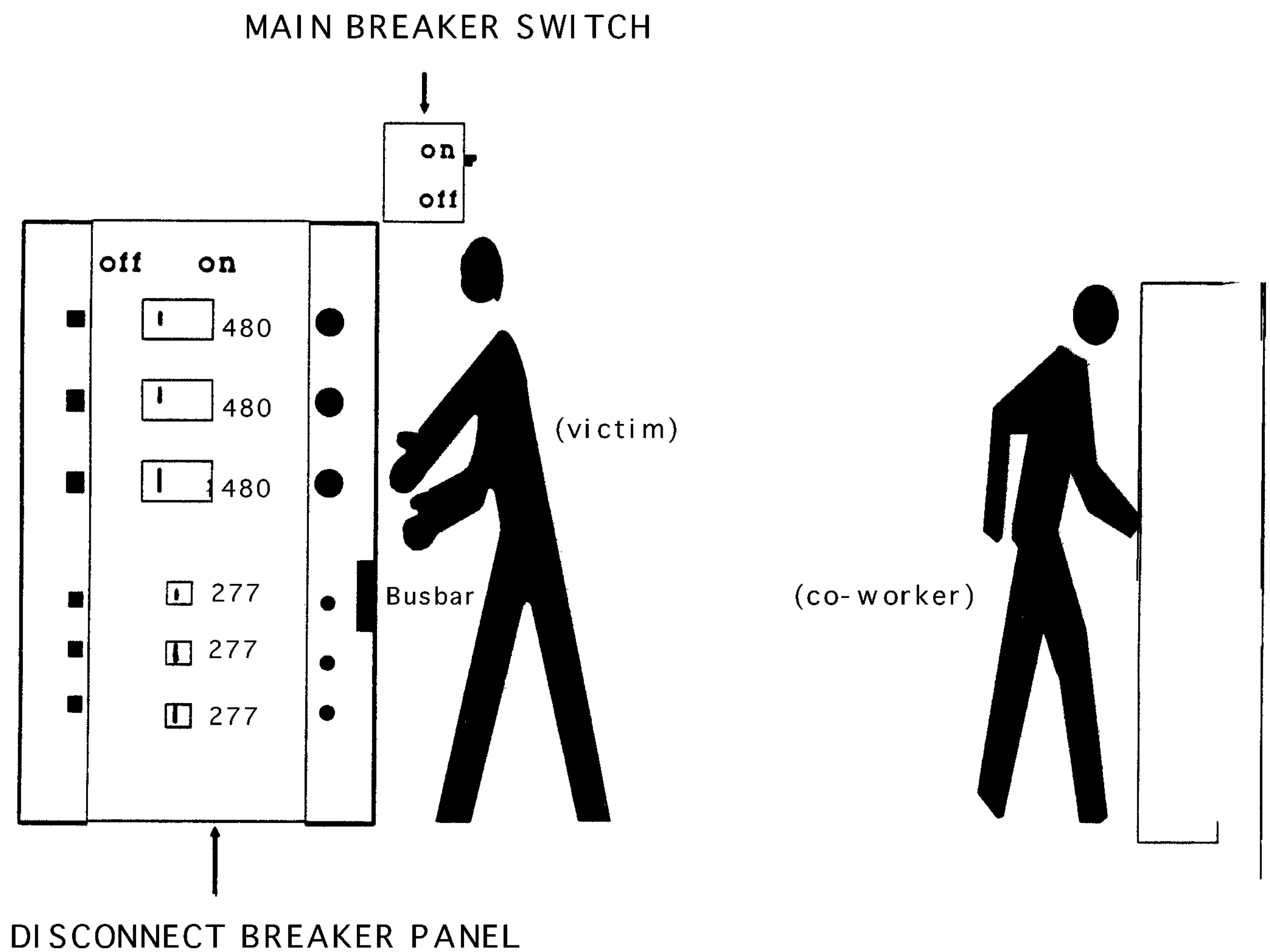

Figure. *Main Service Disconnect Breaker Panel*
480/277-Volt

FACE 90-26: **Lineman Electrocuted After Contacting 7,200-Volt Cutout Switch on Utility Pole in Tennessee.**

SUMMARY

A lineman was electrocuted when he contacted a 7,200-volt cutout switch on a newly installed utility pole. Just prior to the incident the victim had climbed the utility pole, installed a cutout switch, and connected it (with a jumper cable) to a 7200-volt conductor that had not yet been energized. He was wearing lineman gloves and a body safety belt with a lanyard. The victim then climbed down the pole, removed his lineman gloves and disconnected his safety belt, and radioed other crew members to energize the distribution line. He was about to close the cutout switch with a hot stick when he noticed a piece of electrical tape hanging from the energized side of the cutout switch. In an attempt to remove the electrical tape, the victim climbed back up the pole (without first putting his lineman gloves and safety belt back on), grabbed a guy wire with his right hand to stabilize himself, and reached with his left hand to remove the tape. In doing so, the victim's climbing boots slipped, causing his left hand to contact the energized side of the cutout switch, and the victim was electrocuted. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- ensure that workers wear required personal protective equipment before climbing utility poles that have energized circuits

- ensure that workers wear lineman safety belts while performing work from utility poles

- conduct scheduled and unscheduled safety inspections to ensure that safety procedures are being followed.

INTRODUCTION

On February 21, 1990, a 60-year-old male lineman was electrocuted when he contacted the energized side of a 7,200-volt cutout switch on a newly installed utility pole. On February 22, 1990, officials of the Tennessee Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the death and requested technical assistance. On March 8, 1990, a research industrial hygienist from DSR traveled to the incident site to conduct an investigation. The DSR investigator reviewed the incident with company representatives and employees, the medical examiner, and the OSHA compliance officer assigned to this case. Photographs and diagrams of the incident site were obtained during the investigation.

The employer in this incident is an electrical contractor that has been in operation for 42 years. Most of the work performed by the company involves powerline construction. The company employs approximately 1,000 full-time employees, including 5 full-time safety officers. The company has a comprehensive safety program and provides on-the-job training to the employees. The company conducts 1-hour monthly safety meetings with all employees. Additionally, weekly "tailgate" safety meetings are held at construction sites to discuss safety concerns specific to the jobsite. The victim had attended a 1-hour safety meeting 1 month prior to the incident. During this meeting the company's safety policy concerning the requirement for linemen to wear lineman gloves and a safety belt while working from utility poles was discussed.

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INVESTIGATION

The company had been contracted by the local utility company to replace approximately 1 mile of a power distribution line to accommodate the added electrical demand for a new housing subdivision in the area. A crew of eight employees were working at the jobsite performing various powerline installation tasks. After the new utility poles and powerlines had been installed, the crew began energizing the powerlines. This was accomplished by installing utility pole cutout switches and jumper cables to connect sections of the lines on the poles and closing the switches (using a hot stick) along the power distribution line.

On the day of the incident the work crew had energized nearly all of the new power distribution line. At 4:00 p.m., a lineman (the victim) and a groundman (the co-worker) who were part of the work crew arrived at a utility pole located approximately 100 feet from one of the houses in the subdivision. They were to install a cutout switch and jumper cables near the top of the pole (approximately 30 feet above the ground). The utility pole held a 7200-volt conductor which had not yet been energized. The victim put on his climbing boots (pole climbers), safety belt, and lineman gloves. He then climbed to the top of the pole, installed the cutout switch, and connected it (with jumper cables) to the conductor on both sides of the pole. After making the connection he climbed down the pole, disconnected his safety belt, and removed his lineman gloves and hooked them on his belt. The victim then radioed crew members working several hundred yards down the distribution line to energize the line.

After receiving word that the line had been energized, the victim was about to take a hot stick and close the cutout switch (thereby energizing the distribution line to the homes being served), when he noticed a piece of electrical tape hanging from the top of the cutout switch. Wanting to leave a "clean" job, the victim decided to climb back up the pole and remove the tape. However, he did not put his lineman gloves or safety belt back on before climbing the pole, a violation of the company safety policy and procedures. Instead, he put on his leather work gloves. The co-worker stated that the victim had planned on putting his lineman gloves and safety belt back on after reaching the top of the pole since they were attached to his belt. Although the event was not witnessed, evidence suggests that, after climbing to the top of the pole, the victim grabbed a guy wire with his right hand in order to stabilize himself as he reached with his left hand to remove the tape. As he did so, his climbing boots began to slip from the pole causing his left hand to contact the top of the live 7200-volt circuit cutout switch (Figure). This provided an electrical path to ground through the victim's chest, causing his electrocution.

The co-worker (who was standing on the ground 30 feet directly below the victim) heard an electrical arcing noise and the victim's yell. When the co-worker looked up, he saw the victim falling and reached out in an attempt to break the victim's fall. The victim fell to the ground through the co-worker's hands, and fractured the victim's right leg. The co-worker radioed for help. Within minutes the jobsite foreman and other crew members who were nearby arrived at the site and initiated cardiopulmonary resuscitation (CPR). They administered CPR for 20 minutes until local emergency medical service (EMS) personnel arrived. EMS personnel administered advanced cardiac life support to the victim and transported him to a local hospital where he was pronounced dead on arrival by the attending physician.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that workers wear required personal protective equipment before climbing utility poles that have energized circuits.

Discussion: The company has a comprehensive safety program in place with specific safe work procedures for working on energized lines and equipment. The procedures specifically require the wearing of rubber lineman gloves for any work performed from a utility pole with energized circuits: "On climbing any pole possessing energized circuits at any voltage, linemen must put on rubber lineman gloves and/or other necessary protective equipment before leaving the ground to do work in the air, and must keep rubber gloves and/or other necessary protective equipment on their hands until returning to the ground after the completion of the work." Employers should ensure that all workers wear all required personal protective equipment and that they are aware of the hazards of not wearing such equipment.

Recommendation #2: Employers should ensure that employees working from utility poles wear body belts with safety straps or lanyards as in 29 CFR 1926.951,(b),(1).

Discussion: Although the victim wore his safety belt when he initially climbed the utility pole to connect the jumper cable, he did not wear it when he climbed back up the pole to remove the electrical tape from the cutout switch. Failure to wear the safety belt may have contributed to the victim's pole climbers slipping out of the pole. When this occurred the victim grabbed the energized top of the cutout switch with one hand (while holding on to the guy wire with the other hand) in an attempt to keep from falling.

Recommendation #3: Employers should conduct scheduled and unscheduled safety inspections regularly at each jobsite.

Discussion: Although the company has a comprehensive safety program which includes monthly employee safety meetings and weekly "tailgate" safety meetings (which the victim had attended regularly), upper management personnel should conduct, or appoint safety personnel to conduct, scheduled and unscheduled safety inspections at each jobsite to ensure that safety procedures are being followed. Admittedly, regular company safety inspections are no guarantee that worker fatalities will not occur. However, it does demonstrate to workers that the company is committed to enforcing its safety policies and procedures.

REFERENCES

1. Code of Federal Regulations, Labor, 29 CFR Part 1926.951, page 285, U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C. 1989.

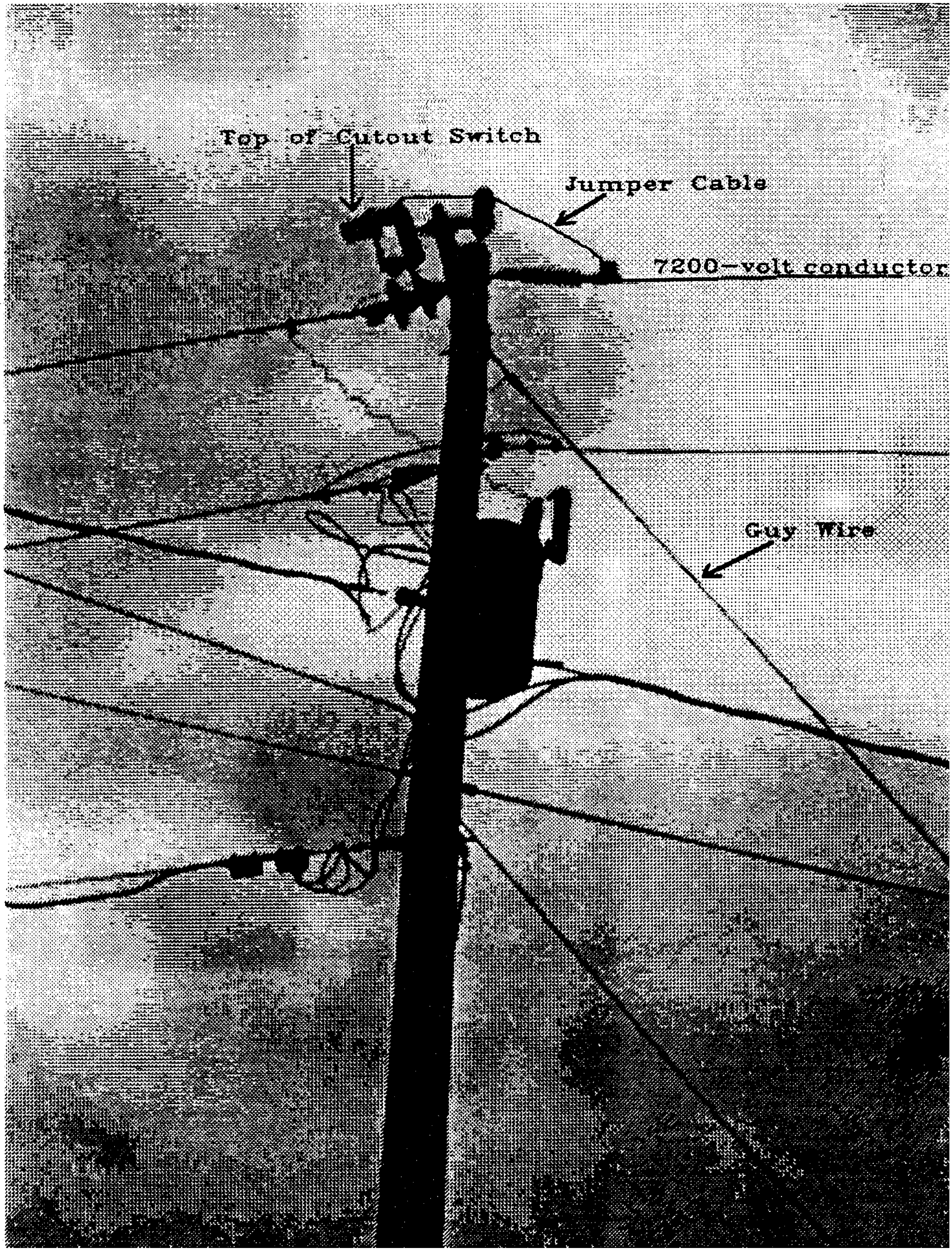

Figure. *Utility Pole*

FACE 90-27: **Lineman Electrocuted When He Contacts a 7200-volt Powerline While Installing a Guy Wire in North Carolina**

SUMMARY

A 30-year-old journeyman lineman (victim) was electrocuted when he contacted a 7200-volt powerline while installing a guy wire. The victim was a member of a crew that was installing a new single-phase 7200-volt powerline parallel to, and 24 inches away from, an existing energized single-phase 7200-volt powerline. The new utility poles had been set and the crew had begun to string the new powerline. The lineman had previously insulated the existing powerline by placing a 36-inch-long protective line hose over the powerline on each side of the utility pole. On the day of the incident, the victim was instructed by the supervisor to place more line hoses on the existing powerline, to attach a guy wire to an anchor on the new utility pole, and to put the drag rope for the new powerline through a roller at the top of the new pole. The victim told the supervisor that he would further insulate the existing powerline after he installed the guy wire. The victim entered an insulated aerial bucket and was handed the looped end of the guy wire by the supervisor. The victim pulled the guy wire into the bucket and stood on it as he raised the bucket. When the victim reached the guy wire anchor, he took an adjustable wrench from his tool bag and began to loosen the anchor nut closest to the existing powerline. The supervisor was on the ground giving instructions to the groundmen when he heard an arcing sound and looked up to see the victim's right arm in contact with the existing powerline. The victim's clothes caught on fire, and soon afterward the powerline burned in two, breaking contact. Burn marks on the powerline indicated that the victim contacted the powerline 39 inches from the pole, 3 inches beyond the protective line hose. The NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- ensure that all energized components of an electrical system in proximity to the work area are insulated before any line work is performed

- ensure that employees strictly adhere to established safe work procedures.

INTRODUCTION

On March 5, 1990, a 30-year-old male journeyman lineman was electrocuted when he contacted a 7200-volt powerline while installing a guy wire. On March 6, 1990, Officials of the North Carolina Occupational Safety and Health Administration notified the Division of Safety Research of the incident and requested technical assistance. On April 4, 1990, two safety specialists from DSR traveled to the incident site to conduct an investigation. The incident was reviewed with company and OSHA personnel. The police report and photographs and videotape of the incident site were also obtained during the investigation.

The employer in this incident is an electrical contractor that has been in operation for 53 years and employs 350 workers. The contractor has a written safety policy and a comprehensive safety program that requires training of all new employees and periodic retraining of all employees. Training is conducted both in the classroom and on the job. Tailgate safety meetings are conducted each day at the jobsite prior to work and the safety director makes periodic visits to all jobsites. All employees are required to be certified in cardiopulmonary resuscitation (CPR).

INVESTIGATION

The company had been contracted to install a new single phase 7200-volt powerline by the local electrical cooperative. The new powerline was to be installed parallel to, and approximately 2 feet away from, an existing energized single-phase 7200-volt powerline. The crew (a supervisor, a journeyman lineman (the victim) and two groundmen) arrived at the site on the day of the incident to install a guy wire on the new utility pole and to string the new powerline through a roller on the crossarm at the top of the new pole. The victim had previously placed a 36-inch-long insulated line hose on each side of the pole over the existing energized powerline. The supervisor wanted to further insulate the existing powerline before the new powerline was strung. As the supervisor was obtaining additional line hoses out of the truck, the victim said he would attach the guy wire to its anchor, then place the additional line hoses on the powerline before putting the drag rope for the new powerline through the roller. The supervisor handed the looped end of the guy wire up to the lineman in the aerial bucket. Rather than place the loop over a hook on the bucket as was standard practice, the lineman pulled the loop into the bucket and stood on it. He then raised himself in the bucket to the guy wire anchor. The lineman was not wearing linemen's gloves or sleeves as required by company safety rules.

Using an adjustable wrench, the lineman began to loosen the nut on the guy wire anchor so that he would be able to place the loop over it. The nut was on the side of the utility pole that was closest to the existing energized powerline. As the supervisor was giving instructions to the groundmen, he heard an arcing sound from above. He looked up to see the lineman's right arm in contact with the existing powerline, and the victim's clothes on fire. As the supervisor began to lower the victim using the controls on the back of the truck, the powerline burned in two, breaking contact. With the help of the groundmen, the supervisor removed the lineman from the bucket and extinguished his burning clothes. The supervisor initiated cardiopulmonary resuscitation (CPR) while one of the groundmen summoned the emergency medical squad (EMS). The victim was transported to the hospital by the EMS where he was pronounced dead on arrival by the attending physician.

Burn marks on the existing powerline indicate that the lineman's right arm contacted the powerline 39 inches from the power pole, 3 inches beyond the insulated line hose. The current passed through the victim and the guy wire on which he was standing to ground.

CAUSE OF DEATH

The attending physician listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that all energized components of an electrical system that might be contacted directly or indirectly by a worker be insulated before any work is performed on or near that system.

Discussion: Before work is performed on or in proximity to an electrical system, all energized components of that system which could be contacted either directly or indirectly (via conductive tools or materials) by a worker should be insulated. Even though a 3-foot-long insulated hose had been placed on the energized powerline on each side of the power pole, the victim was still exposed to the hazards of the energized powerline in proximity to his work area.

Recommendation #2: Employers should ensure that established company safety procedures are followed at all times.

Discussion: Management should re-affirm the necessity of following established safety procedures with all supervisors. This company has a comprehensive safety program in place. Established safety procedures require that linemen's gloves and sleeves be worn when working from an aerial bucket. Additionally, standard operating procedure for lifting the guy wire to the anchor was to place the looped end of the guy wire around a hook on the outside of the aerial bucket. Pulling the guy wire into the bucket introduced a conductor at ground potential which negated the protection afforded by an insulated aerial bucket.

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FACE 90-29: **Laborer Touching Suspended Cement Bucket Electrocuted When Crane Cable Contacts 7200-Volt Powerline in North Carolina**

SUMMARY

A 29-year-old male laborer was electrocuted when the crane cable suspending a 1-yard cement bucket he was touching contacted a 7200-volt powerline. The victim was a member of a crew that was constructing the back wall of an underground concrete water holding tank at a sewage treatment plant. Before work on the tank was begun, the company safety director, aware of the hazards involved in using a crane near an overhead powerline, requested assistance from the local electrical utility company. As a result, utility company workers placed insulated line hoses over sections of the powerline near the jobsite. The safety director also had markers placed to indicate where arriving cement trucks should stop while the cement bucket was loaded. Loading the bucket at the marked location ensured that the crane boom and cable would remain at least 14 feet from the powerline. (OSHA regulations require that a minimum distance of 10 feet be maintained.) As a result of the precautions taken, the concrete for the wall was poured without incident. However, after the crew had poured the last bucket of concrete to finish the top of the wall, the driver of the cement truck cleaned the loading chute on his truck with a truck-mounted water hose and began to pull away. As he did the crew supervisor yelled to him and asked if the crew could use the water hose to wash out the cement bucket suspended from the crane. The driver stopped the truck under the powerline and the crane operator, not realizing the truck had been moved, swung the boom to position the bucket behind the truck. The victim grasped the handle of the bucket's door and pushed down to open it, bringing the crane cable into contact with the powerline. The electrical current traveled down the cable and through the bucket and victim to ground, causing the victim's electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- ensure that all workers adhere to existing regulations regarding clearance distances between cranes and powerlines, and remain constantly aware of the clearance between the crane and any powerlines that might be present

- evaluate alternative methods of pouring concrete in proximity to overhead powerlines which do not require the use of a crane

- conduct daily jobsite surveys to identify any potential hazards.

INTRODUCTION

On March 1, 1990, a 29-year-old male laborer was electrocuted when the crane cable suspending a 1-yard concrete bucket he was touching contacted a 7200-volt powerline. On March 6, 1990, Officials of the North Carolina Occupational Safety and Health Administration notified the Division of Safety Research of the incident and requested technical assistance. On March 28, 1990, two safety specialists from DSR traveled to the incident site to conduct an investigation. The DSR investigators reviewed the incident with the company safety director, and obtained photographs, diagrams of the incident site, and police reports.

The employer is a heavy construction company that specializes in power station, bridge, and wastewater treatment plant construction. The company employs 600 workers, including a safety director. The company has a comprehensive safety program and provides on-the-job training for all employees. New employees undergo a 6-day orientation period. Each week, a safety meeting is held on site for all company employees. Crew supervisors hold tailgate safety meetings daily at their respective work areas. The tailgate safety meetings include a hazard review for each task that the workers will perform that day. Each employee undergoes a drug test before being hired and is subject to random drug testing thereafter. The victim had received training in crane safety (including the hazards associated with overhead powerlines) on February 12, 1990.

INVESTIGATION

The company was contracted in 1988 to construct a large addition that would upgrade an existing wastewater treatment plant. The victim's crew was pouring concrete for the back wall of an underground water holding tank that measured 20 feet long by 29 feet wide by 23 feet high. Prior to the start of construction on the holding tank, the company safety director contacted the local electrical utility and requested that they relocate a 7200-volt powerline at the site. The powerline presented a serious hazard, since a crane would be used to position a 1-yard bucket during the pouring of the concrete. Electrical utility engineers determined that the powerline could not be relocated because the adjacent swampy ground would not permit the proper anchoring of the utility poles. Instead, the powerline was covered with insulated line hoses in the vicinity of the worksite. In order to comply with OSHA regulations pertaining to clearances between cranes and powerlines, the safety director had markers placed in the ground that identified the spot where truck drivers would back the cement trucks for the unloading of the bucket. This action ensured that the crane boom would come no closer than 14 feet to the powerline, greater than OSHA's required minimum clearance distance of 10 feet. Because of subsequent damage caused by Hurricane Hugo, the insulated hoses were removed from the powerline so that the slack in the powerline could be adjusted. The insulated hoses were not replaced by electrical utility workers after the slack in the powerlines was adjusted.

On the day of the incident, the victim was working on the floor of the holding tank cleaning up spilled concrete. After the last bucket was poured, the truck driver cleaned the loading chute on the truck with a truck-mounted water hose. The victim joined the rest of the crew at ground level. When the driver finished cleaning the truck, he began to pull away. The supervisor called for him to stop and asked if the crew could use the water hose to clean the concrete bucket. The driver stopped the truck under the powerline. The supervisor signaled the crane operator to swing the bucket around to the truck. Without realizing the truck had been moved, the crane operator positioned the bucket behind the cement truck. The victim grasped the door handle on the bucket and pushed down to open it, causing the crane cable to contact the powerline. The electrical current traveled down the cable and through the bucket and victim to ground, causing his electrocution. The supervisor detected a pulse, but the victim was not breathing. The supervisor immediately began mouth-to-mouth resuscitation while one of the crew members summoned the emergency medical squad (EMS). The EMS transported the victim to the hospital where he was pronounced dead-on-arrival by the attending physician.

CAUSE OF DEATH

The coroner listed the cause of death as electrocution. No autopsy was performed.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure adherence to existing OSHA regulations concerning crane operations.

Discussion: OSHA standards 1926.550 (a)(15) and 1910.180 (j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be 10 feet, unless the electrical lines have been "de-energized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented" by the erection of insulating barriers which cannot be part of the crane. Additionally, 29 CFR 1926.550 (a)(15)(iv) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means.

Recommendation #2: Employers should ensure that all crew members remain constantly aware of the clearance between a crane and any powerline that may be present.

Discussion: In this instance, the powerline had been identified as an overhead hazard. Measures were developed to control this hazard and crew members may have become complacent with the procedure of loading the bucket behind the cement truck. When the crane operator received the signal from the supervisor, he automatically positioned the bucket behind the truck, not knowing that it had moved toward the powerline. All crew members must remain constantly aware of the hazards associated with overhead powerlines.

Recommendation #3: Employers should evaluate alternative methods of pouring concrete in proximity to overhead powerlines.

Discussion: One alternative way to pour concrete in proximity to overhead powerlines would be to use a concrete pumping truck. The truck could be positioned in a manner that would avoid the hazard of overhead powerlines. A truck-mounted flexible hose could be used to dispense the concrete.

Recommendation #4: Employers should conduct daily jobsite surveys to identify all potential hazards.

Discussion: It could not be determined exactly when the insulated hoses had been removed by the utility company. A daily jobsite survey might have identified that the line hoses had been removed. The utility company could then have been contacted to replace the insulative hoses.

REFERENCES

1. 29 CFR 1926.550 (a)(15) Code of Federal Regulations, Washington, D.C.: U.S. Government Printing Office, Office of the Federal Register.

2. 29 CFR 1910.180 (j) Code of Federal Regulations, Washington, D.C.: U.S. Government Printing Office, Office of the Federal Register.

3. 29 CFR 1926.550(a)(15)(IV) Code of Federal Regulations, Washington, D.C.: U.S. Government Printing Office, Office of the Federal Register.

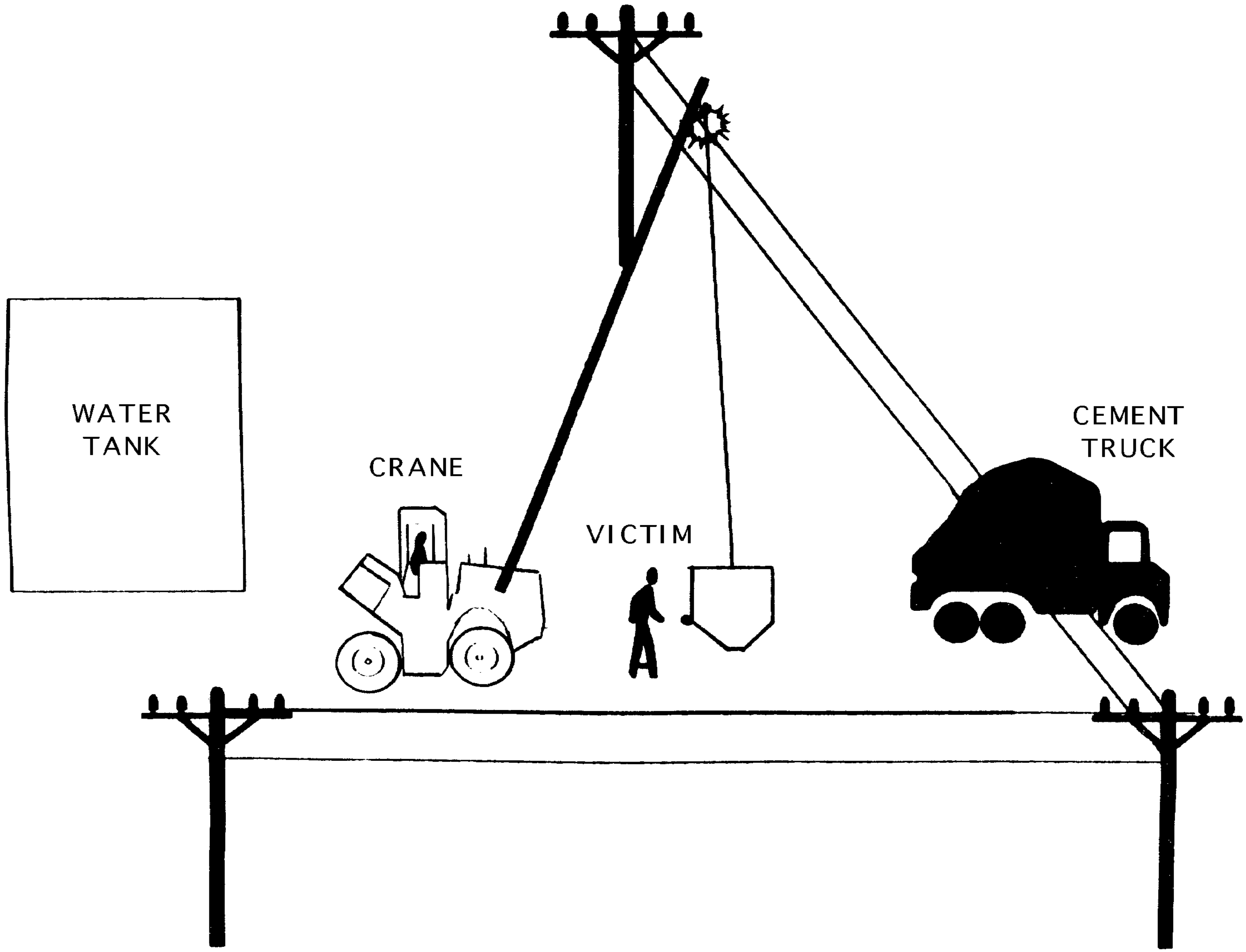

***Figure*.**

FACE 90-31: **Laborer Dies from Electrical Injuries Sustained in an Electrical Distribution System Substation in Virginia**

SUMMARY

A laborer died 15 days after a 10.5-foot-long galvanized pipe he was carrying contacted an energized 12,500-volt jumper wire at an electrical distribution system substation. One end of the jumper wire, was attached to a step-down transformer at a position approximately 11 feet above ground level. The other end of the jumper wire was attached to an overhead powerline. The victim was part of a two-person crew assigned to pull wire through a newly installed underground conduit. The victim positioned a truck containing reels of wire, a reel rack, and a galvanized pipe that was going to be used as a reel rack spindle, inside the substation approximately 8 feet from a transformer. While his co-worker (the crew leader) was working on a separate task approximately 40 feet away, the victim apparently lifted the pipe from the back of the truck and turned toward the transformer with the pipe in a vertical position. The pipe contacted the jumper wire, and the current passed through the pipe and the victim to ground, injuring the victim. NIOSH investigators concluded that in order to prevent future similar occurrences, employers should:

- evaluate their existing safety program to ensure that appropriate procedures to reduce worker exposures to hazards, especially electrical hazards, have been developed and implemented

- provide employees with adequate training to ensure that they can recognize potential hazardous exposures

- conduct initial jobsite surveys to identify hazards associated with each jobsite and develop job specific methods of controlling these hazards.

INTRODUCTION

On April 23, 1990, a 21-year-old male laborer was injured when the galvanized pipe he was carrying contacted a 12,500-volt jumper wire. He died as a result of those injuries on May 8, 1990. On May 16, 1990, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality and requested technical assistance. On May 24, 1990, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with a company representative and the OSHA compliance officer assigned to the case. Photographs of the incident site and the victim's death certificate were obtained during the investigation.

The employer in this incident is a public electric cooperative company that has been in operation for 52 years and employs 31 workers. The company maintains an electrical power distribution system that serves a six-county area. The company has written safety procedures and the general manager administers the safety program. On-the-job and classroom training are provided to the employees, and safety tailgate meetings are held prior to the start of all new projects. Pre-employment physicals are required of all new employees. The victim worked for this employer for 8 months prior to this incident.

INVESTIGATION

The company was in the process of installing an energy conservation control system at one of their nine substations. Work on the project had begun on April 1, 1990. At the time of the incident, construction had been completed on an 8-foot-wide by 8-foot-long by 8-foot-high wooden building. Remote control electronic equipment had been installed inside the building to enable operation of the substation voltage regulators from the main office. Conduit had been installed underground from the building to the regulators, a distance of approximately 30 feet.

On the day of the incident, a two-man crew consisting of a crew leader and a laborer (the victim), arrived at the substation to pull wire from the voltage regulators, through the buried conduit, to the electronic equipment in the wooden building. The substation consisted of three step-down transformers; three voltage regulators; incoming overhead powerlines (34,500 volts); outgoing overhead powerlines (12,500 volts); and the newly constructed building, equipment, and conduit.

The crew arrived at the substation in two vehicles. One vehicle, containing reels of wire, a reel rack, and a 10.5-foot-long galvanized pipe that was going to be used as a reel rack spindle, was driven into the substation by the victim. The victim positioned the back of the truck approximately 8 feet from the transformers, unloaded the reel rack and placed it near the regulators. Although no one witnessed the incident, it is assumed that the victim lifted the galvanized pipe from the back of the truck and turned toward the transformers. As the victim turned holding the pipe in a vertical position, the pipe contacted a 12,500-volt energized jumper wire, which was attached between a step-down transformer and an overhead powerline (approximately 11 feet from ground level). The current passed through the pipe and victim to ground seriously injuring the victim (Figure).

The victim's co-worker (the crew leader) had parked the vehicle he was driving and walked to the wooden building. He was preparing to pull a piece of wire through the conduit when he noticed a bright flash. He turned toward the victim and saw him fall to the ground. The co-worker ran to the victim and found him conscious. The co-worker then ran to the truck and radioed the company office to report what had occurred. The emergency medical service (EMS) was summoned and arrived at the incident site within 5 minutes after being contacted. The EMS transported the victim to the local hospital where he died 15 days later.

CAUSE OF DEATH

The certificate of death listed the cause of death as sepsis due to complications from electrical injury.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should evaluate their existing safety program to ensure that appropriate procedures to reduce worker exposures to hazards have been developed and implemented.

Discussion: Employers should ensure that existing safety programs include specific written procedures and guidelines for workers to follow pertaining to hazardous exposures likely to be encountered. Particular emphasis should be given to electrical hazards (e.g., energized jumper wires), and the need for and proper use of personal protective equipment. For example, employers should require that any employee entering a substation should be provided and required to wear hardhat, gloves, and boots suitable for the maximum voltage of the equipment in the installation. Adherence to employers' safe working procedures and guidelines should be enforced at all times.

[Note: The company has instituted the following revision to their current safety program: All personnel entering substations will be required to wear insulated footwear.]

Recommendation #2: Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures.

Discussion: OSHA standard 1926.21(b)(2)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control to eliminate any hazards or other exposure to illness or injury." Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures. When new company procedures or guidelines are developed or existing ones modified, employers should ensure that workers are provided with appropriate supplemental training.

Recommendation #3: Employers should conduct an initial jobsite survey to identify all hazards associated with each specific jobsite, and implement, where applicable, additional methods of safeguarding employees in those working areas.

Discussion: Employers should conduct jobsite surveys to identify potential worker hazards so that appropriate preventive measures (e.g., subsequent training to employees specific to identified site hazards), to control these hazards can be applied prior to the start of any work. Two characteristics of this jobsite combined to produce a very serious hazard: 1) an energized jumper wire located 11 feet above ground level, and 2) the use of a conductive 10.5-foot galvanized pipe in the vicinity of the energized jumper wire. Such potential hazards can be minimized by ensuring that employees maintain a safe distance from energized conductors, by providing employees with non-conductive tools and materials, and/or by de-energizing or covering electrical conductors with insulating material (e.g., line hoses). [Note: The conductive galvanized pipe involved in this incident was to be used as a spindle to support the reels of wire on the reel rack. A spindle made of wood, fiberglass, plastic, or other nonconductive material, may have been substituted for the galvanized pipe.] Additionally, when work needs to be completed within a substation, employers should consider isolating the substation and de-energizing all circuits in the installation before work begins. To minimize disruption of service to customers, employers could schedule such work inside substations during periods when customers are minimally affected or consider providing service through alternate paths in area electrical networks.

REFERENCES

1. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 294. July 1, 1989.

2. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 20. July 1, 1989.

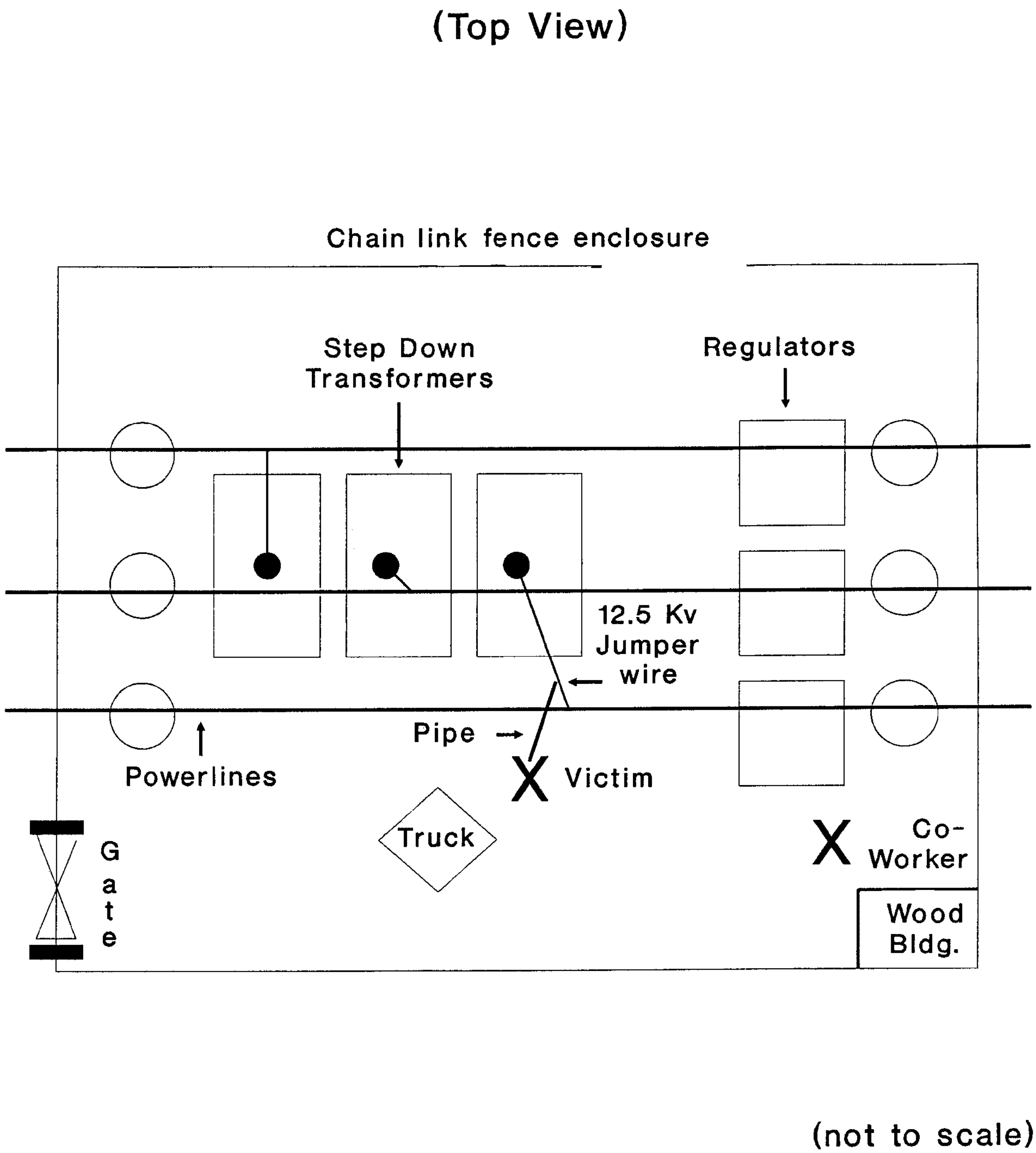

Figure. *Electrical Distribution System Substation*

FACE 90-32: Electrician Electrocuted When He Contacts Energized Conductor in a Manhole in Virginia

SUMMARY

A 24-year-old male electrician was electrocuted when he inadvertently contacted a 2,300-volt, 6.6-amp conductor. The incident occurred while the victim was working inside a manhole splicing a conductor. The victim and a co-worker were part of a six-person crew assigned to install a new lighting system at an airport. The system consisted of three circuits: 1) an energized 2,300-volt, 6.6-amp runway lighting circuit; 2) an energized 700-volt temporary taxiway lighting circuit; and 3) a de-energized taxiway lighting circuit. The victim entered the manhole through a 24-inch-diameter manway opening and descended a metal ladder attached to the inside of the 5-foot-square by 7-foot-deep concrete manhole. The victim removed a pair of insulated side (wire) cutters from his tool belt to prepare the de-energized taxiway lighting conductor for splicing. He cut a size 8 AWG conductor which was hanging over a rung of the metal ladder without determining whether or not the circuit was energized. The conductor, which was part of the energized runway lighting circuit, separated into two pieces. The energized end came in contact with the back of the victim's right hand. Current passed through the victim's right hand and exited his right thigh at the point where it was in contact with the grounded metal ladder. NIOSH investigators concluded that, in order to prevent future occurrences, employers should:

- establish required procedures for the protection of employees exposed to electrical hazards and provide worker training in the recognition and avoidance of hazards that addresses procedures for identifying, testing and de-energizing circuits

- conduct initial jobsite surveys to identify electrical hazards and apply job specific methods for controlling these hazards.

INTRODUCTION

On May 1, 1990, a 24-year-old male electrician was electrocuted when he inadvertently contacted an energized conductor in a manhole. On May 16, 1990, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On May 24, 1990, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with a company representative and the OSHA compliance officer assigned to the case, and photographed the incident site. Copies of the police report, autopsy report, and death certificate were obtained during the investigation.

The employer in this incident is an electrical contractor, engaged primarily in commercial and industrial electrical construction. The company has been in operation for 22 years and employs 97 workers, including 51 electricians. The company has a written safety policy and safety rules which are administered by the loss control/personnel manager. In addition, weekly safety toolbox meetings are held. The employer also uses a safety incentive program and a stepped (graduated) disciplinary system which consists of: 1) first incident - verbal counseling, 2) second incident - a written warning, and 3) third incident - discharge. The victim worked for this employer for 3 years and 9 months prior to the incident.

INVESTIGATION

The company had been contracted to install a lighting system for the taxiway and runway at a local airport. Work had been intermittent since September 5, 1989. At the time of the incident, the job was within 3 weeks of completion. Pre-formed concrete manholes 5-feet-square by 7-feet-deep with 24-inch-diameter openings (manways), which provided access to the underground circuitry for the three lighting systems, had been previously installed (Figure). An existing, energized 2,300-volt, 6.6-amp, runway lighting circuit was operating during twilight and night hours each day. Additionally, each manhole contained an energized, 700-volt temporary taxiway lighting circuit, and a de-energized permanent taxiway lighting circuit. Work was in progress to complete the wiring for the permanent taxiway lights. Temporary work area lighting (vapor lights) had been installed.

On the evening of the incident, a crew of six employees (i.e., one equipment operator, two apprentice electricians, two journeyman electricians, and one electrician/foreman) arrived at the incident site to continue work on the lighting systems. The victim and a co-worker were assigned the task of splicing the temporary taxiway lighting circuit conductors into the new conductor for the permanent taxiway lighting circuit, and making the appropriate connections. All the conductors were buried underground and the manholes provided access to the conductor junctions. Standard company procedure involved testing each circuit in the manhole by using an amp probe (i.e., a device used to detect current in a conductor) prior to working on that circuit, identifying the energized runway and temporary taxiway circuits, cutting the de-energized circuit (permanent taxiway circuit), and splicing together the appropriate conductors.

Prior to the incident, the victim and co-worker had completed connections for the permanent taxiway lights in four separate manholes. The victim entered the fifth manhole via a 24-inch-diameter manway, descended a metal ladder attached to the inside of the manhole, and positioned himself on the ladder facing the circuit conductors. He removed a pair of insulated side (wire) cutters from his tool belt and, without using the amp probe to test for current in the conductors, cut a hanging conductor. The conductor, which was part of the energized runway lighting circuit, came in contact with the back of the victim's right hand after being cut in half. Current passed through the victim's right hand and exited his right thigh at the point of contact with the grounded ladder.

The co-worker was standing near the top of the manhole observing the victim. After realizing what had occurred, he knocked the victim off the ladder away from the energized conductor. He entered the manhole and carried the victim out. The co-worker then notified the electrician/foreman, who was in the area but working on a separate task. The foreman summoned airport emergency rescue personnel who arrived within 3 minutes after being contacted. The rescue squad provided advanced cardiac life support and transported the victim to the local hospital where he was pronounced dead 45 minutes after the incident occurred.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should establish required procedures for the protection of employees exposed to electrical hazards and provide worker training in the recognition and avoidance of such hazards.

Discussion: Employers should comply with OSHA construction safety standard 29 CFR 1926.416 (a)(1) by prohibiting employees from working in close proximity to energized electrical circuits where the employee could make contact in the course of work, unless the employee is protected against electric shock by de-energizing and grounding the circuit and/or by effective guarding. Employers should provide worker training in recognizing electrical hazards and in safe work procedures, including identifying circuits, testing circuits, de-energizing circuits, locking/tagging de-energized circuits, and verifying de-energization.

Recommendation #2: Employers should conduct initial jobsite surveys to identify all hazards associated with each specific jobsite, and develop specific methods of controlling the identified hazards.

Discussion: Employers should comply with OSHA construction safety standard 29 CFR 1926.416 (a)(3) by conducting initial jobsite surveys prior to the start of any work to identify potential situations for employee contact with energized electrical circuits, and by providing subsequent employee notification about protective measures (i.e., identification, testing, de-energization, locking/tagging of energized conductors, verification, and sufficient work area lighting) to be implemented to control the hazards.

REFERENCES

1. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 162. July 1, 1989.

FACE 90-34: **Tree Trimming Groundsman Electrocuted after Grasping a Guy Wire that Contacted an Energized Guy Wire in Virginia**

SUMMARY

A 20-year-old male tree trimming groundsman was electrocuted after he grasped a guy wire that swayed into contact with an energized pole-mounted jumper wire. One end of the jumper wire was attached to a one amp fuse on a pole-mounted transformer, while the other end was attached to a 14,400-volt powerline. The victim was part of a five-man crew assigned to clear brush and trees from an electric utility right-of-way. The victim had just completed cutting brush and trees from around the guy wire. The guy wire was secured to a utility pole at one end and to a steel rod anchored in the ground at the other end. After cutting the brush and trees, the victim laid the chain saw he was using on the ground. He grasped the butt of a fallen tree with one hand, and the guy wire with the other hand. When the victim grasped the guy wire, it swayed (due to approximately 8 inches of slack in the wire) and contacted the energized jumper wire. The current passed through the guy wire and victim to ground, electrocuting the victim. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- conduct a jobsite survey before starting any job to identify potential hazards and implement appropriate control measures

- review and revise, where applicable, the existing safety program to include measures that enable workers to recognize and control hazards

Additionally, utility companies should:

- avoid placing transformers and jumper wires on utility poles in close proximity to unguarded uninsulated guy wires

When prime and subcontractors perform work at single worksites, all involved parties should:

- ensure that areas of responsibility for safety and health issues are specified as part of the contract provisions.

INTRODUCTION

On May 7, 1990, a 20-year-old male tree trimming groundsman was electrocuted when he grabbed a guy wire causing it to contact an energized conductor on a utility pole. On May 16, 1990, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On June 29, 1990, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with a company representative, the jobsite foreman, and the OSHA compliance officer assigned to the case. Photographs of the incident site and the corresponding medical examiner's report were obtained during the investigation.

The employer in this incident is a tree service company that has been in operation for 2 years and employs 280 workers, including 93 groundsmen. The company has a written safety policy and safety rules which are administered by the safety officer and jobsite foremen. Weekly safety meetings are held and documented, and quarterly safety task force meetings are attended by both employer representatives and employees. A progressive disciplinary system for safety violations is in place and consists of: 1) first violation--verbal warning, 2) second violation--written warning, and 3) third violation--dismissal. The victim worked for this employer for 3 months and 11 days prior to this incident.

INVESTIGATION

The company had been contracted to keep an electric utility right-of-way (consisting of approximately 6,000 miles of lines) clear of brush and trees on a continuing basis. Work was progressing as normal at the jobsite located in a rural part of the state.

On the day of the incident, a five-man crew consisting of a jobsite foreman, two equipment operators, and two groundsmen, arrived at the site to clear brush and trees from the electric utility right-of-way. The foreman and the two equipment operators were working near a utility pole, located approximately one-quarter mile ahead of the two groundsmen. The equipment operators were mowing the right-of-way using brush cutters attached to tractors, while the groundsmen were working ahead of the others using chain saws to cut brush and trees from around utility poles and guy wires. One groundsman, the victim, had just finished cutting brush and trees from around a utility pole guy wire attached to a steel rod anchored in the ground. The utility pole supported a step-down transformer with an attached 1-amp fuse. An uninsulated jumper wire connected the 1-amp fuse to a 14,400-volt powerline. After the victim completed cutting the brush and trees, he laid the chain saw he was using on the ground. Next, he apparently reached down with one hand to grasp the butt of a small tree while grasping the guy wire located next to the fallen tree with his other hand. The guy wire, which had approximately 8 inches of slack in it, swayed and contacted the energized, uninsulated jumper wire. The current passed through the metal guy wire and through the victim to ground. The 1-amp fuse burned in half, stopping the current flow, and the victim fell to the ground.
The victim's co-worker had walked to a nearby truck to check his equipment when he saw the victim fall to the ground. The co-worker immediately ran to the victim suspecting that he had suffered a heart attack. After realizing the victim was unconscious, he ran back to the truck and radioed the jobsite foreman for assistance. The foreman, while on his way to the victim, radioed the office and requested an ambulance. The foreman arrived at the incident site about 4-5 minutes after being contacted. He checked the victim's breathing and began administering cardiopulmonary resuscitation (CPR). An emergency medical service (EMS) squad arrived approximately 25 minutes after being contacted. EMS personnel continued CPR and transported the victim to the hospital where he was pronounced dead 75 minutes after the incident occurred.

CAUSE OF DEATH

The medical examiner's certificate listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should conduct a jobsite survey before starting any job to identify potential hazards and implement appropriate control measures.

Discussion: Employers should conduct initial jobsite surveys to identify potential hazards to workers. Once initial hazards have been identified, appropriate control measures can be implemented prior to the start of any work. Employees should not be permitted to begin work until appropriate controls have been implemented at the site.

Recommendation #2: Employers should review and revise, where applicable, the existing safety program to include measures that enable workers to recognize and control hazards.

Discussion: Although the employer has a written safety policy and safety program the incident still occurred. The employer should review and revise, where applicable, the safety program to include, but not be limited to, providing training to workers to recognize and avoid unsafe conditions in their work environment.

Recommendation #3: Utility companies should ensure that transformers and jumper wires on utility poles are not placed in close proximity to unguarded uninsulated guy wires.

Discussion: The utility pole, transformer, jumper wire and uninsulated guy wire had been installed more than 5 years before the incident. Upon initial installation, utility companies should ensure that transformers and jumper wires are not placed close to uninsulated conductive guy wires. If conditions dictated the placement of the transformers and jumper wire in close proximity to guy wires, then appropriate control measures should be implemented to avert unintentional contact between the guy wire and jumper wire (i.e., guarding or insulating the guy and jumper wires).

Recommendation #4: Prime contractors and subcontractors should ensure that areas of responsibility for safety and health issues are specified as part of the contract provisions.

Discussion: All contracts should contain provisions that ensure the safety and health of all workers covered by that contract. Where prime contractors (electric utilities) and subcontractors (tree trimming operations) are involved, the contract must contain clear and concise language as to which party is responsible for a given safety and health issue. The provisions for these responsibilities should be established based upon which party has personnel with the necessary technical expertise (i.e., employees of electrical utilities are normally better equipped to assess electrical hazards than the employees of tree-trimming operations). The respective parties should periodically inspect worksites to ensure that the provisions of the contract regarding safety and health issues are upheld.

FACE 90-36: **Concrete Worker Electrocuted after Grabbing an Energized 440-Volt Conductor in Virginia**

SUMMARY

A 21-year-old male concrete worker was electrocuted at a precast concrete manufacturing plant when he climbed a steel column, stepped onto a steam pipe, and grabbed one phase of an energized 3-phase, 440-volt conductor that supplied electrical power to a wall crane. Just prior to the electrocution, the victim was moving an overhead crane with a hand-held pendant controller, when two hoist chains suspended from the crane's load block hook tangled around an I-beam that supported the runway of the wall crane. He succeeded in freeing one chain by using the pendant controller to maneuver the load block hook up and down. Intending to free the other chain by hand, the victim climbed a steel support column, stepped onto the steam pipe, and reached out (apparently to support himself) and grabbed the bare conductor. As the current passed through him and the steel column to ground, he fell to the floor. He was pronounced dead on arrival at the local hospital. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- guard crane runway conductors to reduce the likelihood of contact by persons or objects
- affix warning signs (e.g., Danger--High Voltage) at conspicuous places along crane runways
- ensure that workers follow crane manufacturer recommendations regarding the operation of overhead cranes
- develop, implement, and enforce a comprehensive safety program that includes worker training in recognizing and avoiding hazards including electrical hazards.

INTRODUCTION

On July 16, 1990, a 21-year-old male concrete worker was electrocuted at a precast concrete manufacturing plant when he climbed a steel column, stepped onto a steam pipe, and grabbed one phase of an energized 3-phase, 440-volt conductor that supplied electrical power to a wall crane. On July 30, 1990, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On August 15, 1990, a safety specialist from DSR conducted an investigation of the incident. The investigator reviewed the incident with the company plant manager, the company safety consultant, a police department investigator, and the OSHA compliance officer assigned to the case. Photographs of the incident site and a copy of the police report were obtained.

The employer in this incident manufactures precast concrete structures such as box culverts, manholes, and pipes. The company has been in operation for 22 years and employs 115 workers, including 34 concrete workers. The company has written general safety rules that are administered by the plant manager. On-the-job training is provided to the employees. In addition, a part-time safety consultant conducts weekly walk-around safety audits. The victim worked for this employer for 3 months prior to the incident.

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INVESTIGATION

The company manufactures precast concrete structures in a rectangular building approximately 50 feet high by 125 feet wide by 250 feet long. The building contains five floor-operated overhead cranes and one wall crane that are used to move manufactured products within the building. The overhead crane runway (i.e., an assembly of rails, beams, guides, baskets, and framework in which the cranes travel) is located approximately 40 feet above the floor. The wall crane runway is attached to the building's steel support columns (H-beams) and runs parallel to the inside wall, approximately 20 feet above the ground. The wall crane services approximately one-fourth of the building; whereas, the overhead cranes run the entire length of the building. Electrical power is supplied to the overhead cranes and the wall crane by 3-phase, 440-volt conductors that run parallel and adjacent to each runway.

On the day of the incident, two three-man crews were building box culvert forms in separate areas. The victim and two co-workers had just completed the form work for a box culvert and were breaking for lunch. One co-worker walked to the lunchroom. The victim and the other co-worker discussed moving the box culvert to the next work area. Using a hand-held pendant controller, the victim moved a 5-ton overhead crane down the runway toward the box culvert. As the overhead crane approached the culvert, two hoist chains suspended from the load block hook tangled around an I-beam supporting the runway of the wall crane. The victim moved the load block up and down, dislodging one chain. Unable to free the second chain, he told his co-worker that he was going to climb a steel support column (H-beam) to free the chain by hand. The co-worker remarked, "use a stick to knock it down; you might fall." Climbing the H-beam to approximately the 16-foot level, he was able to step onto a steam pipe located approximately 4 feet below the wall crane runway conductors. In his attempt to free the hoist chain, he reached out (possibly to support himself) and grabbed the energized conductor. As the current passed through the victim to the grounded H-beam, he screamed, his body became limp, and he fell to the ground.

The co-worker notified the floor supervisor of the incident. The supervisor ran to the victim, checked for vital signs, radioed the office for an ambulance, and started cardiopulmonary resuscitation (CPR). A volunteer emergency medical service (EMS) rescue squad arrived about 30 minutes after being contacted and continued CPR. The EMS transported the victim to the local hospital, where he was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should implement Article 610-21(a) of the National Electrical Code, "Locating or Guarding Contact Conductors."

Discussion: This Article states: "Runway contact conductors shall be guarded and bridge contact conductors shall be located or guarded in a manner that persons cannot inadvertently touch energized current-carrying parts." The National Electrical Code defines guarded as "covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger."

Recommendation #2: Employers should affix warning signs (e.g., Danger--High Voltage) at conspicuous places along crane runways.

Discussion: Posted warning signs alert workers to exercise caution and use appropriate personal protective equipment when working in the area of the identified hazards. [Note: The employer has since affixed "Danger--High Voltage" signs at locations where crane runways are attached to steel support columns (H-beams).]

Recommendation #3: Employers should ensure that workers follow crane manufacturer recommendations regarding operation of overhead cranes.

Discussion: According to the operating manual, the crane manufacturer recommends that, when moving an overhead crane without a load, the load block should be in the uppermost (raised) position. The crane involved in this incident was being moved with the load block in a lowered position. This allowed the hoisting chains to tangle around the I-beam. Workers who operate or maintain overhead cranes, or any other machinery, should receive training in the manufacturer's recommended methods for safe operation of such equipment.

Recommendation #4: Employers should develop, implement, and enforce a comprehensive safety program that includes worker training in recognizing and avoiding electrical hazards.

Discussion: The victim and at least one other employee were apparently unaware of the hazard created by the uninsulated energized wall crane runway conductors.

REFERENCES

1. National Fire Protection Association: National Electrical Code 1990, NFPA 70 p. 593.

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FACE 90-37: Maryland Steelworker Electrocuted When He Contacted Energized Toaster Oven Casing in Employee Lunchroom

SUMMARY

A 53-year-old male steelworker was electrocuted when he contacted the energized case of a toaster oven. While taking a break from his normal work routine, the victim sat upon a wooden bench and rested his right forearm on a floor model air conditioner upon which the 120-volt toaster oven was setting. The victim's right arm contacted the energized casing of the toaster oven while his right calf contacted the grounded air-conditioning unit. The victim received an electrical shock and went into cardiac arrest. The victim was treated by the local emergency medical service and transported to the local hospital where he was pronounced dead on arrival. NIOSH investigators concluded that, in order to prevent future occurrences, employers should:

- periodically inspect all areas of the facility for electrical hazards and implement appropriate controls

- adopt a policy requiring that all appliances brought into their facility be tested for electrical integrity by qualified persons before they are used

- periodically re-evaluate safety programs and reinforce training related to worker recognition, avoidance, and reporting of hazards

- provide cardiopulmonary resuscitation (CPR) training to all workers, both management and labor.

INTRODUCTION

On August 17, 1990, a 53-year-old male steelworker (caster attendant) was electrocuted when he contacted the energized case of a toaster oven in the employee lunchroom at a steel manufacturing plant. On August 27, 1990, officials of the Maryland Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On September 20, 1990, a safety specialist from DSR traveled to the worksite and conducted an investigation. The investigator reviewed the incident with a company safety supervisor and a safety engineer, interviewed the OSHA compliance officer assigned to the case, and gathered further data. Photographs of the incident site and an autopsy report were obtained after the investigation.

The victim's employer is a major steel company that has been in operation for 74 years and employs 8000 workers. The company has a written safety policy and a comprehensive safety program. The safety department is comprised of a superintendent, two supervisors, two engineers, one industrial hygienist, and two union safety personnel. On-the-job and classroom training are provided to all employees, as well as training videos and safety manuals. Additionally, weekly safety contacts are made and documented. Pre-employment physicals are required of all new employees. The victim worked for this employer for 26 years prior to this incident.

INVESTIGATION

On the day of the incident, the day shift (7:00 a.m. to 3:00 p.m.) of the steel-making department in which the victim worked, was conducting normal daily operations. A crew of 4 workers including the victim, had been performing maintenance on a tundish (i.e., an intermediate pouring vessel which is used to control the pouring of molten steel into molds). At about 9:50 a.m., the crew decided to take a break. The crew took a 15-minute break once an hour due to the hot working environment.

The victim walked to the lunch room and sat on a wooden bench next to a floor-model air conditioner, which was approximately 30 inches tall. The toaster oven was on top of the air conditioner and plugged into a 120-volt electrical circuit.

The victim, who was sweating profusely and wearing a short sleeved shirt, rested his right forearm on top of the air conditioner. The victim's right arm contacted the energized casing of the toaster oven while his right calf was in contact with the grounded air-conditioning unit. The victim began to shake which attracted the attention of the co-workers. A co-worker, suspecting the victim was being shocked, knocked the toaster oven off the air conditioner, disconnecting the plug from the receptacle. Current had traveled through the victim and exited at the point of contact between the victim's right leg and the grounded casing of the air conditioner.

A co-worker laid the victim on the wooden bench, positioned a jacket beneath his head, and began pushing on the victim's chest. Another co-worker contacted the foreman, who called the plant emergency medical service. The plant EMS team responded in 15-20 minutes and provided advanced cardiac life support. The victim received additional treatment from the local emergency medical service which transported him to the local hospital where he was pronounced dead on arrival.

Investigators learned that the toaster oven's power cord had a non-polarized plug which, sometime prior to the incident, had been inversely inserted into a polarized receptacle. The heating element in the toaster oven had been previously damaged and was in contact with the oven casing. Reverse insertion of the plug in the polarized receptacle created a condition known as reversed polarity. Electrical current flowed through the heating element without the switch being turned to the ON position and energized the toaster oven casing (Figure).

CAUSE OF DEATH

The autopsy report listed the cause of death as arteriosclerotic cardiovascular disease complicated by electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should periodically inspect all areas of their facility for electrical hazards and apply appropriate control measures.

Discussion: Employers should periodically inspect all areas of their facilities, especially non-production areas, lunch rooms, break rooms, rest rooms, etc., to identify non-polarized plugs, improper grounding, and any other electrical hazards that may be present, and then apply appropriate measures to eliminate the hazard. Additional information pertaining to electrical hazards can be found in the NIOSH Alert "Request for Assistance in Preventing Fatalities of Workers Who Contact Electrical Energy (1)."

Recommendation #2: Employers should require that all appliances brought into their facility be tested for electrical integrity by a qualified person before they are used.

Discussion: Employers should not only require such testing, but also ensure that all supervisors and workers are aware of the testing policy. *[Note: The employer in this incident has adopted such a policy.]*

Recommendation #3: Employers should periodically re-evaluate safety programs and reinforce training related to worker recognition, avoidance, and reporting of hazards.

Discussion: A subsequent interview of the witnesses revealed that the victim and his co-workers were aware that a problem existed with the oven. On a number of occasions the workers, including the victim, had received electrical shocks from the oven. Employers should periodically re-evaluate existing safety programs and reinforce worker training related to recognizing, avoiding, and reporting hazards, especially electrical hazards.

Recommendation #4: Employers should provide CPR training to all workers, both management and labor.

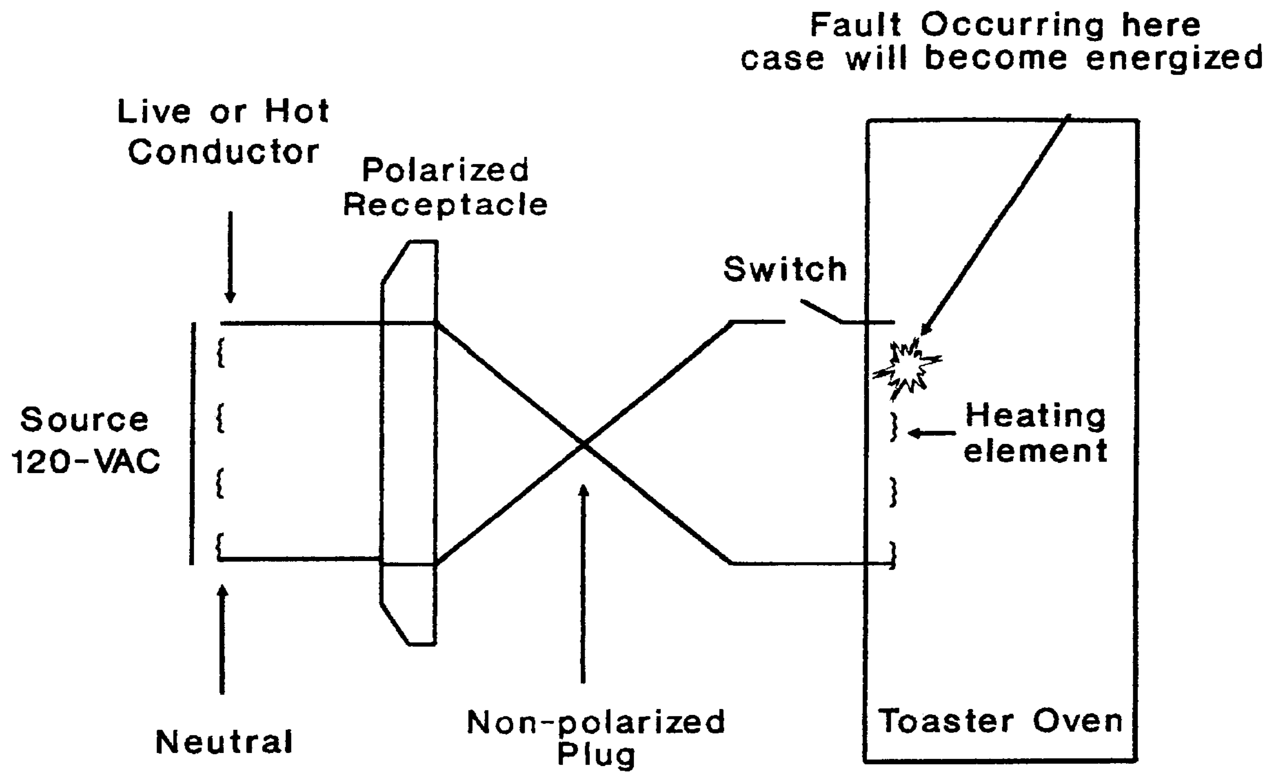
Discussion: Employers should ensure that all workers are provided with CPR training to support circulation and ventilation until trained medical personnel arrive. To optimize results, CPR should begin within 4 minutes (in accordance with American Heart Association guidelines). (2) Initial CPR was administered by a co-worker whose last CPR training occurred about 15 years previous to this incident. CPR training should be repeated at least annually to ensure that employees retain knowledge, and keep up with advances in life support techniques.

REFERENCES

1. NIOSH [1986]. Request for Assistance in Preventing Fatalities of Workers Who Contact Electrical Energy. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-103.

2. 1985 National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). Standards and Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). JAMA 255(21):2905-2989 (June 1986).

[1]Note: On a polarized plug, the neutral terminal is wider than the hot terminal. Therefore, a polarized plug can be inserted into a polarized receptacle in one way only. On a non-polarized plug, the neutral and hot terminals are the same width. Therefore, the non-polarized plug can be inserted two ways.



When the Live/hot conductor and Neutral wire are reversed, the current path is also reversed.

Figure. *Reversed Polarity*

FACE 90-38: Well Driller Electrocuted When Pipe on Crane Cable Contacts 12,000-Volt Overhead Powerline in Virginia

SUMMARY

A well driller was electrocuted when a metal pipe that was being hoisted by a truck-mounted crane contacted one phase of a three-phase, 12,000-volt overhead powerline. The victim and a co-worker had been assigned the task of repairing a submersible pump for a water well at a private residence. The two workers began the repair work the day before the incident. The day of the incident they used a truck-mounted crane to pull piping and the submersible pump from the well. The well was located in a pasture that is intersected by three separate and parallel overhead powerlines. A phase from one of the powerlines passes directly over the well, 31 feet, 6 inches above the ground. On the day of the incident, the victim positioned the truck-mounted crane beneath the powerline. Using a hand-held remote control pendant, the victim fully extended the end of the boom 36 feet above the ground. The crane cable was attached to a 1-inch diameter galvanized pipe that ran to the pump inside the well. As the victim raised the pipe it contacted the powerline phase directly above the well. This action energized the crane, including the hand-held remote control pendant. The victim provided a "path to ground" and was electrocuted. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- conduct a jobsite survey to identify potential hazards before starting any job, and implement appropriate control measures
- ensure that cranes are not operated within 10 feet of energized powerlines according to current OSHA regulations
- ensure that boomed vehicle operators are trained in the safe operation of these vehicles
- contact the local utility company to de-energize or insulate the powerlines when circumstances require operating a crane in close proximity to a powerline
- develop and implement a safety program to help workers recognize and control hazards
- consider retrofitting truck-mounted cranes with electrically-isolated crane control systems.

INTRODUCTION

On August 11, 1990, a 33-year-old male well driller was electrocuted when a metal pipe that was being hoisted with a truck-mounted crane contacted a three-phase, 12,000-volt overhead powerline. On August 21, 1990, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the death and requested technical assistance. On September 27, 1990, a research industrial hygienist from DSR traveled to the incident site and conducted an investigation. The DSR investigator reviewed the incident with company representatives and employees, the medical examiner, and the Virginia OSHA compliance officer assigned to this case. Photographs and diagrams of the incident site were obtained during the investigation.

The employer in this incident is a well drilling company that has been in business for about 50 years. The work performed by the company involves water well drilling and repair. The company employs 16 full-time employees, most of whom perform water well drilling and well repair work. The victim had been performing this type of work for the company for 15 years. The company has no safety program, and no written safety policy or procedures.

INVESTIGATION

Two well drillers (victim and co-worker) had been assigned the task of repairing a submersible pump and other electrical-related equipment for an existing water well at a private residence. Other company employees, including one of the company owners, had made repairs on the well on previous occasions. None of those repairs required the use of a crane.

The well was about 100 feet from an interstate highway and inside a fenced pasture. The pasture is intersected by three separate and parallel overhead powerlines, one of which is a three-phase, 12,000-volt powerline that crosses directly above the well head, 31 feet 6 inches above the ground. The well head is surrounded by a concrete enclosure, 6 feet long by 6 feet wide by 3 feet high, with a removable corrugated steel cover.

At 5:00 p.m. on the day before the incident, the victim and co-worker arrived at the site and worked on the well for about 2 hours. They returned the following day at 8:15 a.m. and continued the repair work for about 30 minutes. At that time, they decided they needed a truck-mounted crane to pull the submersible pump out of the well. The two workers drove to the company office in their service truck and returned to the site in a 5-ton hydraulic derrick crane truck.

The victim positioned the crane truck near the well, and the outriggers of the truck were lowered to stabilize it. The victim stood near the side of the truck and operated the crane with a hand-held remote control pendant while the co-worker stood near the back of the truck. The victim fully extended the end of the boom 36 feet above the ground.

With the end of the boom approximately 33 feet above the top of the well enclosure, a steel cable with a hook at the end was lowered. The co-worker then attached the cable and hook to the end of a 1-inch diameter galvanized pipe protruding from the well head. The end of the pipe included an elbow fitting that extended 4.5 inches horizontally. The rest of the pipe extended down vertically to the submersible pump, about 100 feet below the surface, inside a 4-inch diameter well casing.

With the pendant control in his left hand, the victim began hoisting the pipe out of the well. The co-worker stated that the victim yelled for him to "get out of the way." In response, the co-worker began running away from the crane. While running, the co-worker heard a loud noise "like a shotgun going off." A motorist driving along the highway at that same time reported later that he saw a ball of fire rising from the well enclosure.

The co-worker did not see the galvanized pipe contact the overhead powerline. However, a solidified molten drip at the end of the galvanized pipe suggests contact at that point. When contact occurred, the truck-mounted crane, the remote control cable, and the hand-held pendant became energized. A "path to ground" was established through the victim's body. The electric current entered the victim's left hand (holding the pendant) and exited his feet to the ground. The powerline phase, directly over the well head, melted in two at a point where the galvanized pipe made contact. This caused the non-energized end (load end) of the powerline phase to fall to the ground. The energized end (line end) of the phase also fell, dangling about 12 feet above the ground from a utility pole 17 feet from the well.

After hearing the noise, the co-worker looked back and saw the victim lying face down about 10 feet from the well enclosure. The co-worker immediately ran to the victim and noted that he was still conscious. The hand-held pendant was lying on the ground nearby.

The co-worker called the company office on a two-way radio inside the crane truck, and the secretary who answered called the emergency medical service (EMS) on 911. The co-worker returned to the victim, who was now unconscious, and attempted cardiopulmonary resuscitation (CPR) but was unsuccessful in reviving the victim. A police officer and an emergency rescue squad from the local fire department arrived at the scene 2 and 8 minutes, respectively, after the 911 emergency call was received. The police officer and rescue squad personnel continued CPR on the victim, including advanced cardiac life support. The victim was transported to a local hospital where he was pronounced dead on arrival by the attending physician.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrical injury.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct a jobsite survey to identify potential hazards before starting any job, and implement appropriate control measures.

Discussion: Employers should conduct initial jobsite surveys to identify potential worker hazards. Once potential hazards have been identified, appropriate control measures can be implemented prior to the start of any work. Control measures in this incident could have included de-energizing the powerline or insulating or "sleeving" the powerline phases with line hoses.

Recommendation #2: Employers should ensure adherence to existing OSHA regulations concerning crane operations.

Discussion: OSHA standards 1926.550(a)(15) and 1910.180(j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be 10 feet, unless the electrical lines have been "de-energized and visibly grounded." Additionally, 29 CFR 1926.550(a)(15)(iv) requires that a person be designated to observe clearance of the equipment and to provide timely warning for all operations where it is difficult for the operator to maintain desired clearances by visual means. A NIOSH alert entitled "Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines" provides additional recommendations pertaining to work with boomed vehicles near energized overhead powerlines.

Recommendation #3: Employers should ensure that boomed vehicle drivers/operators are trained in the safe operation of these vehicles.

Discussion: All workers who are required to operate boomed vehicles should be provided with appropriate training. At a minimum, such training should address:

1. all OSHA standards applicable to cranes

2. recognition of hazards associated with hoisting of equipment and materials, especially near overhead powerlines

3. positioning of the crane boom to maintain a 10-foot minimum clearance from overhead powerlines

4. proper use of outriggers according to the manufacturer's recommendations

5. use of established procedures in emergency situations (Example-In the event of vehicle contact with an electrical powerline, never contact the vehicle or allow anyone else to contact the vehicle. Also, keep all unauthorized personnel away from the area).

Recommendation #4: When circumstances offer no alternative to operating a crane (or other boomed vehicle) close to a powerline, the employer should contact the local utility company to de-energize or insulate the powerline before the start of work.

Discussion: De-energizing or insulating powerlines in work areas serves to provide a measure of protection to crane operators should contact with powerlines occur. When there is no alternative to operating a crane near a powerline, this procedure provides a viable option.

Recommendation #5: Employers should develop and implement a safety program designed to help workers recognize, understand, and control hazards.

Discussion: OSHA Standard 29 CFR 1926.21(b)(2) states, "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Even small companies should evaluate the tasks performed by workers, identify potential hazards, develop and implement a safety program addressing these hazards, and provide worker training in safe work procedures.

Recommendation #6: Employers and crane manufacturers should consider retrofitting truck-mounted cranes with electrically-isolated crane control systems.

Discussion: The remote control system (hand-held pendant) used on this crane was electrically connected to the crane. This system provided the "path to ground" in this incident. A crane control system that is electrically isolated would provide protection to anyone operating the crane in the event of contact with an energized overhead powerline. Electrical isolation for remote control devices could be accomplished by radio-frequency controls, fuse-equipped control lines, fiber optic controls, insulated control boxes, etc. Another approach for electrical isolation of truck-mounted controls could be accomplished by an electrical hazard protection platform mounted near the crane controls. With this system, the crane cannot be operated unless the operator is standing on the platform. Since the platform is mounted above ground on the truck, it is electrically isolated. If any part of the crane boom contacts a powerline, the electrical current would go to ground through the tires or outriggers instead of through the operator. Manufacturers of crane systems should evaluate these options and incorporate an electrically-isolated crane control system in the design of newly manufactured truck-mounted cranes. Manufacturers and their customers should also consider retrofitting existing truck-mounted cranes with these systems.

REFERENCES

1. Office of the Federal Register, Code of Federal Regulations, Labor, 29 CFR Part 1910.180(j), 29 CFR Part 1926.21(b) (2) and 29 CFR Part 1926.550(a) (15), U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C., July 1989.

2. National Institute for Occupational Safety and Health, Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines, DHHS (NIOSH) Publication Number 85-111, July 1985.

FACE 90-39: Foreman Electrocuted and Lineman Injured After Truck-mounted Crane Boom Contacts 7,200-volt Overhead Powerline in Virginia

SUMMARY

A foreman for a telecommunications company was electrocuted when he grabbed the door handle on a truck-mounted crane whose boom was in contact with a three-phase, 7,200-volt overhead powerline. The foreman (victim) and three other workers (lineman, cable splicer, and laborer) were attempting to remove four poles that had previously supported an advertisement billboard. The poles stood 20 feet high, were buried 5 feet in the ground, and were located 15 feet away from and parallel to the powerline. To remove the poles, the lineman positioned the truck-mounted crane directly under the powerline. While standing on the ground, the lineman maneuvered the crane boom using the rubber-coated hand control levers mounted at the back of the truck. The poles were removed by hooking the crane boom cable around the middle of each pole and vertically hoisting each pole out of the ground. While the workers were pulling out the third pole, the end of the boom contacted the overhead powerline. The laborer, working in the back of the truck, noticed the lineman being shocked. He further noticed that the lineman was unable to let go of the "boom up" hand control. The laborer kicked the lineman in the chest and the lineman collapsed unconscious to the ground. He revived without assistance about 3 minutes later, with apparent electrical burns to his left hand. The crane boom remained in contact with the powerline, the truck tires ignited, and the truck began to burn. When the foreman (victim) saw this he tried to open one of the truck doors. When his left hand contacted the door handle he was electrocuted. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- conduct a jobsite survey to identify potential hazards before starting any job, and implement appropriate control measures
- ensure that cranes are not operated within 10 feet of energized powerlines as required by current OSHA regulations
- ensure that boomed vehicle operators are trained in the safe operation of these vehicles
- contact the local utility company to de-energize or insulate the powerlines when circumstances require operating a crane in close proximity to a powerline
- develop and implement a safety program to help workers recognize and control hazards
- consider retrofitting truck-mounted cranes with electrically isolated crane control systems.

INTRODUCTION

On August 22, 1990, a 24-year-old male lineman foreman was electrocuted when he grabbed the door handle on a crane truck whose boom was in contact with a three-phase, 7,200-volt, 24-foot-high overhead powerline. On September 10, 1990, officials of the Virginia Occupational Safety and Health Administration (OSHA) notified the Division of Safety Research (DSR) of the death and requested technical assistance. On September 28, 1990, a research industrial hygienist from DSR traveled to the incident site and conducted an investigation. The DSR investigator reviewed the incident with company representatives and employees, the medical examiner, and the Virginia OSHA compliance officer assigned to this case. Photographs and diagrams of the incident site were obtained during the investigation.

The employer in this incident is a telecommunications company that has been in business for 8 years. Most of the work performed by the company involves telecommunication line installation and repair. The company employs 50 full-time employees. Most of the employees are linemen, cable splicers, and line construction/repair laborers. The victim had been employed by the company for 7 years. The company has no safety program, and no written safety policy or safety procedures.

INVESTIGATION

The company had assigned a foreman (victim) and a crew of three other workers (lineman, cable splicer, and laborer) the task of removing four poles that supported an advertisement billboard. The poles were each 25 feet long and were set vertically, 5 feet deep in the ground, with the top of each pole 20 feet above the ground. The four poles were located 15 feet laterally from a 7,200-volt, three-phase, 24-foot-high overhead powerline and about 150 feet from an interstate highway. The poles ran parallel with and between the powerline and highway.

At 1:00 p.m. on the day of the incident, the work crew arrived at the site to remove the poles. To accomplish the task, the crew used a 3-ton, truck-mounted, hydraulic derrick crane. The lineman maneuvered the crane boom for the entire task while standing on the ground and operating rubber-coated hand control levers mounted at the back end of the truck. While the crew was setting up to remove the first pole, the victim walked to a business about 200 feet away to make a phone call. During his absence, the workers removed three of the poles in the following manner:

- The lineman positioned the truck directly under and parallel to the powerline
- The other workers lowered the outriggers to stabilize the truck
- The lineman raised the end of the boom to about 22 feet above the ground, directly above the pole to be removed
- The other workers hooked the boom cable around the middle of the pole
- The lineman hoisted the boom cable with the "boom up" control lever, pulling the pole vertically out of the ground
- The lineman lowered the pole to the ground with the "boom down" control lever and the other workers unhooked it.

While the lineman was hoisting the third pole with the "boom up" control lever, he became distracted and looked away. As a result, the end of the boom continued moving in a vertical direction until it contacted the overhead powerline phase nearest the highway, energizing the crane and truck.

When the crane boom contacted the powerline, the lineman saw a flash of light but did not remember anything from that moment until several minutes later. The cable splicer was standing near the pole that was being lifted, guiding its removal, while the laborer was working in the crane truck bed. At first, the laborer and cable splicer were not aware that the end of the boom had contacted the overhead powerline. However, when the laborer saw the lineman "gasping and grunting" and unable to let go of the "boom up" control lever, he realized that the lineman was being electrically shocked.

The laborer immediately kicked the lineman in the chest. As a result, the "boom up" control lever broke off and the lineman fell to the ground. The laborer jumped off the truck and tried to drag the injured lineman away from the truck. However, when he grabbed the lineman by his bare arm he received an electrical shock (presumably the effect of ground gradient current from the energized crane truck). The crane boom remained in contact with the powerline, causing three of the truck's tires to ignite. The cable splicer, noticing the downed lineman, ran over to the laborer to assist him. The two workers dragged the injured lineman away from the truck by his pant legs and received no electric shock in doing so. At this time they noted that the injured lineman was unconscious, yet breathing. He regained consciousness 2 or 3 minutes later.

The crane truck was now on fire. The foreman, who had been making a phone call nearby, saw the commotion and came running up to the truck. The three workers did not notice the foreman until he was within a few feet of the truck. The laborer yelled, "Don't touch the truck!" However, the foreman reached for the door handle. It is presumed that he was attempting to either move the truck, turn the truck engine off or look for a fire extinguisher inside the truck cab. When the foreman grabbed the door handle with his left hand a "path to ground" was established through the victim's body. The victim slumped unconscious with his hand gripping the door handle. The electric current entered his left hand and exited his feet to ground, causing his electrocution. The laborer ran up to the victim in a rescue effort and kicked him loose from the door handle. When the victim fell to the ground, all three workers dragged the victim about 15 feet away from the truck by his pant legs. The workers began cardiopulmonary resuscitation (CPR) on the victim. At the same time, a worker from the business 200 feet away called the emergency medical service (EMS) on 911. EMS and fire department personnel arrived at the scene about 20 minutes after receiving the call. They continued CPR on the victim and started advanced cardiac life support. The victim was transported to a local hospital where he was pronounced dead on arrival by the attending physician. The injured lineman was also transported to the same hospital where he was treated for minor burns on his left hand.

Fifteen minutes after the arrival of fire department personnel, power company workers arrived at the scene and de-energized the powerline. Fire fighters then extinguished the fire that had engulfed the crane truck.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct a jobsite survey before starting any job to identify potential hazards and implement appropriate control measures.

Discussion: Employers should conduct initial jobsite surveys to identify potential worker hazards. Once potential hazards have been identified, appropriate control measures can be implemented prior to the start of any work. Control measures in this incident include: 1) de-energizing the powerline, 2) insulating ("sleeving") the powerline phases with line hoses, 3) positioning the crane-mounted truck so the crane boom will not come within 10 feet of the powerline, or posting an observer to ensure the crane operator does not move the boom within 10 feet of the powerline.

Recommendation #2: Employers should ensure adherence to existing OSHA regulations concerning crane operations.

Discussion: OSHA standards 1926.550(a)(15) and 1910.180(j) require that the minimum clearance between electrical lines rated 50 kV or below and any part of the crane or load shall be 10 feet, unless the electrical lines have been "de-energized and visibly grounded." Additionally, 29 CFR 1926.550(a)(15)(iv) requires that a person be designated to observe clearance of the equipment and to provide timely warning for all operations where it is difficult for the operator to maintain desired clearances by visual means. A NIOSH alert entitled "Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines" provides additional recommendations pertaining to work with boomed vehicles near energized overhead powerlines.

Recommendation #3: Employers should ensure that boomed vehicle drivers/operators are trained in the safe operation of these vehicles.

Discussion: All workers who are required to operate boomed vehicles should be provided with appropriate training. At minimum, such training should address:

1. all OSHA standards applicable to cranes
2. recognition of hazards associated with hoisting of equipment and materials, especially near overhead powerlines
3. positioning of the crane boom to maintain a 10-foot minimum clearance from overhead powerlines
4. proper use of outriggers according to the manufacturer's recommendations
5. use of established procedures in emergency situations.

Recommendation #4: When circumstances offer no alternative to operating a crane or other boomed vehicle close to a powerline, the employer should contact the local utility company to de-energize or insulate the powerline before the start of work.

Discussion: De-energizing or insulating powerlines in work areas serves to provide a measure of protection to crane operators should contact with powerlines occur. When there is no alternative to operating a crane near a powerline, this procedure provides a viable option.

Recommendation #5: Employers should develop and implement a safety program designed to help workers recognize, understand, and control hazards.

Discussion: OSHA Standard 29 CFR 1926.21(b)(2) states, "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work

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environment to control or eliminate any hazards or other exposure to illness or injury." Companies should evaluate the tasks performed by workers, identify potential hazards, develop and implement a safety program addressing these hazards, and provide worker training in safe work procedures. For example, employers should instruct workers that if a vehicle contacts an electrical powerline, they should not contact the vehicle or allow anyone else to contact the vehicle. Employers should also instruct workers to keep all unauthorized personnel away from the area.

Recommendation #6: Employers and crane manufacturers should consider retrofitting truck-mounted cranes with electrically isolated crane control systems.

Discussion: A crane control system that is electrically isolated would provide protection to a worker operating the crane if contact with an energized overhead powerline occurs. Electrically isolating truck-mounted controls could be accomplished by an electrical hazard protection platform mounted near the crane controls. With this system the crane cannot be operated unless the operator is standing on the platform. Since the platform is mounted on the truck above ground level, it is electrically isolated. Therefore, if any part of the crane boom contacts a powerline, the electrical current would go to ground through the tires or outriggers instead of through the operator. Electrical isolation for remote control devices could be accomplished by radio controls, fuse-equipped control lines, fiber optic controls, insulated control boxes, etc. Manufacturers of crane systems should evaluate these options and incorporate an electrically isolated crane control system in the design of newly manufactured truck-mounted cranes. Manufacturers and their customers should consider retrofitting existing truck-mounted cranes with these systems, as well.

REFERENCES

1. Office of the Federal Register, Code of Federal Regulations, Labor, 29 CFR Part 1926, pages 20 & 204, U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C., July 1989.

2. National Institute for Occupational Safety and Health, Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines, DHHS (NIOSH) Publication Number 85-111, July 1985.

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FACE 90-40: Utility Lineman Electrocuted in Ohio

SUMMARY

A 29-year-old utility lineman was electrocuted when he simultaneously contacted both sides of a fused powerline jumper. One end of the jumper was attached to the powerline, the other was attached to a recently installed pole-mounted transformer. The jumper served as a temporary connection between a powerline phase and a transformer that allowed electrical service to be provided through the transformer. The week before the incident, the victim had moved the outside phases of a three-phase, 2400-volt powerline to temporary insulators at the center of the crossarm at the top of a utility pole. This work was done to ease tree trimming operations around these lines.

On the day of the incident, the victim was working from an aerial bucket moving the two outer powerline phases back to their permanent positions at each end of the crossarm. Two workers on the ground were using a hemp rope the victim had tied to the powerline phase to position the powerline on the insulator. When the powerline was in position, the victim told the workers on the ground to hold it in position while he secured tied it to the insulator. One of the co-workers then noticed one of the victim's leather gloves smoking and that the victim was slumped over in the bucket. The truck stalled, preventing the workers on the ground from using the truck-mounted controls to lower the aerial bucket. One of the workers ran to a nearby farmhouse to summon the emergency medical squad (EMS). The second worker notified the company of the incident from the truck radio. After alerting the company, the second worker climbed the pole, de-energized the new transformer, entered the aerial bucket and initiated cardiopulmonary resuscitation (CPR). As the first worker was returning from the farmhouse, a tree trimming crew arrived at the site in another aerial bucket truck. The first worker and a member of the tree trimming crew used the tree trimmers' aerial bucket truck to remove the victim from his bucket and lower him to the ground. The EMS transported the victim to the hospital where he was pronounced dead by the attending physician.

The investigation revealed that one end of a temporary fused jumper was connected to the powerline on which the victim was working. The other end of the jumper was connected to the new pole-mounted transformer. This jumper had been pulled in two. It is assumed that the jumper pulled apart as it was being attached to the insulator. While attempting to prevent the separation the victim contacted both sides of the jumper simultaneously. This action allowed current to pass across the victim's chest and caused his electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- ensure that a comprehensive safety program which includes specific written procedures for all work near energized powerlines is designed, developed and implemented

- ensure that workers follow established safe work procedures.

INTRODUCTION

On August 20, 1990, a 29-year-old utility lineman was electrocuted when he simultaneously contacted both ends of a temporary fused powerline jumper. On September 17, 1990, officials of the state Bureau of Worker's Compensation, Division of Safety and Hygiene, notified the Division of Safety Research of the incident and requested technical assistance. On September 28, 1990, two occupational safety and health specialists traveled to the incident site to conduct an investigation. The DSR investigators reviewed the incident with the company superintendent, the state highway patrol, and the university police. Photographs, diagrams of the incident site, and police and coroner's reports with the death certificate were obtained.

The employer is an electrical contractor that has been in operation for 54 years. The company employs 13 workers, seven of which are powerline workers. The company has no written safety policy, safety program, safe work procedures or safety officer. Several unwritten standard operating procedures exist, such as using rubber linemen's gloves while working on energized powerlines. Training is provided on the job. The victim had worked for this employer for eight years.

INVESTIGATION

The company had been contracted by a state university to upgrade a portion of the existing electrical system on university property. This upgrade consisted of replacing pole-mounted transformers containing polychlorinated biphenyls (PCBs). In addition to this task, the line crew was moving powerline phases on the pole-top crossarms to facilitate a tree trimming contractor's operations in the area. The week before the incident, the victim had moved two outside phases of a three-phase 2,400-volt powerline on a pole-top crossarm. The two phases were attached to temporary insulators near the center of the crossarm to provide clearance for tree trimmers who were cutting limbs from around the powerlines. The crew then installed a new transformer on the pole to service a nearby farmhouse. Electric power was provided to the transformer by a temporary fused jumper attached between the new transformer and the powerline phase conductor nearest to the farmhouse. The old transformer was de-energized, but was not removed from the pole.

On the day of the incident, tree trimming operations had been completed and the victim was returning the two outside phases to their permanent positions at the outer ends of the crossarm. Two co-workers on the ground were assisting the victim in moving each phase by either pulling on, or leaving slack in, a length of hemp rope the victim had tied to the powerline. At this time, the victim was wearing only leather gloves. Unwritten company standard operating procedures required the use of rubber linemen's gloves during work on energized powerlines. The victim had re-attached one of the phases to its permanent insulator and had tied the hemp rope on the second phase to be moved. A temporary fused jumper was attached to this phase in the bucket area. The victim told his co-workers on the ground to leave slack in the rope to allow the phase to rest against its permanent insulator. The victim then told his co-workers he had reattached the powerline to the insulator. Upon looking up at the victim, the first co-worker noticed that one of the victim's gloves was smoking. He called to the victim but received no answer. The second co-worker jumped onto the back of the aerial bucket truck to lower the aerial bucket using the truck-mounted controls. However, the truck stalled, disabling the controls. While the second co-worker tried to re-start the truck, the first ran 50 feet to the farmhouse to ask the residents to call the emergency medical service (EMS). When the first co-worker returned to the truck, he saw the second co-worker preparing to climb the pole. After the second co-worker climbed the utility pole and de-energized the new transformer, he entered the aerial bucket and initiated cardiopulmonary resuscitation (CPR) on the victim.

The first co-worker was trying to re-start the truck when a tree trimming crew arrived at the site in another aerial bucket truck. The first co-worker and a tree trimmer, assisted by the second co-worker, transferred the victim into the tree trimmers' aerial bucket and lowered the victim to the ground. The EMS arrived within minutes and transported the victim to the hospital where he was pronounced dead by the attending physician.

An investigation of the incident by university police revealed that the temporary fused jumper had pulled apart. Electrical burns on the victim's hands suggest the victim simultaneously contacted both ends of the jumper while trying to prevent the separation or re-establish the connection. This allowed electrical current to flow across the victim's chest, causing his electrocution.

CAUSE OF DEATH

The county coroner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should ensure that a comprehensive safety program is designed, developed and implemented. This safety program should include specific written procedures for all work to be performed on or near energized high voltage powerlines.

Discussion: Employers should design, develop and implement a comprehensive safety program which includes specific written procedures for tasks such as the temporary relocation of powerlines. These procedures should include, but not be limited to:

1. worker training
2. electrical hazard recognition
3. proper use and maintenance of personal protective equipment
4. supervisory job site surveys prior to the start of work
5. first aid and cardiopulmonary resuscitation (CPR) certification training.

Recommendation #2: Employers should ensure that workers follow established safe work procedures.

Discussion: Employers should continually stress the importance of adherence to safe work procedures and conduct periodic, random safety inspections to ensure that these procedures are being followed.

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FACE 91-01: **Distribution Line Technician Electrocuted in South Carolina**

SUMMARY

A 46-year-old distribution line technician (the victim) for an electrical utility was electrocuted while clearing branches from a single-phase, 7200-volt primary powerline. The victim and a co-worker (groundman) had been dispatched to clear damage following a tropical storm. Because the dirt access road into the damage area was impassable by truck, the victim and his co-worker walked in until they saw a white pine limb lying across the powerline. The victim used a telescopic hot stick (an insulated pole used by line technicians to make energized powerline connections) to knock the limb off. Walking out the access road, the victim heard a popping sound that he thought came from a second limb contacting the powerline in the pine tree above him. Because of the dense growth of the limbs, the victim could not see which limb was making contact and could not use the telescopic hot stick. The victim and co-worker drove to a utility pole to open a fused switch on the pole-mounted transformer that was expected to de-energize the 7200-volt primary line. They returned to the pine tree, and the victim climbed it to correct the problem. The victim called to his co-worker that the limb was not contacting the powerline where he thought. The co-worker next heard an arcing sound and saw the victim fall 20 feet to the ground. The co-worker summoned the emergency medical service (EMS), which transported the victim to the hospital where he was pronounced dead by the attending physician. NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- ensure that prior to any work on an electrical system, all involved workers are familiar with the operation of every electrical component

- ensure that workers are trained in and follow established safe work procedures relevant to their duties and responsibilities.

INTRODUCTION

On October 15, 1990, a 46-year-old distribution line technician was electrocuted while clearing branches from a 7200-volt primary powerline. On October 22, 1990, officials of the South Carolina Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality and requested technical assistance. On November 7, 1990, two safety specialists from DSR went to the site of the fatality and conducted an investigation. The investigators reviewed the incident with the company's manager of engineering and manager of safety and industrial hygiene. The final autopsy report and photographs of the incident site were obtained.

The employer is a public electric utility that has been in operation 85 years and employs more than 20,000 workers. The victim had been with the company for 8 years and was one of 632 distribution line technicians employed in the construction and operations division. The company has a written safety policy, a comprehensive safety program, and a corporate safety director. Seven safety professionals are employed in the construction and operations divisions. In addition to weekly tailgate safety meetings at the jobsite, documented monthly safety meetings are held at the company office.

INVESTIGATION

On the day of the incident, a distribution line technician (the victim) and a groundman were assigned the task of clearing tree branches from a 7200-volt primary powerline. The two line electrical distribution system in this area consisted of an upper energized single-phase 7200-volt powerline, and a second neutral line suspended 40 inches below the energized phase. The tree limbs were interfering with the powerline due to wind damage caused by a tropical storm. When the victim and co-worker arrived at the assigned work area, they found the access road to the primary powerline was impassable by truck because of the heavy rains. The victim got a telescopic hot stick from the aerial bucket truck and with his co-worker began to walk the access road. The victim saw a white pine limb lying across the powerline which he knocked off with the hot stick.

The victim was walking back to the truck when he heard a crackling sound in an area above him where the powerline passed through a white pine tree. Because of the density of the tree limbs, the victim could not see if a limb was in contact with the powerline. The victim told his co-worker that they would open a switch 300 feet away to de-energize the powerline. The victim would then climb the tree and try to correct the problem. The victim and the groundman drove to the pole-mounted switch and opened it. After opening the switch, the victim did not attempt to ground the primary powerline. If an attempt had been made to attach a ground clamp to the energized primary powerline, a flash would have occurred to alert the workers that the primary powerline was still energized. The switch controlled electrical power to a tap line located on the same pole as the primary powerline at this location. The tap line supplied several residences in the area. Opening this switch did not de-energize the 7200-volt primary powerline.

The victim and groundman returned to the previous location where the victim climbed the tree. Because of the density of the tree limbs, the groundman could not see the exact location of the victim. The victim told the groundman that he could not see any limbs in contact with the powerline. The groundman then heard an arcing sound and saw the victim falling through the tree limbs to the ground.

The groundman ran to the aerial bucket truck and told the company dispatcher what had happened. The dispatcher summoned the emergency medical service (EMS). The groundman then returned to the victim and initiated cardiopulmonary resuscitation. Another company worker heard the radio communication and traveled to the site to provide aid. The EMS transported the victim to the hospital where he was pronounced dead by the attending physician. Although the event was unwitnessed, electrical burns on the victim's back, torso and limbs suggest that the victim lost his balance and fell into the powerline. A path for the electrical current was established through the victim and the tree to the ground.

CAUSE OF DEATH

The county coroner listed electrocution as the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Prior to any work being performed on an electrical system, employers should ensure that all involved workers are familiar with the operation of every electrical component in that electrical system.

Discussion: It appears that the victim was not sure which powerline was controlled by the pole-mounted switch. Before beginning work on any electrical system, all persons involved should be aware of the function of each system component in the system, and of any hazards created by the functioning of these components. Additionally, workers should be instructed that if any questions regarding the electrical system arise, qualified personnel should be contacted to answer these questions before work proceeds.

Recommendation #2: Employers should ensure that workers are trained in and follow established safe work procedures relevant to their duties and responsibilities.

Discussion: Established safe work procedures required de-energizing and grounding a powerline before any work was performed on that line. Employers should ensure that workers are trained in and follow established safe work procedures relevant to their duties and responsibilities. If an attempt had been made to connect a ground clamp to the energized primary powerline, a flash would have occurred to alert the workers that the primary powerline was still energized.

FACE 91-03: **Tree Trimming Groundsman Electrocuted after Contacting an Energized Aerial Bucket Truck in South Carolina**

SUMMARY

A 27-year-old male tree trimming groundsman (victim) was electrocuted while contacting an aerial bucket truck that became energized. The victim was part of a five-man crew assigned to clear brush and trees from an electric utility right-of-way. The tree trimmer, while inside the bucket, extended the boom/bucket between the bottom energized phase of a 23,000-volt, 3-phase powerline and a lower neutral conductor to a tree located about 15 feet on the opposite side of the powerline. The tree trimmer climbed out of the bucket into the tree to proceed with the tree trimming operation. The foreman climbed onto the aerial bucket truck to retract the boom/bucket using the controls mounted on the boom pedestal. During boom repositioning, boom contact with the powerline allowed electrical current to flow through the uninsulated boom and truck to the ground. The victim, who was standing on the ground in contact with the aerial bucket truck, was electrocuted. NIOSH investigators concluded that in order to prevent future similar occurrences employers and utility companies should:

- conduct a pre-work survey at jobsites to identify potential hazards, implement appropriate control measures, and provide subsequent training to employees that specifically addresses all identified site hazards

- ensure that line-clearance tree trimmers maintain the minimum working distances from energized conductors established in current OSHA regulations and ANSI standards

- ensure that aerial bucket truck operators are trained in the safe operation of these vehicles

- contact the local utility company to de-energize or insulate the powerlines when circumstances require operating a aerial bucket truck (or other boomed vehicle) in close proximity to a powerline

- comply with applicable OSHA standards regarding the marking of controls

- review and revise, where applicable, written safety rules and procedures that address working in close proximity to energized overhead powerlines.

INTRODUCTION

On October 23, 1990, a 27-year-old male tree trimming groundsman was electrocuted while touching an aerial bucket truck that became energized. On October 30, 1990, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On November 6, 1990, two safety specialists from DSR conducted an investigation of this incident. The investigators reviewed the incident with one of the company owners and the OSHA compliance officer assigned to the case. Photographs and diagrams of the incident site and equipment, the medical examiner's report, and the police report were also obtained during the investigation.

The employer in this incident is a tree service company that has been in operation for 42 years and employs 62 workers, including 28 groundsmen. The company has written safety rules and procedures which are administered by the safety officer/company owners and jobsite foremen. Weekly safety meetings are held and documented. The victim worked for this employer for 5 months before this incident.

INVESTIGATION

The company had been contracted by the local electric utility company to clear brush and trees from a powerline right-of-way in a rural part of the state. Work had been in progress for about 3 months prior to this incident, and had been proceeding normally.

On the day of the incident, a five-man crew consisting of a jobsite foreman, one tree trimmer/bucket operator, and three groundsmen, arrived at the jobsite. The three groundsmen, including the victim, were assigned to cut and clear brush from beneath the powerlines at ground level. The tree trimmer/bucket operator was working from the bucket of the aerial bucket truck clearing tree limbs away from the powerline. The foreman was supervising the operation.

About 15 to 20 minutes before the incident, one of the company owners arrived at the worksite to observe the crew's progress and conduct a safety inspection. At that time, the tree trimmer had completed trimming tree limbs near the powerline and was bringing the boom/bucket back to the "landed" position over the cab of the truck. After retrieving his tree climbing gear, the tree trimmer re-entered the bucket and maneuvered the boom/bucket between the neutral wire and the bottom phase of a 23,000-volt, 3-phase powerline.[1] The boom/bucket was extended through the powerline about 15 feet and the operator climbed out onto a tree. At this time, the foreman climbed onto the aerial bucket truck to retract the boom using controls mounted on the boom pedestal.[2] The boom was inadvertently raised while still positioned between the neutral wire and bottom phase of the powerline (Figure 2). This action brought the boom into contact with the powerline and allowed current to flow through the uninsulated boom and truck to the ground. The victim, who was standing on the ground in contact with the bucket truck, provided an alternate path to ground for the electrical current. The current flow ceased when the powerline burned in half and the victim then collapsed to the ground.

The victim's co-workers saw him fall and ran to him, suspecting that he had been shocked. After realizing the victim was unconscious, the foreman ran back to the truck and radioed for an ambulance. In the interim, a groundsman administered cardiopulmonary resuscitation (CPR). An ambulance arrived about 20 minutes after being contacted. Ambulance personnel continued CPR and transported the victim to the hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner's certificate listed the cause of death as electrocution.

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[1]The distance between the neutral wire and powerline was approximately 54 inches, and the height of the boom/bucket was 42 inches. This condition, assuming that the bottom of the bucket was at least 1 inch above the neutral wire, allowed for only an 11 inch clearance between the top of the occupied boom/bucket and the 23,000-volt powerline (Figure 1).

[2]Four levers mounted on the boom pedestal controlled the different functions of the boom (i.e., up, down, angle, and rotation). The function was not marked for any of the control levers.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Before starting any work, employers should conduct a jobsite survey to identify potential hazards, implement appropriate control measures, and provide subsequent training to employees that specifically addresses all identified site hazards

Discussion: Employers should conduct a jobsite survey to identify potential hazards prior to beginning work. The jobsite contained at least three identifiable hazards: a) uninsulated overhead powerlines, b) work to be performed in close proximity to the powerlines, and c) the use of an aerial bucket truck with an extendable boom. Once potential hazards are identified, appropriate control measures should be implemented and workers provided training in the control measures to be taken. Control measures for this jobsite include maintaining a minimum distance between the powerline and bucket truck, and/or insulating or de-energizing the powerline.

Recommendation #2: Employers should ensure that line-clearance tree trimmers maintain the minimum working distances from energized conductors as established in current OSHA regulations and ANSI standards.

Discussion: The minimum working distance from energized conductors established in 29 CFR 1910.268(q)(2)(iv) and ANSI Z133.1-1988 5.2.20, Tables R-3 and 1, is 2 feet 4 inches for 23,000 volts (phase-to-phase, RMS).

Recommendation #3: When circumstances offer no alternative to operating an aerial bucket truck (or other boomed vehicle) close to a powerline, the employer should contact the local utility company to de-energize or insulate the powerline before the start of work.

Discussion: De-energizing or insulating powerlines in work areas serves to provide a measure of protection to equipment operators should contact with powerlines occur. When there is no alternative to operating an aerial bucket truck near a powerline, this procedure provides a viable option.

Recommendation #4: Employers should ensure that aerial bucket truck operators are trained in the safe operation of these vehicles.

Discussion: All workers, who are required to operate aerial bucket trucks, should be provided with proper training. At a minimum, such training should address:

1. all OSHA standards applicable to aerial bucket trucks

2. recognition of hazards associated with hoisting of personnel, equipment, and materials, especially near energized overhead powerlines

3. positioning of the boom to maintain specified minimum working clearances from energized overhead powerlines

4. establish procedures for emergency situations (Example: In the event of boom contact with an energized powerline, never contact the vehicle or allow anyone else to contact the vehicle. Also, keep all unauthorized personnel away from the area).

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Recommendation #5: Employers should comply with applicable OSHA standards regarding the marking of controls.

Discussion: Employers should comply with 29 CFR 1926.556 (b)(ix), which states that "Controls shall be plainly marked as to their functions." The control levers used by the foreman to retract the boom/ bucket, were mounted on the boom pedestal. The four control levers were close to each other and not marked for the function they controlled. The apparent inadvertent movement of the lever controlling the upward motion of the boom brought it into contact with the energized powerline.

Recommendation #6: Employers should review and revise, where applicable, written safety rules and procedures that address working in close proximity to energized overhead powerlines.

Discussion: Employers should review and revise, where applicable, written safety rules and procedures that address working in close proximity to energized overhead powerlines. In this instance, alternative work procedures to positioning the boom/bucket between energized powerlines and the lower neutral wire included instructing the tree trimmer/bucket operator to either: a) climb the tree without the use of the boom/bucket truck, or b) position the boom/bucket beneath the neutral wire thereby maintaining the minimum working distance from the energized powerline.

REFERENCES

1. 29 CFR 1920.268(q)(2)(iv) Code of Federal Regulations, Washington, D.C.: U.S. Government Printing Office, Office of the Federal Register.

2. American National Standards Institute (ANSI) Inc., for tree care operations. ANSI Z133.1-1988 5.2.20.

3. 29 CFR 1926.556(b)(ix) Code of Federal Regulations, Washington, D.C.: U.S. Government Printing Office, Office of the Federal Register.

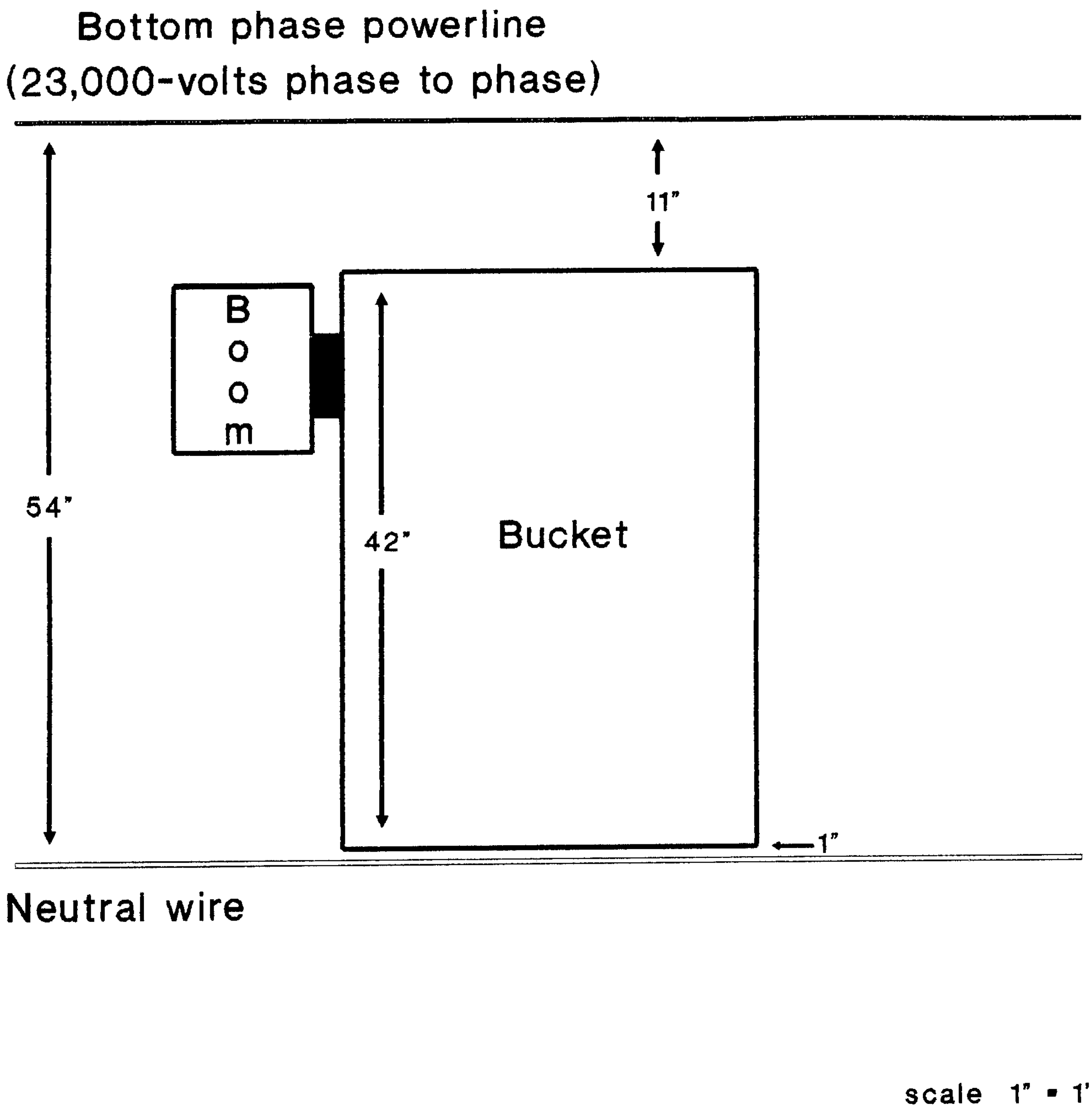

Figure 1. *Boom/bucket Clearance Between Powerline and Neutral Wire*

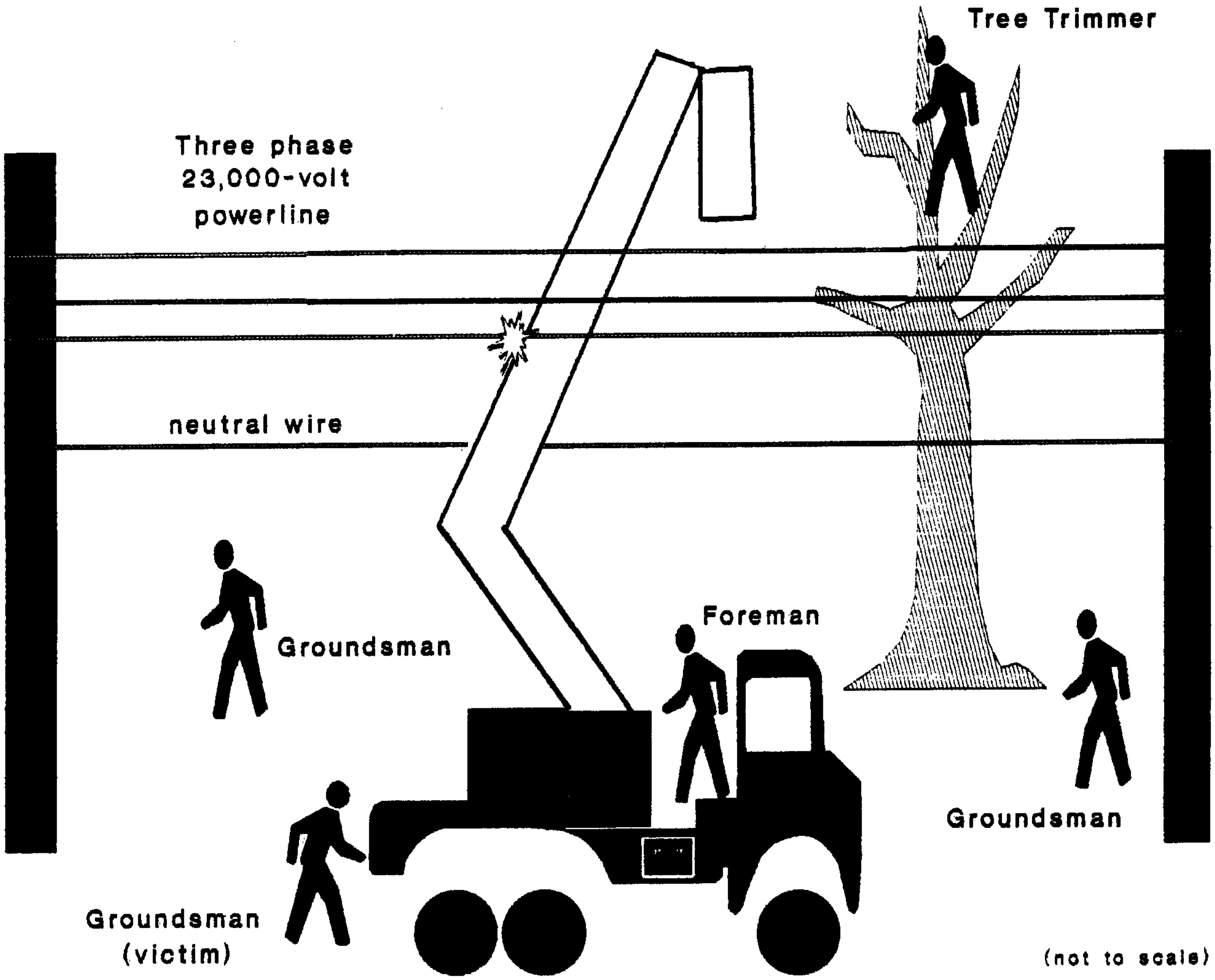

***Figure 2**. Tree Trimming Operations*
Boom Contacting Powerline

FACE 91-05: Construction Laborer Electrocuted After Handling Damaged Energized Extension Cord in Virginia

SUMMARY

A 19-year-old male construction laborer (victim) was electrocuted after handling a damaged extension cord that was energized. The victim, a second laborer, and a foreman were constructing a waterfront bulkhead for a residence at the edge of a lake. Electric power was supplied from an exterior 120-volt, grounded AC receptacle located at the back of the residence. On the day of the incident, the victim plugged in a damaged extension cord and laid it out towards the bulkhead. There were no eyewitnesses of the incident. However, evidence suggests that while the victim was handling the damaged and energized extension cord, he provided a "path to ground," and was electrocuted. The victim collapsed into the lake and sank 4 1/2 feet to the bottom. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- ensure that the electrical service for construction sites complies with OSHA standards, NEC standards and local regulations

- conduct a jobsite survey before starting any job to identify potential hazards, and implement appropriate control measures, including safety training that specifically addresses all identified site hazards

- develop and implement a safety program to help workers recognize and control hazards.

INTRODUCTION

On October 11, 1990, a 19-year-old male construction worker was electrocuted while handling a damaged electrical extension cord that was energized. On October 22, 1990, officials of the Virginia Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the death, and requested technical assistance. On December 5, 1990, a research industrial hygienist from DSR traveled to the incident site and conducted an investigation. The DSR investigator reviewed the incident with the company owner, the medical examiner, and the Virginia OSHA compliance officer assigned to this case. Photographs of the incident site were obtained during the investigation.

The employer in this incident is a construction company that has been in business for 10 months. The company builds docks, piers and waterfront bulkheads for private residences. The company employs three full-time employees who are construction workers. The victim had been employed by the company for 3 months. The company has no safety policy, and no written safety program or safe work procedures.

INVESTIGATION

The company owner had assigned a construction crew consisting of a foreman, a laborer (victim), and a second laborer (co-worker) the task of installing a waterfront bulkhead for a private residence. The bulkhead would serve as an erosion control retaining wall (150 feet long) along the rear of the property which bordered a lake.

The workers constructed much of the bulkhead from a floating work platform. The bulkhead consisted of squared timbers stacked horizontally at the water's edge, and secured in place with 6-inch-diameter wooden posts which were driven into the lake bottom against the outboard side of the timbers at 5-foot intervals. The bulkhead was further secured with several pilings 20 feet back from the bulkhead. The workers had planned to drill 1/2-inch-diameter holes through the bulkhead timbers and posts from the outboard side. Galvanized rods with threaded ends would then be installed and bolted in place, tying the bulkhead to the pilings.

After the bulkhead timbers had been set in place, the workers drilled 1/2-inch-diameter weep holes (for drainage) in the bulkhead about 6 inches above the surface of the water. To do this, the workers used a 6-amp electric drill.

Electric power for the construction project was supplied from an exterior 120-volt, grounded AC receptacle (with a 20-amp breaker) located at the back porch of the residence. The workers plugged in two 100-foot electrical extension cords to reach the bulkhead where they were using the drill and a circular saw. The receptacle at the back porch was not equipped with a ground-fault circuit interrupter (GFCI), nor did the workers use a portable GFCI device for any of the electric work at the construction site.

One of the extension cords being used had been previously damaged. In an effort to repair the damaged cord, someone had replaced both the original equipment manufactured female receptacle and male plug with splice-on-type units. An examination of the extension cord revealed that the noncolor-coded extension cord wires in the receptacle were cross-wired, thus establishing a reversed polarity condition. In addition, the ground wire inside the plug had pulled loose from its connection. The power tools used at the construction site had been plugged into the receptacle end of this extension cord.

The victim and co-worker had previously complained to the foreman that they had received electric shocks while using the damaged extension cord. In response to these complaints, the foreman removed the cord and placed it in the back of the construction utility truck. However, a few days before the incident the workers resumed using the damaged cord.

The day of the incident occurred about two weeks after the bulkhead construction started. By this time most of the bulkhead had been installed, and the workers were preparing to drill the holes in the bulkhead for the anchor rods. The foreman had previously told the victim to set out the tools and equipment, and that he (the foreman) and the co-worker would join the victim at the site later that morning. At 9:30 a.m. the victim arrived at the construction site and placed the power tools near the bulkhead. The homeowner witnessed the victim plug the good extension cord into the residential outlet. After this, the homeowner went to bed. From this moment on, there were no eyewitnesses of the incident. However, evidence suggests the following sequence of events:

1. The victim plugged the connector end of the damaged extension cord into the receptacle end of the good extension cord.

2. The victim laid out the damaged extension cord (now energized) as he walked toward the bulkhead.

3. As the victim was handling the damaged extension cord, he presumably contacted the receptacle end of the cord. This provided a path to ground for the electrical current, and the victim was electrocuted.

4. The victim collapsed, fell into the lake, and sank 4 1/2 feet to the bottom.

The co-worker and foreman arrived at the site at 10:30 a.m. They noticed the victim's car at the site, and that the tools and extension cords had been set out. The foreman saw the receptacle end of the extension cord in a water-filled hole on the inboard side of the bulkhead. He removed it from the water by pulling on the cord several feet away. The foreman radioed the company owner that the victim was missing. The owner left his office to look for the victim. The foreman and co-worker began working on the bulkhead, thinking that the victim would show up later.

While standing on the floating work platform, the foreman moved the platform along the edge of the bulkhead by pushing off the lake bottom (about 4 1/2 feet deep) with a pole. The pole contacted the submerged victim and he floated to the surface. By this time, the owner had arrived at the site. He assisted the foreman in removing the victim from the water.

The co-worker called the emergency number (911) from a phone at the residence. Two police officers responded to the emergency call and arrived in about 5 minutes. The police officers started cardiopulmonary resuscitation (CPR) on the victim. Rescue squad personnel from the volunteer emergency medical service (EMS) arrived about 3 minutes later and continued CPR on the victim, but were unsuccessful in their attempt to revive him. The local coroner pronounced the victim dead at the scene. It is estimated that the victim had been submerged in the water for about 30 minutes.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that electrical service supplied to a construction site complies with all OSHA standards, the National Electric Code, and local regulations.

Discussion: OSHA Standard 29 CFR 1926.404(b)(1)(ii) states, "All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection." A similar requirement is stated in Article 305-6(a) of the National Electrical Code. Also, OSHA Standard 29 CFR 1926.404(a)(2) states, "No grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity." Additionally, 29 CFR 1926.404(f)(6) states, "The path to ground from circuits, equipment, and enclosures shall be permanent and continuous." Compliance with these electrical standards at construction sites is imperative for worker protection. A NIOSH Alert entitled "Request for Assistance in Preventing Electrocutions Due to Damaged Receptacles and Connectors" provides additional information and recommendations pertaining to the use and maintenance of power cords and similar electrical equipment. (A copy of this Alert was provided to the employer.)

Recommendation #2: Employers should conduct a jobsite survey before starting any job to identify potential hazards, and implement appropriate control measures, including safety training that specifically addresses all identified site hazards.

Discussion: Once potential jobsite hazards have been identified, appropriate control measures can be implemented prior to the start of any work. Control measures include the use of GFCI's, for all power connections, cutting off the receptacle and connector ends of damaged extension cords when they are removed from service, prompt replacement of damaged extension cords with approved extension cords, and using appropriate circuit testing devices to ensure that all power equipment and tools are properly wired. Workers should also be trained in electrical safety, specific to the above hazard control measures.

Recommendation #3: Employers should develop and implement a safety program designed to help workers recognize, understand, and control hazards.

Discussion: OSHA Standard 29 CFR 1926.21(b)(2) states, "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Even small companies should evaluate the tasks performed by workers, identify potential hazards, develop and implement a safety program addressing these hazards, and provide worker training in safe work procedures.

REFERENCES

1. Office of the Federal Register, Code of Federal Regulations, Labor, 29 CFR Part 1926.404(b)(1)(ii), 29 CFR Part 1926.404(a)(2), and 29 CFR Part 1926.404(f)(6), U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C., July 1989.

2. National Fire Protection Association, National Electrical Code, 1990 edition, Article 305-6(a).

3. National Institute for Occupational Safety and Health, Request for Assistance in Preventing Electrocutions Due to Damaged Receptacles and Connectors, DHHS (NIOSH) Publication Number 87-100, October 1986.

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FACE 91-08: Truck Driver Electrocuted after Contacting an Energized Dump Truck in South Carolina

SUMMARY

A 62-year-old male truck driver (victim) was electrocuted while touching a dump truck that became energized. The victim had been instructed to pick up and transport a load of gravel to a location in a rural section of the state, where a septic system was being installed. The victim picked up the gravel at a limestone quarry and drove a tractor-trailer dump truck to the incident site to unload it. The victim drove the truck off the paved road onto a grassy field where the drain field for the septic system was located. He then backed the tractor-trailer into a position directly beneath one phase of a 7,200 volt, 3-phase powerline located about 20 feet above ground level. The victim set the air brakes, exited the cab of the truck to engage the lever opening the trailer's tailgate, re-entered the truck cab to engage the power takeoff system, and again exited the truck cab. While standing on the ground, the victim engaged the lever that raised the bed of the truck into inadvertent contact with the powerline phase. Contact between the truck bed and powerline allowed current to flow through the truck to the ground. The victim, who was in contact with the lever on the truck, provided an alternate path to ground for the electrical current and was electrocuted. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- conduct a jobsite survey before starting any work to identify potential hazards, implement appropriate control measures, and provide subsequent training to employees specific to all identified site hazards

- contact the local utility company to de-energize or insulate the powerlines when circumstances require operating a dump truck in close proximity to a powerline

- develop, or revise when applicable, safety rules and procedures that address working in close proximity to energized overhead powerlines

- conduct safety meetings/contacts at frequent intervals.

In addition, business owners and contractors should:

- consider the placement of facilities (e.g., septic systems) in relation to known physical hazards (e.g., energized overhead powerlines) that could be hazardous to workers during installation or subsequent maintenance of the facilities.

INTRODUCTION

On August 7, 1989, a 62-year-old male truck driver (victim) was electrocuted while touching a dump truck that became energized. On November 14, 1990, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On December 4, 1990, two safety specialists from DSR conducted an investigation of this incident. The investigators reviewed the incident with the company owner, the victim's co-worker, and the OSHA compliance officer assigned to the case. Photographs of the incident site and equipment, and the corresponding coroner and police reports were obtained during the investigation.

The employer in this incident is a manufacturer of ready-mix concrete and septic tanks. The company has been in operation for 40 years and employs 14 workers, including 10 truck drivers. The company has written safety rules and procedures which are provided by the company's insurance carrier, and administered by the company owner. The company provides on-the-job training to the employees and conducts quarterly safety meetings. The victim worked for this employer for 14 years prior to this incident.

INVESTIGATION

The company had been contracted to provide a 1,000-gallon septic tank and the gravel necessary for the drain field for the septic system to be installed behind a small shopping plaza in a rural section of the state. At the time of the incident, a septic tank had been installed and gravel was being transported to the site for the drain field.

On the day of the incident, the victim arrived at work and received instructions to drive a tractor-trailer with a 20-foot-long dump bed to the local limestone quarry, pick up a load of gravel, and deliver it to a site behind the shopping plaza. The victim drove to the quarry and had the trailer loaded with 26.5 tons of gravel. Upon arrival at the incident site, he pulled the tractor-trailer off the paved roadway onto a grassy field where the drain field for the septic system was located. Directly above the drain field was a 7,200-volt, 3-phase powerline, approximately 20 feet above ground level. The truck was parked in a position directly beneath and parallel to one phase of the powerline.

The victim exited the cab of the truck, operated a lever to open the tailgate on the bed of the trailer, returned to the truck cab to engage the power takeoff system, and again exited the cab of the truck. While standing on the ground, the victim operated the lever raising the 20-foot long bed to its maximum height and inadvertently into contact with the powerline. Contact between the truck bed and powerline allowed current to flow through the truck to the ground. The victim, who was in contact with the lever on the truck, provided an alternate path to ground for the electrical current. The victim was electrocuted and fell to the ground, but remained in contact with the electrical current arcing from one of the tire rims.

Two workers from the contractor installing the septic system saw the disturbance, and ran to a nearby store and telephoned the local police. After the police arrived, they summoned the local fire department and gas/electric company. The gas/electric company arrived and de-energized the powerline. The coroner arrived shortly thereafter and pronounced the victim dead at the scene.

CAUSE OF DEATH

The coroner's report listed the cause of death as electrocution. An autopsy was not performed.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct a jobsite survey before starting any work to identify potential hazards, implement appropriate control measures, and provide subsequent training to employees specific to all identified site hazards.

Discussion: A jobsite evaluation, conducted before employees arrive to perform work, serves to identify potential hazards, so that appropriate control measures can be implemented and corresponding employee training provided (e.g., employee could have been instructed to avoid positioning the trailer beneath the powerline). The jobsite contained at least three identifiable hazards: a) uninsulated overhead powerlines approximately 20 feet from ground level, b) work to be performed beneath and in close proximity to the powerlines, and c) an uninsulated tractor-trailer with a 20-foot-long trailer.

Recommendation #2: When circumstances offer no alternative to operating a dump truck (or boomed vehicle) close to a powerline, the employer should contact the local utility company to de-energize or insulate the powerline before the start of work.

Discussion: De-energizing powerlines in work areas will provide protection as long as clear communication between the utility company, the employer, and workers is maintained. All parties involved must be aware of when the powerlines will be de-energized, the period of time the powerlines will be de-energized, and the exact time power will be restored so that no activities expose any workers to energized conductors. Insulating powerlines by installing line sleeves, or hoses, will provide a measure of protection, but should not be the only means utilized to avoid contact with overhead powerlines. When there is no alternative to operating a dump truck or boomed vehicle near a powerline, these procedures may provide viable options.

Recommendation #3: Employers should develop, or revise when applicable, safety rules and procedures that address working in close proximity to energized overhead powerlines.

Discussion: Employers should ensure that written safety rules and procedures, address all potential worker hazards, including working in close proximity to an overhead powerline. Such rules and procedures should cover, but not be limited to:

- recognizing the hazards associated with loading and unloading materials in close proximity to overhead powerlines
- selecting loading and unloading sites (i.e., permanent and/or temporary) away from powerlines
- establishing procedures for emergency situations (e.g., in the event of contact with an electrical powerline, never contact a vehicle or allow anyone else to contact the vehicle, and keep all unauthorized personnel away from the area)
- training personnel in cardiopulmonary resuscitation (CPR)
- designating a competent person to observe the clearance between the vehicle and powerline when work must be performed in proximity to powerlines.

Recommendation #4: Employers should conduct safety meetings/contacts at frequent intervals.

Discussion: The length of time that individuals retain information from such meetings/contacts varies considerably. Safety meetings/contacts conducted at frequent intervals (e.g., weekly or bi-weekly) should help ensure that more workers retain important safety information and are provided this opportunity to discuss safety issues.

Recommendation #5: Business owners and contractors should carefully consider the placement of facilities (e.g., septic systems) in relation to known physical hazards (e.g., energized overhead powerlines) that could be hazardous to workers during installation or subsequent maintenance of the facilities.

Discussion: The septic system drain field was located beneath a 7,200-volt powerline. Any activity in the working area (e.g., loading/unloading of materials, excavation, etc.), would provide a potential for worker contact between equipment and the overhead powerline. Business owners and contractors should give consideration to the hazards that may be encountered before the installation of such facilities. In this incident, the drain field may have been installed at a different location away from the powerline.

FACE 91-10: Lineman Electrocuted After Contacting 7600-volt Powerline During Attempt To Restore Electrical Power in Tennessee

SUMMARY

A 33-year-old lineman (the victim) was electrocuted after contacting a 7600-volt powerline during an attempt to restore electrical power during a storm. A large tree had fallen across a 7600-volt, single-phase powerline, pulling both the primary and neutral conductors to the ground. After arriving at the site, the victim and a co-worker, also a lineman, did not de-energize the powerline. Instead, the victim told the co-worker he would first ground the line at the utility pole immediately up-line from the fallen tree by temporarily splicing a jumper cable between the primary conductor and the neutral conductor. The two linemen would then repair the powerline by splicing together the downed conductors above the fallen tree. To do this work, the victim entered an insulated aerial bucket and raised it to the primary conductor near the utility pole. At the same time, the co-worker cut the downed primary and neutral conductors next to the fallen tree. Although there were no eyewitnesses to the incident, evidence suggests that the victim began working on the energized powerline without first grounding the line. The victim cut the neutral and primary conductors while inside the aerial bucket, and was attempting to attach a chain hoist to the energized end of the primary conductor. Wearing only his leather work gloves, the victim presumably grabbed the supply end of the primary conductor with his **right** hand. At the same time, the chain hoist that the victim held in his **left** hand contacted the neutral jumper, thus providing a path to ground through his chest, and he was electrocuted. NIOSH investigators concluded that in order to prevent future similar occurrences, employers should:

- ensure that linemen follow established safe work procedures to de-energize, ground, and verify through testing prior to beginning maintenance and repair operations on powerlines
- ensure that linemen use all appropriate protective equipment before attempting any work on powerlines with energized circuits
- ensure that all linemen are familiar with the operation of powerline components, and safe work procedures pertaining to powerline repair
- conduct both scheduled and unscheduled jobsite safety inspections on a regular basis.

INTRODUCTION

On December 23, 1990, a 33-year-old journeyman lineman (the victim) was electrocuted after contacting a 7600-volt powerline in an attempt to restore electrical power during a storm. On December 28, 1990, officials of the Tennessee Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the incident and requested technical assistance. On February 14, 1991, a research industrial hygienist from DSR traveled to the incident site and conducted an investigation. The DSR investigator reviewed the incident with company representatives, the medical examiner, and the OSHA compliance officer assigned to this case. Photographs and diagrams of the incident site were obtained during the investigation.

The employer involved in this incident is an electrical utility cooperative that has been in operation for 50 years. Most of the work performed by the company involves powerline maintenance. The cooperative employs 75 full-time employees, most of whom are linemen. The employer has a written safety policy and comprehensive safety program. A safety manual which contains specific safe work procedures is given to each new employee. These procedures are discussed in weekly, 30-minute safety meetings that all employees are required to attend. A review of the employer's records show that the victim had attended a safety meeting in June 1990 concerning the requirements and procedures for the wearing of lineman gloves. The employer has no full-time safety officer. The engineer for the cooperative is responsible for safety issues. The lineman foreman conducts the safety meetings and experienced co-workers provide on-the-job safety training to new employees. The victim had a total of 13 years of experience as a journeyman lineman (5 years with this employer and 8 years with a previous employer).

INVESTIGATION

On the evening of the incident a storm occurred in the area, bringing heavy rain showers and intermittent gusts of wind. At 9:30 p.m., a dispatcher for the electric utility cooperative telephoned two journeymen linemen (victim and co-worker) who were on call. The dispatcher informed them of a power outage affecting four residences and a school. The victim and co-worker met at the company warehouse, then drove to the power outage site in an aerial bucket truck. At the site, the two linemen saw that a large pine tree had fallen across a 7600-volt, single-phase powerline. The tree had pulled the primary and neutral conductors to the ground between two utility poles. The powerline had not been severed, and the utility poles on either side of the fallen tree were still standing. About 600 feet up-line from the fallen tree was a utility pole where the single-phase powerline branched off from a three-phase powerline. At the three-phase junction were three cut-out fuses. The victim and co-worker noted that the cut-out fuse which served the downed powerline had blown and dropped into the open position (presumably after the tree fell on the single-phase powerline). The other two fuses remained in the closed position. The linemen further noted that between this junction and the damaged section was a bank of three transformers on a utility pole near a school. After reviewing this electrical configuration, the victim and co-worker discussed the possibility of feedback electrical energy in the downed powerline.

The victim and co-worker did not de-energize the downed powerline. Instead, they discussed doing only one of two alternatives: (1) disconnect a jumper cable on the primary phase conductor, or (2) ground the line by temporarily splicing a jumper cable between the primary phase conductor and the neutral conductor. Either one would be accomplished from the aerial bucket at the top of a utility pole about 200 feet immediately up-line from the fallen tree. According to the co-worker, the victim decided to ground the line. The linemen then decided on the following sequence to restore electrical power to the downed powerline: (1) cut the downed conductors, (2) free the conductors from the fallen tree, (3) take the slack out of the primary and neutral conductors using a come-along chain hoist, (4) splice the conductors back together above the fallen tree, and (5) remove the jumper cable.

The victim positioned the bucket truck next to the utility pole immediately up-line from the fallen tree. The co-worker walked to the tree to cut the downed conductors. From this point forward there was no eyewitness to the incident. However, burn marks on the primary conductor, neutral jumper cable, chain hoist, and electrical burns on the victim's hands (entry and exit wounds), and other evidence suggest the following sequence of events as the two linemen attempted to restore electrical power during the storm:

1. The victim put on his protective helmet and leather work gloves, leaving his lineman gloves in one of the side compartments of the truck.

2. The victim climbed into the insulated aerial bucket and raised it to where the primary and neutral conductors were attached to the utility pole. (The primary phase conductor was 34 feet above ground level, and the neutral phase conductor was 4 feet directly below the primary conductor.)

3. The victim apparently did not attempt to ground the line. Instead, he began to work on a powerline which remained energized.

4. The victim first cut the neutral and primary conductors about 3 feet away from the utility pole (Figure 1). This caused the supply end of both conductors to dangle at the side of the utility pole.

5. With his left hand, the victim picked up the cable grip end of the come-along chain hoist, and reached up with it toward the dangling primary conductor.

6. The victim grabbed the dangling end of the primary conductor with his right hand. Presumably, he was attempting to attach the come-along grip to the supply end of the primary conductor in order to remove the slack for splicing the conductor later.

7. While the victim held the primary conductor in his right hand and the chain hoist in his left hand, the dangling end of the chain hoist apparently contacted the neutral jumper cable (attached to the dangling neutral conductor). The victim thus provided the electric current with a "path to ground" through his chest, and he was electrocuted.

The co-worker returned to the truck to get some line to replace part of the downed conductors. When the co-worker looked up at the elevated bucket he did not see the victim, so he yelled the victim's name three times. When the co-worker did not receive a response, he immediately radioed the company dispatcher and asked him to call the emergency medical service (EMS). The co-worker then lowered the aerial bucket to the ground and saw the victim inside the bucket in a squatted position. The co-worker made several attempts to lift the victim out of the bucket (in order to administer cardiopulmonary resuscitation), but was unsuccessful.

EMS rescue personnel arrived at the scene (approximately 15 minutes after the co-worker called the company dispatcher), and assisted the co-worker in removing the victim from the aerial bucket. The victim received CPR at the site and en route to a local hospital, where the attending physician pronounced him dead on arrival. The company completed an investigation of the incident 2 weeks later. As a result of this investigation, the company superintendent of operations determined that the victim had been electrocuted by feedback electrical energy in the primary phase of the downed powerline.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that linemen follow established safe work procedures to de-energize, ground, and verify through testing prior to beginning maintenance and repair operations on powerlines.

Discussion: Section 507 (a) of the American Public Power Association (APPA) Safety Manual for an Electric Utility states, "All conductors and equipment shall be treated as energized until tested or otherwise determined to be de-energized and grounded." A similar requirement is stated in OSHA Standard 29 CFR 1926.954(a). This is also a written, company standard operating procedure. Additionally, OSHA Standard 29 CFR 1926.950(d)(c)(iii-iv) states, "After all designated switches and disconnectors have been opened, rendered inoperable, and tagged, visual inspection or tests shall be conducted to ensure that equipment or lines have been de-energized. Protective grounds shall be applied on the disconnected lines or equipment to be worked on." According to a NIOSH Alert, "Request for Assistance in Preventing Electrocutions by Undetected Feedback Electrical Energy Present in Powerlines" (NIOSH Publication Number 88-104), powerlines should not be repaired or otherwise accessed unless they have been de-energized and properly grounded. The Alert further states, "Unless a powerline is effectively grounded on both sides of a work area, it must be considered energized even though the line has been de-energized." During the investigation, the DSR investigator gave a copy of this Alert to the company representative.

Recommendation #2: Employers should ensure that linemen use all appropriate protective equipment before attempting any work on powerlines with energized circuits.

Discussion: According to Section 502 (a) and (b) of the APPA Safety Manual, "Employees shall not touch or work on any exposed energized lines or apparatus except when wearing approved protective equipment approved for the voltage to be contacted. When work is to be done on or near energized lines, all energized and grounded conductors or guy wires within reach of any part of the body while working shall be covered with rubber protective equipment, except that part of the conductor on which the employee is to work." Also, section 504 (d) of the APPA safety manual states that employees shall wear rubber lineman gloves with the leather protectors, under the following conditions: (1) "When working on or within falling or reaching distance of conductors, electrical equipment, or metal surface (crossarms, crossarm braces or transformer cases) which are not effectively grounded and which may be or may become energized," and (2) "During wet or stormy weather, working on or within falling or reaching distance of any conductor or equipment which may be or may become energized at any voltage."

Recommendation #3: Employers should ensure that all linemen are familiar with the operation of powerline components, and safe work procedures pertaining to powerline repair.

Discussion: Although the victim was an experienced lineman, evidence suggests that he may have thought the downed powerline on which he was working had been de-energized when one of the fuses blew (at the up-line junction). Even though the blown fuse served the downed primary phase conductor, the electrical configuration allowed the electric current to feed back into the downed primary phase through another up-line phase. This incident underscores the importance of ensuring that all linemen continually receive comprehensive training in electrical theory, the function of each component in electrical transmission and distribution lines, the hazards associated with feedback electrical energy, and safe work procedures during powerline maintenance. Such training will help linemen to become more familiar with the proper procedures to follow pertaining to powerline maintenance, and the hazards of feedback electrical energy.

Recommendation #4: Employers should conduct scheduled and unscheduled jobsite safety inspections on a regular basis.

Discussion: In addition to the development and implementation of a comprehensive safety program, company management personnel should conduct (or appoint safety personnel to conduct) scheduled and unscheduled jobsite safety inspections on a regular basis to ensure that employees are following established safety procedures. Such inspections help demonstrate to workers that the company is committed to enforcing its safety policies and procedures.

REFERENCES

1. American Public Power Association, Safety Manual for an Electric Utility, Sections 502(a) and (b), 504(d), and 507(a), 1983.

2. Occupational Safety and Health Administration, 29 CFR 1926.954(a), and 29 CFR 1926.950(d)(c)(iii-iv), July 1990.

3. National Institute for Occupational Safety and Health, NIOSH Alert, Request for Assistance in Preventing Electrocutions by Undetected Feedback Electrical Energy Present in Powerlines, Publication Number 88-104, December, 1987.

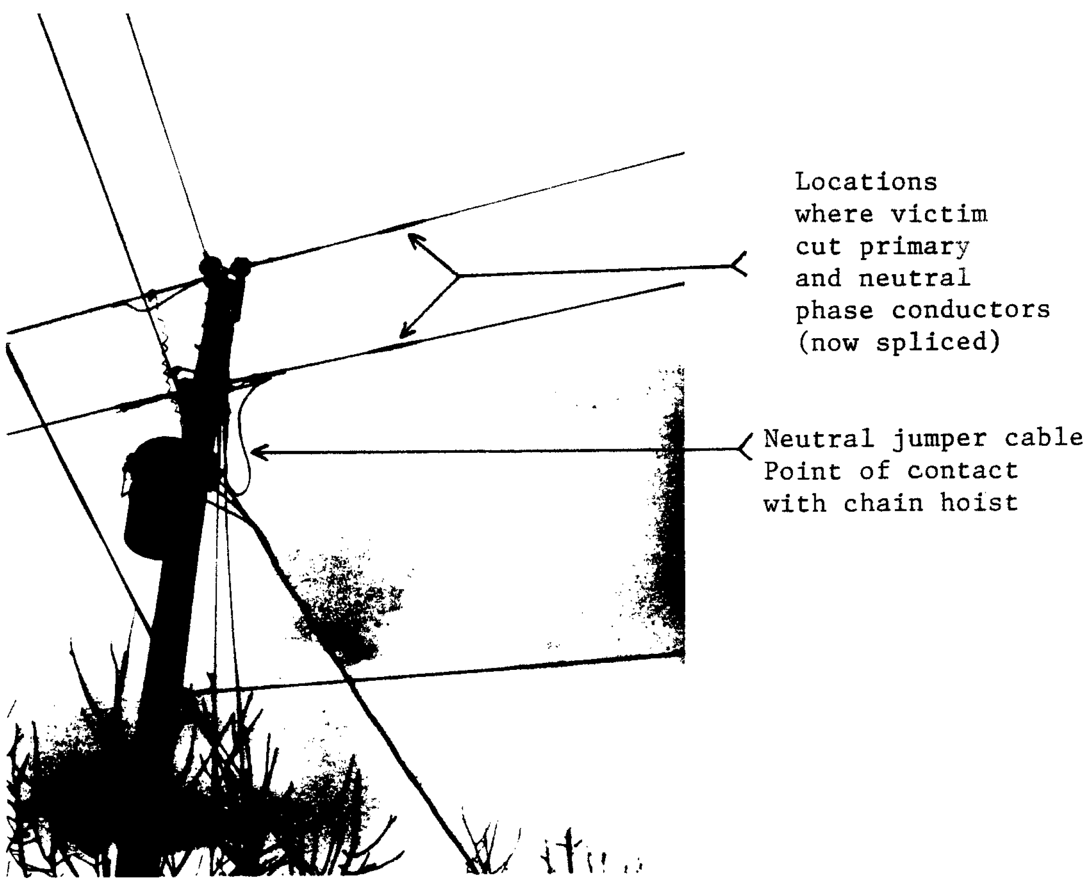

Figure 1.

FACE 91-20: **Lineman Trainee Electrocuted after Contacting an Energized Pickup Truck in South Carolina**

SUMMARY

A 21-year-old male lineman trainee (victim) was electrocuted after he contacted an energized pickup truck. The victim was part of a four-man crew assigned to convert a single-phase 7,200-volt overhead powerline to a three-phase 7,200-volt overhead powerline system, and remove the single-phase powerline. An aerial bucket truck was being used to provide access to the overhead powerlines, while a pickup truck was being used as a utility vehicle. At the time of the incident, the conversion had been completed and the crew was removing the de-energized single-phase powerline from the utility poles. The bucket truck crew, consisting of the foreman and victim, had cut the single-phase powerline and dropped one end to the ground without incident. When the other end of the powerline with attached come-along was dropped, it contacted the ground and the front of the pickup truck. The line recoiled when dropped causing it to contact an energized jumper wire on a utility pole one span away. This contact energized the single phase-powerline, which in turn energized the pickup truck. The victim, in an apparent attempt to move the pickup truck, jumped down from the bucket truck, removed his protective rubber glove from his right hand, and grasped the energized truck door handle. Contact with the handle provided a path to ground for the electrical current and the victim was electrocuted. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers and utility companies should:

- enforce compliance with established safe work procedures for covering or insulating all energized powerlines and jumper wires
- investigate alternative methods for lowering de-energized powerlines to ground level
- ensure that worksites are free of non-essential equipment
- retrofit utility/service vehicles used in the vicinity of energized powerlines with chassis/frame-energization alarm systems
- test, and instruct employees to inspect, personal protective equipment on a regular basis
- evaluate training programs to ensure that emergency situations and appropriate worker responses are addressed.

INTRODUCTION

On June 18, 1991, a 21-year-old male lineman trainee was electrocuted when he touched an energized pickup truck. On June 20, 1991, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On July 10, 1991, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with company representatives, company employees, and the OSHA compliance officer assigned to the case. Photographs of the incident site and equipment, and a copy of the corresponding medical examiner's report, were obtained.

The employer in this incident was an electrical contracting company that had been in operation for 46 years and employed 2,100 workers, including approximately 300 lineman trainees. The company had a written safety policy and written safety rules and procedures which were administered by the safety officer, company owners, and jobsite foremen. The safety department was comprised of a safety director, three safety supervisors, a safety training supervisor, equipment testing supervisor, and related clerical staff. Monthly safety meetings were held and documented, and the company promoted safety through the use of safety evaluations, communications, and incentive programs. The victim had worked for this employer for 19 months before this incident.

INVESTIGATION

The company had been contracted by an electric utility company to convert a single-phase 7,200-volt overhead distribution powerline to a three-phase 7,200-volt overhead distribution system, and to remove the single-phase powerline. Work had been completed on the conversion of the powerlines and the crew was in the process of removing the de-energized single-phase powerline from the utility poles.

On the day of the incident, a four-man crew consisting of a jobsite foreman, truck operator, lineman, and lineman trainee, arrived at the jobsite to remove the single-phase de-energized powerline from the utility poles. The single-phase de-energized powerline had been previously offset away from the energized powerlines by mounting an additional section of crossarm to the permanent crossarm on the utility pole, and attaching the de-energized powerline to an insulator on its end. Two of the crew members were working as a team, four spans away. The victim and jobsite foreman were working as a team at the incident site. An aerial bucket truck was being used to provide access to the overhead powerlines, while a pickup truck was being used as a utility vehicle. The trucks were parked close to the utility pole, and beneath the overhead powerlines (Figure).

The foreman, working from the elevated bucket, had cut the de-energized single-phase powerline and lowered both sections, still connected by a hand winch (come-along), to the victim standing on the back of the bucket truck. The foreman continued to maneuver the bucket into its resting position over the truck cab thus placing his back to the victim.

Apparently, the victim released the grip on the left side of the come-along and dropped the left section of the de-energized powerline to the ground. When the victim dropped the right section of powerline, including the come-along, they both contacted a winch attached to the front of the pickup truck and the ground. The powerline recoiled and contacted a bare jumper wire on the three phase system at a utility pole one span away. This contact energized the single-phase powerline, which in turn energized the pickup truck. The victim, positioned on the back of the bucket truck, possibly saw electrical arcing between the powerline and the ground, and/or saw grass burning around the powerline. The victim jumped down from the bucket truck in an apparent attempt to move the pickup truck away from the area. The victim removed a protective rubber glove from his right hand and grasped the door handle of the energized pickup truck. This contact provided a path to ground for the electrical current and the victim was electrocuted.

The foreman saw the victim fall to the ground, and immediately ran to him, suspecting he had been shocked. After realizing the victim was unconscious, he ran back to the bucket truck and radioed the electric utility company to call for an ambulance. The foreman then contacted the other crew members

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for additional assistance, and returned to the victim to initiate cardiopulmonary resuscitation (CPR). An ambulance arrived about 9 minutes after being contacted. Ambulance personnel continued CPR and transported the victim to the hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner's certificate listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should enforce compliance with established safe work procedures for covering or insulating energized powerlines and jumper wires.

Discussion: Safe job procedures covering the work being performed at the incident site were specific (i.e., all secondary transmission lines and jumper wires were to be covered with line hose). Although the secondary transmission lines were covered with line hose, the jumper wires were not. When the de-energized powerline was dropped, kinetic energy caused the de-energized powerline to recoil into contact with an energized jumper wire, which ultimately resulted in an electrocution. Employers should enforce compliance with established work procedures for covering or insulating energized powerlines and jumper wires through the periodic monitoring of worksites to evaluate field compliance with company safety rules and procedures. To be effective, a safety program must be enforced at the worksite. Regular company safety inspections show workers that the company is committed to enforcing its safety policies and procedures. Any violations of safety rules should be corrected immediately.

Recommendation #2: Employers should investigate alternative methods of lowering de-energized powerlines to the ground.

Discussion: The de-energized powerline was handed down to the victim standing on the back of the bucket truck; from that position the powerline was dropped to the ground. The uncontrolled release of kinetic energy caused the line to recoil unpredictably, and ultimately resulted in a fatality. Employers should consider alternative methods of lowering powerlines to the ground (e.g., possibly attaching non-conductive ropes to control the powerline and eliminate the risk of recoil caused by dropping the powerline from a height).

Recommendation #3: Employers should ensure that worksites are free of non-essential equipment.

Discussion: A utility pickup truck had been parked adjacent to the utility pole and bucket truck, and beneath the overhead powerlines. When the powerline was dropped from the bucket truck, the come-along and powerline contacted the winch attached to the front of the pickup truck. The victim may have seen the arcing between the powerline and ground, and without noticing the come-along and powerline contacting the winch, attempted to move the pickup truck. Employers should ensure that worksites are free of non-essential equipment (e.g., the utility pickup truck), that may interfere with the safe completion of tasks.

Recommendation #4: Employers should retrofit utility/service vehicles used in the vicinity of energized powerlines with chassis/frame-energization alarm systems, and provide periodic testing to ensure alarms are operational.

Discussion: When the energized powerline contacted the winch attached to the front of the pickup truck, the truck became energized and an electrocution resulted. Prior to the incident, the victim was on the back of the bucket truck, which was parked adjacent to, and partially in front of, the pickup truck. The position of the vehicles may have obstructed the victim's line of sight such that he could not see the powerline in contact with the winch. Vehicles should be equipped with alarm systems that warn workers when the frames of vehicles become energized. Such an alarm system would signal all employees that a vehicle is energized. Employers should ensure that workers understand the meaning of the alarm, and specific procedures they should follow to avoid contact with the vehicle, and correct the problem. Additionally, the alarm systems should be tested on a periodic basis.

Recommendation #5: Employers should test, and instruct employees to inspect, personal protective equipment on a regular basis.

Discussion: The victim was wearing insulated rubber gloves in accordance with the employer's safety program. Additionally, the victim was issued, and was wearing, insulated rubber overshoes as an added measure of safety. However, the overshoes were not required to be worn, nor were they tested for electrical integrity. When the overshoes were tested after the incident at the rubber goods testing laboratory, the left shoe was found to have three holes in the sole which allowed electrical current (50 milliamperes) to pass through to ground at 5,400-volts. It is not known, but when the victim removed his rubber glove to open the truck door, he may have relied on the rubber overshoes to protect him. Employers should periodically test all personal protective equipment provided to employees. Employees provided rubber overshoes as an added measure of protection should be instructed to routinely inspect for holes, cuts, tears, etc., and not to rely upon rubber overshoes for primary protection from electrical hazards.

Recommendation #6: Employers should evaluate training programs to ensure that workers know and practice appropriate responses to emergency situations.

Discussion: The energized powerline contacting the ground and pickup truck should have indicated to any employee that there was an emergency situation and that contacting the truck was unsafe and a dangerously inappropriate response. An appropriate countermeasure may have been to use a "hot stick" to remove the energized powerline from the pickup truck, rather than trying to move the pickup truck from the area. Employers should evaluate the training programs to ensure that workers know appropriate response measures to emergency situations, and are drilled to respond properly under simulated emergency conditions.

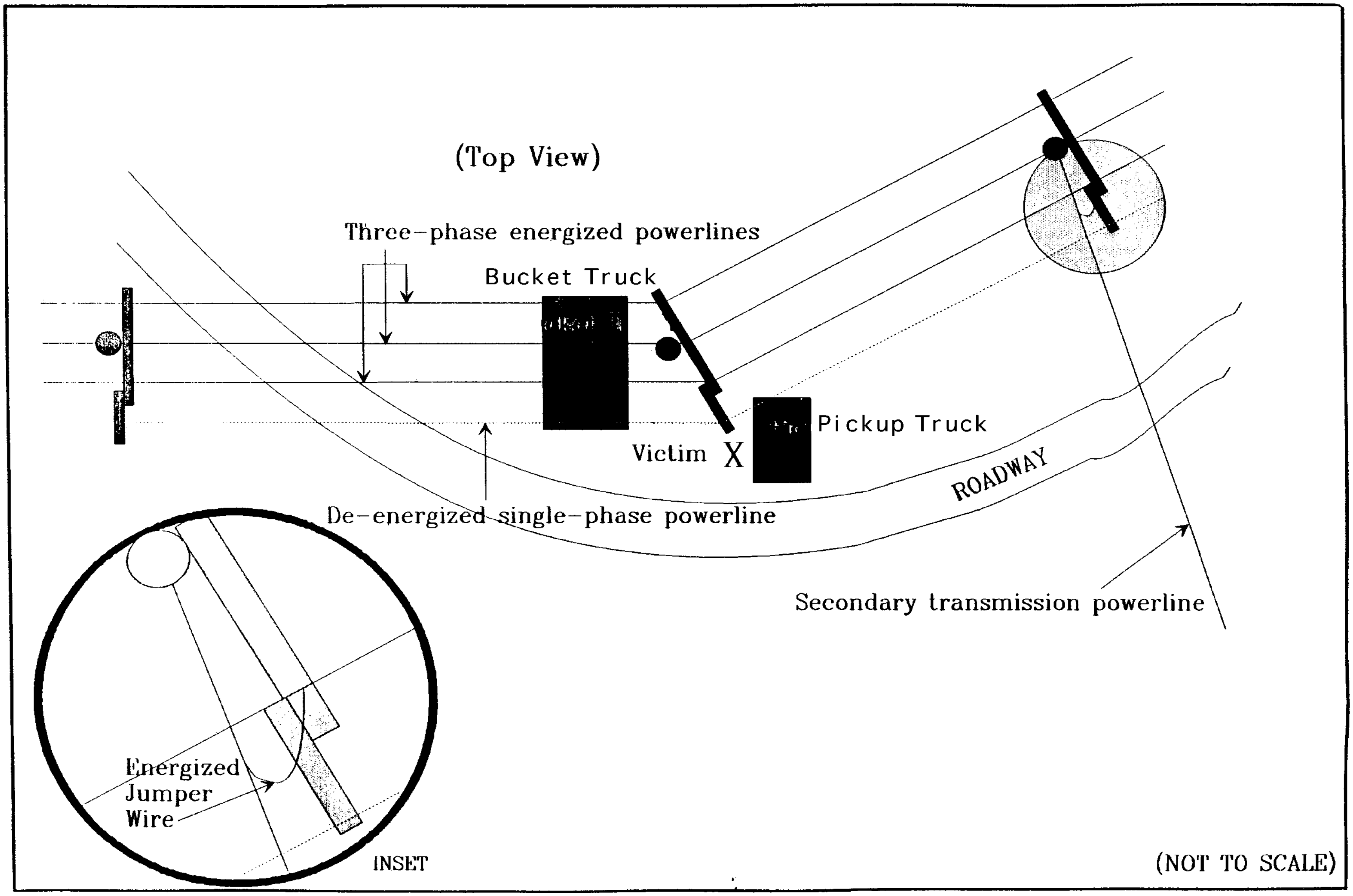

***Figure*.** *Conversion of Single-phase Powerline to Three-phase Powerlines*

FACE 91-21: Construction Laborer is Electrocuted When Crane Boom Contacts Overhead 7200-volt Powerline in Kentucky

SUMMARY

A 37-year-old construction laborer (victim) was electrocuted while pulling a wire rope load choker attached to a crane cable toward a load. The choker was to be connected to a steel roof joist which was to be lifted 150 feet across the roof of a one-story school and set in place. The cab of the crane was positioned 11 feet 6 inches from a three-phase 7200-volt powerline. After a previous roof joist had been moved, the crane operator swung the crane boom and cable back toward the victim. The victim grasped the choker in his left hand and with his right hand held onto a steel rod that had been driven into the ground nearby. At this point, the crane cable contacted the powerline and the electrical current passed across the victim's chest and through the steel rod to ground, causing his electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- comply with existing regulations pertaining to clearance distances between cranes and powerlines
- use a designated signal person when necessary
- evaluate a jobsite prior to the start of work to determine the safest areas for material storage, machinery placement during operations, and the size and type of machinery to be used
- contact the local electric utility when work is to be performed in proximity to overhead powerlines
- instruct employees to use non-conductive links, chokers, or taglines when working in proximity to overhead powerlines.

INTRODUCTION

On June 24, 1991, a 37-year-old construction laborer was electrocuted when the crane cable connected to the wire rope choker he was holding contacted a 7200-volt powerline. On July 25, 1991, officials of the Kentucky Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the death, and requested technical assistance. On July 31, 1991, a DSR safety specialist, safety engineer, and medical officer traveled to the incident site to conduct an investigation. The incident was reviewed with OSHA officials, employer representatives, and the county coroner's office. The autopsy report, medical records, and photographs of the incident site were obtained.

The employer in this incident was a crane rental service that also provided services in steel erection and demolition. The employer had been in business for 6 years and employed 15 workers. The company owner managed the safety function as a collateral duty. Meetings were conducted prior to the start of each project to discuss the safety considerations associated with that project. Additionally, monthly safety meetings for all employees were held at the company office and tailgate safety meetings were conducted at jobsites. Training was accomplished on-the-job. Company workers were aware of OSHA regulations regarding the clearance between cranes and powerlines.

INVESTIGATION

The company had been subcontracted to install steel roof joists and roof decking above the existing roof of a one-story school building. Steel columns to support the joists had been installed through the roof by another contractor. The new roof would raise the height of the one-story structure by 4 feet. The prime contractor's 50-ton conventional crane with a 190-foot-long boom and jib was used to lift the joists and set them in place. The company had a 50-ton hydraulic crane with a 150-foot-long boom at the site. The owner felt that the conventional crane, because of its greater lifting capacity, would be the safer machine to use for this particular job. The crane was positioned between the school and a three-phase, 7200-volt powerline--11 feet from the powerline (Figure). The distance between the school and the powerline was 58.5 feet. Two stacks of joists had been placed between the powerline and school, one 14 feet from the powerline, and the other 32 feet from the first stack and 12 feet from the school. The lengths of joists ran parallel to the powerline.

The day before the incident, the crew had begun to set the joists on the far side of the roof, approximately 150 feet away from the crane. The crew consisted of a crane operator, three laborers on the roof setting the joists, and one laborer on the ground (victim) connecting the joists to the crane. The crew set the joists the entire day without incident.

On the day of the incident, the crew began setting the joists on the side of the roof away from the crane. The crane operator lifted a joist from the stack nearest the school, swung it across the roof, and began to set it in place when the laborers noticed that it was the wrong length. The operator returned the joist to the stack nearest the school, where the victim unhooked it. The operator then swung the boom toward the stack of joists nearest the powerline. The victim grabbed the choker (a short length of wire rope with eyes spliced into either end; it was designed to be wrapped around a load, threaded through itself, and hooked to a crane hook) with his left hand and began to pull the choker and crane cable toward the stack of joists and away from the powerline. As the victim grabbed a steel rod that had been driven into the ground with his right hand (possibly to steady himself), the crane cable contacted the powerline 36 feet above the end of the choker. The electrical current passed down the cable, across the victim's chest, and down the steel rod to ground, causing the victim's electrocution.

A worker on the roof was certified in cardiopulmonary resuscitation (CPR) and initiated CPR within a minute. The emergency medical service was summoned, and transported the victim to the hospital, where he was pronounced dead on arrival. The body displayed burn marks consistent with death by electrocution.

During interviews immediately following the incident, the crane operator stated that he did not know how close the boom of the crane was to the powerline, since he was watching the ball at the end of the crane cable. The operator was maneuvering the ball so as not to hit the victim, who was 97 feet from the body of the crane. The cable's length from the end of the boom to the cable hook was 142 feet. It is assumed that counter forces on the cable--the boom swinging the cable in one direction and the victim pulling the cable in the opposite direction--caused the cable to whip into the powerline. Although the victim was standing 10 feet from the power pole, a scale drawing of the area demonstrates that with the crane positioned 11 feet from the powerline and its 190-foot boom positioned at a 70-degree angle with 142 feet of cable extended, the ball would be 10 feet from the power pole but only 5 to 7 feet from the powerline at 33 feet above ground level--the height of powerline.

CAUSE OF DEATH

The medical examiner ruled the cause of death as accidental electrocution with cardiorespiratory arrest.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that employees comply with existing regulations pertaining to clearance distances between cranes and powerlines.

Discussion: OSHA regulations 29 CFR 1926.550 (a)(15) and 1910.180 (j) require that the minimum clearance between electric lines rated 50 kV or below and any part of the crane or load shall be 10 feet, unless the electrical lines have been "de-energized and visibly grounded" at the point of work or physical contact between the lines, equipment, or machines is "prevented by the erection of insulating barriers which cannot be part of the crane."

Recommendation #2: Employers should designate a worker as a signal person if it is difficult for the crane operator to maintain clearance by visible means.

Discussion: OSHA regulation 29 CFR 1926.550 (a) (15) (IV) requires that a person be designated to observe clearance of the equipment and to give timely warning for "all" operations where it is difficult for the operator to maintain desired clearances by visual means. In this instance, the operator's attention was focused on the ball on the end of the crane and the victim 97 feet away, not the clearance between the crane boom and the powerline.

Recommendation #3: Employers should evaluate a jobsite prior to the start of any project involving the use of construction machinery, such as a crane, to identify the safest areas for the storage of materials, the placement of machinery during operations, and the type and size of machinery to be used.

Discussion: During the planning stages of a project, a comprehensive workplace assessment should be conducted by qualified professionals to identify the appropriate size and type of machinery, safest areas for material storage, and the proper position for machinery during operations. If the areas had been identified during the planning phases, it may have been possible to stack the steel roof joists on the opposite side of the school where the powerline hazard could have been eliminated. The joists could still have been lifted 150 feet across the top of the roof to the far side, but the powerline would have been 52 feet away. It might also have been possible to use a smaller crane on each side of the school to position the steel joists. The figure of the crane drawn to scale demonstrates that with the 190-foot-long boom of the crane at a 70-degree angle and 142 feet of cable extended, the ball and choker are 10 feet from the power pole at ground level but only 5 to 7 feet from the powerline at 33 feet above ground (height of powerline). In this instance, the crew may have believed that a 10-foot clearance was maintained. By evaluating the distance and height of the lift, given the crane boom angle and height, potential hazards associated with overhead powerlines can be identified and controlled.

Recommendation #4: Employers should contact the local electric utility when work is to be performed in proximity to overhead powerlines.

Discussion: When work is to be performed in close proximity to overhead powerlines, employers should contact the local electric utility to discuss the work that is to be performed and what safety measures, if any, need to be enacted. In this instance, covering the phase of the powerline nearest the crane with insulated line hoses would have reduced the severity of, and the exposure to, the electrical hazard.

Recommendation #5: Employers should instruct workers to use nonconductive links, chokers, and/or taglines when guiding or hooking loads near overhead powerlines.

Discussion: When cranes are scheduled for use in work areas where overhead powerlines are present, employers should consider installing nonconductive links between the lifting cable and the breaker ball/hook assembly. Nonconductive chokers wrapped around loads and connected to the hook assembly provide an additional measure of worker protection. Employers also should instruct workers that nonconductive taglines should be used when hooking or guiding loads near overhead powerlines. Dry polypropylene rope is an excellent material for use as a nonconductive tagline.

REFERENCES

29 CFR 1926.550 (a)(15) Code of Federal Regulations, Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

29 CFR 1910.180 (j) Code of Federal Regulations, Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

29 CFR 1926.550 (a)(15)(IV) Code Of Federal Regulations, Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

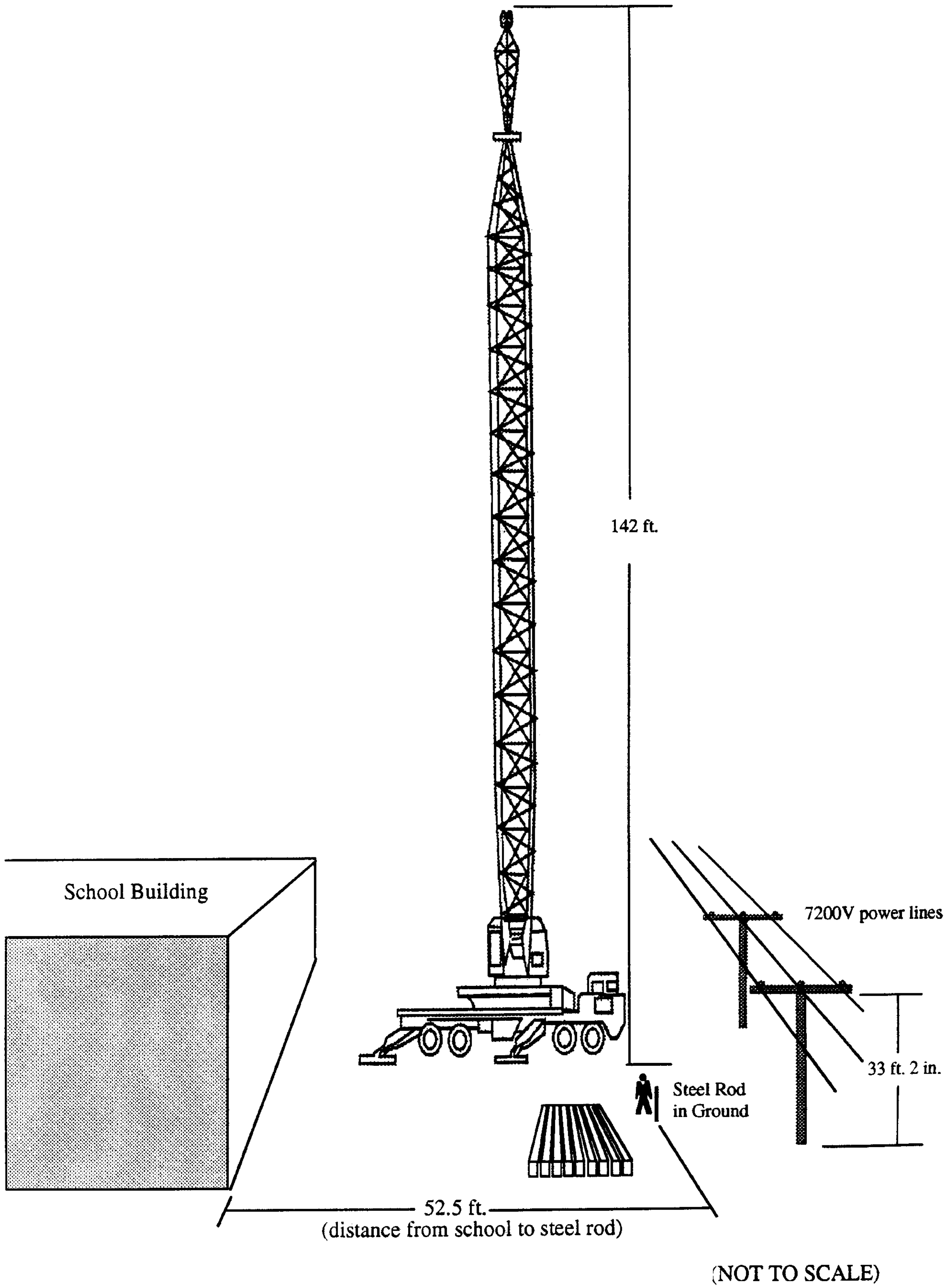

Figure. *Configuration of the Incident Site*

FACE 91-22: **Laborer Electrocuted Upon Contacting an Energized Conveyor in Kentucky**

SUMMARY

A 59-year-old male laborer (victim) was electrocuted while painting a section of support steel for a conveyor system that was being installed at an automotive parts assembly plant under construction. The victim and a co-worker were in separate single-man lifts, "touching-up" the steel with paint brushes. After lowering their lifts to get additional paint, the victim and co-worker discussed getting "minor" shocks from the conveyor. The co-worker assumed it was from nearby welders. Within minutes after the victim and co-worker resumed painting, the co-worker turned and saw the victim slumped in his lift. Once the victim was lowered to the ground by others in the area, co-workers immediately administered cardiopulmonary resuscitation (CPR). The victim was unresponsive. An emergency medical service (EMS) unit arrived within 10 minutes and transported the victim to the local hospital, where he was pronounced dead, 45 minutes after arrival. Co-workers at the scene indicated that shortly after the incident several pieces of equipment and materials were removed from the site. NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- conduct thorough investigations when workers report electrical "bites," "nips," or other descriptions of mild shock, and immediately implement appropriate corrective measures
- provide effective electrical grounding of all conductive assemblies and structures during the installation of conveyor systems and ensure that this provision is addressed during the planning and design phases of all projects
- provide thorough inspections of all electrically powered tools and equipment prior to, and periodically during, their use at the worksite
- provide ground-fault circuit interrupter (GFCI) protected power circuits for all electrically powered hand tools and equipment used on construction sites
- advise employees of the shock hazard associated with touching or contacting a suspected electrocution victim
- provide, as part of the emergency response program, an assurance that injury worksites remain as undisturbed as possible to facilitate a safe, prompt incident investigation.

INTRODUCTION

On May 31, 1991, a 59-year-old male laborer was electrocuted while painting a section of support steel for a conveyor system that was being installed at an automotive parts assembly plant under construction. Officials of the Kentucky Labor Cabinet, Division of Compliance (KYOSHA), notified the Division of Safety Research (DSR) of the fatality on July 25, 1991, and requested technical assistance. On July 29, 1991, a DSR Occupational Safety and Health Specialist, a safety engineer, and a medical officer conducted an investigation. The DSR investigators met with company officials, the coroner, and KYOSHA compliance officials. Since photographing the site was not permitted, a figure illustrating the site at the time of the incident was developed and is attached to this report.

Several subcontractors were actively installing structure and equipment inside the plant. There were 2 painters and more than 20 welders, working on the conveyor structure at the time of the incident. The company, which employed the victim, had no safety officer, but did have a brief, written safety program with job-specific safety and emergency response procedures. On-the-job safety training was provided to their employees. Toolbox meetings were routinely held on site to discuss job-specific safety practices. At the time of the electrocution, the victim was using fall protection. The victim had been employed by the company for 1½ months.

INVESTIGATION

The victim was painting a section of support steel during the construction of a 200,000-square-foot automated, conveyor-based assembly plant. The structural steel had already been erected, and fabrication work was partly completed on the assembly line conveyor. Welders continued the fabrication while painters worked alongside them, painting supports which were already in place.

At the time of the incident, the victim was painting from a battery-powered single-man lift. The batteries in the lift needed to be charged, so the lift was plugged into a receptacle through an extension cord, that did not have ground-fault circuit interruption (GFCI) capabilities. The 55-foot extension cord had the mechanical ground (third) prong removed, and had a poorly made splice 5 feet from the receptacle end. Two co-workers were in a scissors-lift, and a third co-worker was using a single-man lift within 20 feet of the victim. All were painting the same structure (Figure).

Two hours prior to the incident, the victim told the supervisor that he had been receiving shocks from the conveyor. The supervisor checked the "grounds on the welders" and both went back to work. The victim discussed the shocks with co-workers several times in the next hour, but they were dismissed as being "minor," and probably due to "the welders." About 1 hour after the last discussion (and several minutes prior to the incident), the victim and co-worker descended to obtain more paint and the victim again told his co-workers that he was receiving shocks; again they were dismissed as insignificant. After getting more paint, the victim and closest co-worker ascended (12 feet) in their lifts and continued painting.

At about 4:40 p.m., the victim's son, a welder on the job, was asked by his co-worker if "something was wrong with his dad." The victim was slumped in his lift 12 feet in the air. The son immediately ran to the lift and climbed to his father. When he touched the victim, he received a pronounced shock; when he pulled the victim away from the conveyor support, the shock abated. Since the victim was tied-off to the conveyor rail, he disconnected the safety belt, lowered the victim to floor level, and removed him from the lift.

A co-worker initiated CPR and an emergency medical service (EMS) unit was summoned. The job superintendent ushered the son away from the site and into a nearby office. The EMS unit arrived in about 12 minutes and took the victim to a local hospital. After 45 minutes in the emergency room, he was pronounced dead by the attending physician.

Co-workers at the scene indicated that shortly after the incident several pieces of equipment and materials were removed from the site.

In order to determine the source of the electrical energy, the coroner had an electrician test the lift at the incident site. With the lift properly plugged into a grounded receptacle, the electrician read approximately 55 volts between the lift's frame and the receptacle's mechanical ground. No voltage was measured between the conveyor rail and the mechanical ground with an employee welding on the conveyor.

Later, a manufacturer's representative of the lift company, and a consulting engineer from the University of Kentucky came to perform comprehensive checks on the lift. NIOSH investigators also conducted tests on the lift. A thorough visual inspection revealed two areas on the outriggers that looked as though there had been electrical arcing to them. Neither the consulting engineer nor the NIOSH investigators found the lift frame to be energized when it was plugged into a receptacle. The mechanical ground of the line cord was connected to the frame of the battery charger, but *not* to the frame of the lift. Since the lift was electrically isolated from the battery charger, it would not have been energized even if improperly plugged into a receptacle.

NIOSH investigators conducted a visual and electrical inspection of the receptacle after it had been removed from the plant by the coroner's electrician. A portion of the receptacle face was burned adjacent to the neutral pole. It was not known when this occurred.

NIOSH investigators also conducted a visual and electrical inspection of the extension cord thought to be used with the lift at the time of the incident. (It was uncertain which cord was the one actually being used.) The 55-foot, 3-wire cord was in generally good condition along its length. The mechanical ground prong on the plug had been removed which defeated the grounding capabilities of the cord. Reversal of the hot and neutral poles of the cord's receptacles was possible by reversing the placement of the cord's plug in a receptacle. There were no low resistance paths measured between any pole at the receptacle end of the cord, and any damaged area along the cord's insulation. This indicated that an arc from the cord to a grounded object was very unlikely. Approximately 5 feet from the receptacle end was a 3-wire splice. In addition to being poorly made, the mechanical ground portion of the splice had been subsequently crushed and the bare wires exposed. The hot and neutral portions had bare wire exposed also, but the splice caps were still in place. The receptacle, extension cord and lift had all been removed from the site and tested by others before DSR personnel arrived.

NIOSH investigators concluded that the secondary source of electrical energy causing the fatality was the conveyor. (The conveyor is considered a secondary source in this case because it acted only as a conductive path for the primary source; the defective device which energized it.) No conclusive evidence was found to indicate that the receptacle, extension cord, or lift acted as a source of electrical energy in the electrocution of the laborer. Statements of the co-workers, burns on the victim's hand, and test results substantiated this conclusion. The primary source of electrical energy which energized the conveyor could not be determined. It should be noted, however, that several welding machines, grinders, and other electrical tools were being used on or near the conveyor at the time of the incident. None of this equipment was available for testing by the NIOSH investigators.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct thorough investigations when workers report electrical "bites," "nips," or other descriptions of mild shock, and immediately implement appropriate corrective measures.

Discussion: Any electrical shock, no matter how slight, indicates an unsafe work condition requiring immediate attention. The victim and co-workers reported receiving electrical shocks while painting on several occasions earlier in the day. No corrective action was taken to eliminate the shocks, and work continued. If causal factors cannot be immediately identified, or corrective measures immediately implemented, operations at the work area should be suspended until such factors are identified and corrected. When arc welders are being used in the area, as in this case, their proper operation and maintenance should be carefully addressed (3).

Recommendation #2: Employers should provide effective electrical grounding of all conductive assemblies and structures during the installation of a system, and ensure this provision is addressed during the planning and design phases of all projects.

Discussion: Although not always required, this is consistent with the employee protection requirements for work on power transmission lines (5). Conductive structures, such as the conveyor, will be difficult to energize when properly grounded. Although this strategy will not eliminate all shock hazards, when used in conjunction with ground-fault protection, it provides a very effective intervention that will reduce the risk of electrical injury.

Recommendation #3: Employers should provide a thorough inspection of all electrically powered tools and equipment prior to, and periodically during, their use at the worksite.

Discussion: Anytime employees indicate receiving "bites," "nips," or other indications of mild shock, the actions discussed in recommendation #1 should be taken immediately. Often the problem can be an electrically powered tool or extension cord. Scheduling periodic tool inspections (1) is an effective preventive measure that will identify such problems before a tool causes an injury or work suspension. Double-insulated or properly grounded hand-tools are recommended (2) for use. When splice caps (or wire nuts) are used, they should be applied as specified by the manufacturer (8).

Recommendation #4: Employers should provide ground-fault circuit interrupter protected power circuits for all electrically powered hand-tools and equipment used on construction sites.

Discussion: Although an "assured equipment grounding conductor program" is permissible by OSHA requirements (4), it is often very difficult to administer and requires significant record keeping. Ground-fault circuit interrupters (GFCI) are readily available for use in the construction industry in various configurations. Initial costs of GFCI protection will be returned through the savings in time needed for record keeping and administration of the assured grounding program. Descriptions of operation, and general applications of GFCI units are readily available (6,7).

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Recommendation #5: Employers should advise employees of the shock hazard when contacting a suspected electrocution victim.

Discussion: The first co-worker to contact the victim received a pronounced shock that caused him to "jump back." In doing so, he could have received a fatal shock himself, or an injury sustained from a subsequent fall. Employers should alert employees to this hazard through their emergency response program, or other written safety guidelines. All power sources suspected of contributing to electrical shock should be de-energized before any contact with the victim is made. If this is not possible, appropriate personal protective equipment should be used.

Recommendation #6: Employers should provide, as part of the emergency response program, an assurance that injury worksites remain as undisturbed as possible to facilitate a safe, prompt, and comprehensive incident investigation.

Discussion: The only changes made to a worksite after an injury should be those which are absolutely essential for the safe rescue and treatment of victims. Coroners generally have the authority to restrict access to a site when such an incident occurs, and they should exercise this authority to enable a thorough investigation. Inspection of the site and witness testimony indicated that materials and equipment were immediately removed from the area. This made an objective, comprehensive assessment of the incident causal factors very difficult. Changes to the incident worksite can prohibit the identification of causal factors and effective interventions.

REFERENCES

1. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.20 (b), p. 19. July 1, 1990.

2. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.302 (a), p. 132. July 1, 1990.

3. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.351 (a), (b), (c), & (d), p. 137-8. July 1, 1990.

4. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.404 (a) & (b), p. 145-6. July 1, 1990.

5. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.954 (e) & (f), p. 315. July 1, 1990.

6. Accident Prevention Manual for Industrial Operations, Laing, P. M., edit., 9th ed, R. R. Donnelly & Sons, 1988, p. 381-384.

7. International Association of Electrical Inspectors News, International Association of Electrical Inspectors, vol. 63, no. 5, p. 29-33, September/October 1991.

8. American Electricians Handbook, W. Summers ed., 10th ed., p. 2-121, par. 189, McGraw-Hill, New York, 1981.

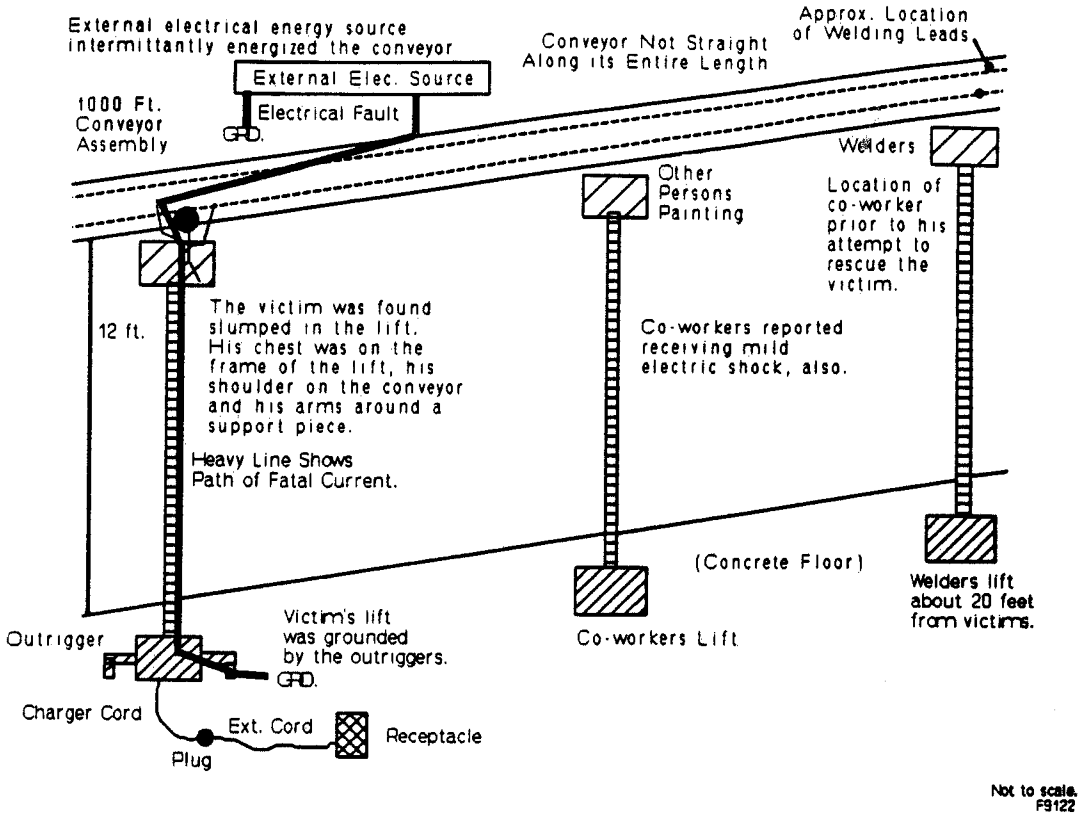

***Figure**. Conveyor Assembly, Lifts, and Worker Locations*

FACE 91-25: **Electrical Lineman Electrocuted After Contacting Energized Trailer-Mounted Line Tensioner in South Carolina**

SUMMARY

A 27-year-old male electrical lineman (victim) was electrocuted when he contacted an energized trailer-mounted line tensioner. The victim was a member on a crew that was stringing new conductors to replace an existing three-phase, 14,200-volt powerline. The existing energized conductors had been repositioned and attached to insulators on extensions bolted to the power pole crossarms. The crew had been pulling a new conductor through rollers attached to the same crossarm on three consecutive power poles, a span of 300 feet. A 4-foot clearance existed between the new conductor and any of the existing conductors. At the time of the incident, the victim and a co-worker (groundman) had been working at a trailer-mounted line tensioner. The new conductor was being pulled in a straight line from the tensioner by a pulling rig located immediately behind the farthest power pole. Because of either improper tension on the new conductor or a failure of the tensioner's braking system, the conductor began to pull from the tensioner in a jerking motion. This motion caused the conductor strung through the rollers to sway back and forth and contact one of the existing phases. Current traveled back through the conductor, energizing the tensioner and fatally shocking the victim, who was in contact with the tensioner. NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- perform a hazard analysis of each project prior to initiating work, and communicate hazard information and control measures during work crew safety meetings

- ensure that all workers comply with established safe work procedures that apply to the use of personal protective equipment

- evaluate the feasibility of incorporating electrical isolation into the design of trailer-mounted line tensioners.

INTRODUCTION

On August 5, 1991, a 27-year-old electrical lineman was electrocuted when he contacted an energized trailer-mounted line tensioner. On August 6, 1991, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On August 22, 1991, a DSR safety specialist traveled to the incident site to conduct an investigation. The incident was reviewed with company representatives, the county sheriff and coroner, and the OSHA compliance officer. Photographs of the incident site were obtained during the investigation.

The employer in this instance was an electrical contractor that specialized in powerline construction. The company had been in operation for 56 years and employed 300 workers, including 150 linemen. The company had a safety director, safety program, safety policy, and written safe work procedures. Training was accomplished on the job.

INVESTIGATION

The employer had an ongoing contract with a local electric utility for powerline construction and maintenance. At the time of the incident one crew was stringing new conductors to replace conductors for a three-phase, 14,200-volt powerline. The crew consisted of a lineman (victim) and three groundmen.

The crew had previously bolted wooden extensions to each end of the crossarms at the top of the three power poles in the 300-foot-long straight span (100 feet between power poles) that they were going to string on the day of the incident. The energized conductors were repositioned on insulators on the extensions (two conductors on one, one on the other extension). Rollers were installed at the center point of each of the three crossarms. The energized conductors were positioned so that there would be a 4-foot clearance on either side of the new conductor as it passed through the rollers.

At the time of the incident, the victim and a co-worker were working at a grounded, trailer-mounted line tensioner. The first new conductor was being pulled from the tensioner by a pulling rig at the other end of the run. Unexpectedly, the new conductor began to pull from the tensioner in a jerking motion. (It could not be determined if the braking system on the tensioner malfunctioned or if it was improperly set--the tensioner had been completely rebuilt since the incident.) This action caused the new conductor to sway and contact an energized conductor. The exact point of contact could not be determined. The electric current passed through the trailer's grounding system to ground. The victim, in contact with the trailer, also provided a path to ground and was electrocuted. The co-worker was standing a few feet from the trailer, and felt a tingling in his feet but was not injured. Neither man was wearing linemen's gloves or rubber overshoes as required by the company. The co-worker immediately initiated cardiopulmonary resuscitation (CPR) and continued CPR until the emergency medical service (EMS) arrived. The EMS transported the victim to a local hospital where he was pronounced dead by the attending physician.

CAUSE OF DEATH

The coroner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should perform a hazard analysis of each project prior to initiating work, and communicate hazard information and control measures during work crew safety meetings.

Discussion: Each project differs in the scope of work to be accomplished, the makeup of the work crews, the physical layout of the jobsite, and the equipment used to perform the work. This uniqueness creates differing situations for exposure to job hazards. Therefore, the hazards associated with each work effort must be analyzed so that appropriate control measures can be developed and implemented. A serious safety hazard which existed at this jobsite, the potential that the new conductor would contact an existing energized conductor, was not recognized and, therefore, not controlled. The fact that energized conductors were present on both sides of the new conductor increased the hazard potential. This factor should have been identified prior to the initiation of work. Corrective measures to prevent the hazardous contact might then have been adopted and communicated to the crew.

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Recommendation #2: Employers should ensure that all workers comply with established safe work procedures that apply to the use of personal protective equipment (PPE).

Discussion: In this instance, neither the victim nor the co-worker were wearing linemen's gloves or rubber overshoes as required by the company's written safety rules. Compliance might be improved if qualified safety professionals conducted scheduled and unscheduled safety inspections. These safety inspections would not guarantee compliance, but would demonstrate the company's dedication to the prevention of occupational injury.

Recommendation #3: Employers should evaluate the feasibility of incorporating electrical isolation into the design of trailer-mounted line tensioners.

Discussion: In this incident, the new conductor made contact with conductive parts of the trailer as it exited the spool. This allowed the trailer to become energized when the new conductor contacted an energized conductor. If the new conductor and spool were electrically isolated from the body of the tensioner, inadvertent energization of the trailer would be less likely, thereby enhancing worker safety.

FACE 91-28: Textile Worker (Fixer) Electrocuted When He Contacts an Energized Conductor in South Carolina

SUMMARY

A 44-year-old fixer (the victim) was electrocuted at a textile plant when he contacted an energized electrical conductor inside the 550-volt control box of a carding machine. The victim and a co-worker arrived at the plant 1 hour prior to the midnight-to-8:00 a.m. shift, to start the 42 carding machines. The victim proceeded down the line of machines, pushing the start buttons. Forty of the machines started and two did not. On his second round to check the machines, the victim restarted one machine; the remaining machine's control box had overheated for undetermined reasons, prohibiting the machine from being restarted. The victim positioned himself in front of the control box then opened the door. He held one end of a screwdriver against the reset button with his right hand, while the other end of the screwdriver rested against his abdomen. The victim held the metal nozzle of an air hose with his left hand and directed a stream of air into the control box. At some point the metal nozzle contacted an energized conductor inside the control box. Current passed through the nozzle and victim's left hand exiting through the victim's abdomen and screwdriver to ground, electrocuting the victim. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- perform periodic inspections of plant electrical systems, and initiate a procedure for correcting all identified hazardous conditions

- evaluate their current safety program and incorporate specific procedures and training designed to enable workers to recognize and avoid hazards, especially electrical hazards (e.g., exposed energized conductors)

- inspect handtools on a regular basis.

INTRODUCTION

On August 4, 1991, a 44-year-old male fixer was electrocuted when he contacted an energized conductor in a carding machine control box. On August 6, 1991, officials of the South Carolina Occupational Safety and Health Administration (OSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On September 18, 1991, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with the company's personnel manager, industrial relations manager, one of the plant electricians, and the OSHA compliance officer assigned to the case. The investigator visited and photographed the incident site, and discussed the medical examiner's report with the medical examiner.

The employer in this incident was a textile manufacturer that had been in operation for 29 years. The company operated 27 textile factories; 506 employees/workers were employed at this plant, of whom 99 were fixers. A fixer performs mechanical maintenance tasks. The company had a written safety program with written safety procedures that were administered by the plant engineer and personnel manager. On-the-job training was provided to the employees, and drug screening was required of all new employees. The victim had worked for this employer for 12 years, 5 years as a fixer.

INVESTIGATION

On the day of the incident, a two-man crew, consisting of a fixer (the victim) and a machine operator trainee, arrived at the plant 1 hour before the start of the production shift (midnight to 8:00 a.m.) to start the carding machines. Forty-two carding machines (fiber preparation machines that smooth, flatten, and direct fiber into a coil), were normally started about 1 hour prior to the beginning of the shift in order to maximize production.

The fixer travelled down the line of machines, pushing the start buttons. Forty of the machines started on the first try and two did not. The victim made a second trip around the machines and started one of the two idle machines. The victim determined that the 550-volt control box on the remaining idle machine was overheating and would not allow it to start. He opened the unlocked control box door. The handle that opened the door served as an interlock switch to de-energize the line (incoming power) side of the control box. However, the handle was broken inside the box, and the line side of the box remained energized with the door open. The victim obtained a screwdriver, and an air hose equipped with a metal nozzle. The screwdriver had been previously damaged-the shaft had been pushed through the handle and rounded off-which allowed it to conduct electricity through the handle. The victim held the screwdriver in his right hand, positioned the handle against his abdomen, and pushed in the reset button with the tip. With his left hand, the victim positioned the metal nozzle inside the control box to direct the flow of air toward the reset button, presumably attempting to reduce the control box temperature. At some point the nozzle apparently contacted an energized conductor which allowed current to flow through the victim's body to ground.

The victim's co-worker ran to the plant's designated smoking area, where several employees were waiting to begin their shift, and summoned help. A card machine operator rushed to the victim and began cardiopulmonary resuscitation (CPR), while another employee called the emergency medical service (EMS). The EMS arrived in about 10 minutes, continued CPR, and transported the victim to the local hospital emergency room. The victim was pronounced dead about 70 minutes after the incident. The medical examiner's report identified three burn marks across the upper abdomen as exit marks of the electrical current. These burn marks correspond to the area where the handle of the screwdriver contacted the victim's body.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as cardiac arrest due to electrical shock.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should perform periodic inspections of plant electrical systems, and institute a procedure for correcting all identified hazardous conditions.

Discussion: Electrical interlock switches are safety features incorporated into the design of electrical systems. These switches are designed to interrupt electrical power on the line side when the door of a control box, breaker panel, etc. is opened. This allows maintenance or repair to be performed on deenergized electrical components. Because this switch was broken and inoperable, electrical components within the overheated control box remained energized with the door open, exposing the victim to an electrical hazard. Employers should ensure that routine periodic inspections of a plant's electrical system are conducted by qualified persons. If damaged or overheating components of the electrical system are identified, they should be immediately repaired, replaced, or removed from service. A routine inspection would have identified the inoperable interlock switch. Additionally, the unlocked control box which allowed access to any employee, could have been secured with a lock, and the key retained by designated personnel authorized to access the control box.

Recommendation #2: Employers should evaluate their current safety program and incorporate specific procedures and training designed to enable workers to recognize and avoid hazards, especially electrical hazards (e.g., exposed energized conductors).

Discussion: OSHA standard 29 CFR 1926.21(b)(2)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures. Evidence suggests that the victim did not realize the hazard created by the inoperable interlock switch by introducing the metal nozzle into the control box which contained exposed 550-volt conductors. The safety program should be evaluated and specific procedures (i.e., a job safety analysis, which is an analysis of the basic tasks performed by a person in a specific job category) and applicable training designed to recognize and avoid hazards should be incorporated.

Recommendation #3: Employers should inspect handtools on a regular basis.

Discussion: Employers should require that employees visually inspect handtools on a daily basis. Damaged tools, such as the screwdriver in this incident, should be replaced.

REFERENCES

1. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 294. July 1, 1989.

FACE 91-29: **Crew Foreman Electrocuted When He Contacts Energized Conductor in South Carolina**

SUMMARY

A 27-year-old crew foreman was electrocuted when he contacted an energized conductor on a utility pole. The foreman was part of a three man crew stringing new television cable in a residential section of the city. Prior to the incident, the foreman attached one end of a polyethylene rope to the cable wire. A weight was attached to the other end of the rope. The rope was then supposed to be thrown over the existing cable wire which was attached between the utility poles. When the rope was thrown, it became tangled in the overhead powerlines above the existing cable wire. The foreman instructed the lineman to retrieve the wire, but the lineman refused to do so. The foreman then donned a pair of linemen's climbers and, without using a safety belt and lineman's strap or lanyard, ascended the utility pole to a position above the transformer, approximately 25 feet above ground level. At this time, the co-workers had their backs turned to the victim when they heard an electrical arcing noise. The victim apparently touched an energized conductor (e.g., jumper wire, fuse, fuse holder, powerline, etc.,) and fell to the ground. In that neither co-worker had CPR training, potentially critical CPR care could not be immediately administered to the victim. NIOSH investigators concluded that in order to prevent future similar occurrences, employers should:

- evaluate existing safety programs and incorporate specific procedures, including worker training, related to recognition and avoidance of hazards, especially electrical hazards

- train employees in the proper use of safety and personal protective equipment, and ensure its use where appropriate

- consider, evaluate, and adopt alternate methods for positioning guide ropes between wires

- train employees in cardiopulmonary resuscitation (CPR) procedures.

INTRODUCTION

On August 27, 1991, a 27-year-old male crew foreman was electrocuted when he contacted an energized conductor on a utility pole. On September 6, 1991, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On September 18, 1991, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with a company representative and the SCOSHA compliance officer assigned to the case. Photographs of the incident site were taken, and the coroner's report and witnesses' statements were obtained during the investigation.

The employer in this incident was a cable installation company that had been in operation for about 4 years. The company employed 22 workers, including 5 crew foremen. The company had a written safety program and written safety procedures. The field supervisor and crew foreman were responsible for administration of the safety program. On-the-job training was provided to the employees, and employee safety meetings were held monthly. The incident occurred on the victim's first day at work.

INVESTIGATION

The company was working as a subcontractor for a major cable television (CATV) installer on a production-oriented basis installing cable television wire as part of a 2,500 mile up-graded cable system. The company had six three-man crews working throughout the city. The project had been in progress for 3½ months prior to the incident.

On the day of the incident, a three-man crew consisting of a crew foreman (the victim), a lineman, and a groundsman (all hired a day before the incident) arrived at the worksite to continue lashing new CATV wire (i.e., ½ inch, 75 ohm, coaxial wire) around the existing CATV wire. The existing CATV wire was attached to utility poles approximately 4 feet below the existing electrical system ground wire.

Prior to the incident, the crew pulled enough CATV wire from the spool to reach across two spans of utility poles. The foreman then connected a 3/8-inch polyethylene rope to one end of the CATV wire, while a weight was connected to the other end of the rope. The foreman tried to throw the rope between the ground wire and existing CATV wire, but instead the rope landed around the overhead powerlines above the transformer. The foreman then requested the lineman to retrieve the rope, but the lineman refused, stating it was too dangerous. The foreman then donned a pair of linemen's climbers and, without using a safety belt and lineman's strap or lanyard, ascended the utility pole to a position above the transformer about 25 feet above ground level. Although no one witnessed the incident, it is apparent that the victim came into contact with an energized conductor and fell to the ground. The coroners report stated the body had electrical burns on the extremities and upper torso, but did not indicate whether the burns were entrance or exit wounds.

The victim's co-workers ran to a nearby house and requested an ambulance be called. In the interim, another resident, a nurse, saw the commotion and ran to the incident site to offer assistance. The nurse provided cardiopulmonary resuscitation (CPR) until the arrival of the ambulance. The victim was transported to a local hospital where he was pronounced dead 1½ hours after the incident.

CAUSE OF DEATH

The coroner's report listed the cause of death as cardiac arrest due to electrical shock.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should evaluate current safety programs and incorporate specific procedures related to recognition and avoidance of hazards, especially electrical hazards.

Discussion: The crew, including the victim, was hired the day before the incident. Although the victim was supposed to have been experienced in this field of work, no documentation, other than verbal, was provided to ensure the crew's competency. The crew was then sent to a worksite to perform duties where potential life-threatening hazards such as the overhead powerlines existed. No safety training was provided by their employer. OSHA standard 1926.21(b)(2)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures and perform assigned tasks safely. This training is needed to ensure that employees understand the hazards and corrective actions that can be taken to control or eliminate the hazards. The safety program should be evaluated and specific procedures designed to assure that all new employees are able to recognize and avoid hazards.

Recommendation #2: Employers should ensure employees are trained in the proper use of safety and personal protective equipment, and ensure its use where appropriate.

Discussion: After the rope was thrown into the powerlines, the victim climbed the utility pole and was eventually electrocuted. Five sections of "hot stick" (24 feet), were available to the crew in a utility truck 100 feet away. Although the safety procedures specify the use of a "hot stick" to remove objects from powerlines, the procedure was ignored. Since this was the first day on the job for the victim, it is possible that he was not totally familiar with the company's safe work procedures. Also, the victim climbed approximately 25 feet up the utility pole using only climbers, a safety belt and lineman strap or lanyard were not used. When the victim contacted the energized conductor he fell 25-feet to the ground striking his head on a cement block. If the victim would have survived the electrical contact, he may have died from the fall.

Recommendation #3: Employers should consider, evaluate, and adopt alternate methods for positioning guide ropes between wires, especially when any of the wires may be energized and uninsulated.

Discussion: The rope was supposed to have been thrown between an existing cable television wire and an electrical system ground wire. Instead, the rope was thrown onto the powerline. Two alternate methods which exist and should be considered for positioning the rope between the wires are: (1) the use of a "hot stick" to position the rope, or (2) a worker using fall protection and climbing the pole to position the rope. Either method is a safer alternative.

Recommendation #4: Employees who work around powerlines, electrical circuits, and electrical equipment should be trained in cardiopulmonary resuscitation (CPR).

Discussion: To optimize results, CPR should begin within four minutes (in accordance with American Heart Association guidelines). To meet this criteria, workers should be trained to support circulation and ventilation until trained medical personnel arrive. Because neither co-worker was trained in CPR, potentially critical care could not be provided in a timely manner. Employees working on or in proximity to powerlines, electrical circuits, and electrical equipment should be trained in CPR.

REFERENCE

1. Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 20. July 1, 1990.

FACE 91-32: Technician Electrocuted While Performing Maintenance on a Walk-in Cooler in Virginia

SUMMARY

A 33-year-old male (victim), employed as a heating, ventilating, air-conditioning, and refrigeration (HVACR) technician, was electrocuted while performing refrigeration maintenance on a walk-in cooler at a restaurant. The flexible metal conduit housing the power conductors to the refrigeration unit (RU) of the cooler had been designed to serve as the mechanical ground. The insulation on one of the three power conductors in the flexible conduit was damaged and allowed electrical arcing to a conduit connector on the RU starter box (Figure). The conduit connection to the RU starter box (from the RU) was loose, and effectively disconnected the mechanical ground from the RU. As the victim was servicing the RU, the temperature in the walk-in cooler must have caused the thermostat to close the starter, energizing the surfaces of the RU, and fatally shocking the technician when he touched it. NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- require that all electrical equipment be de-energized before any electrical repairs are performed
- provide a mechanical grounding conductor as part of the power feed to an appliance whenever possible
- provide ground-fault protection as part of the power feed to an appliance whenever possible
- provide employees with education and training in the recognition, avoidance, and prevention of unsafe work conditions.

INTRODUCTION

On August 20, 1991, a 33-year-old male HVACR technician was electrocuted while performing maintenance on a walk-in cooler. On September 3, 1991, officials of the Virginia Department of Labor and Industries (VAOSHA) notified the Division of Safety Research (DSR) of the fatality, and requested technical assistance. A DSR safety engineer traveled to the area to conduct an investigation, on September 24, 1991. The incident was reviewed with company representatives, the VAOSHA compliance officer, the city electrical inspector, and the rescue team. Incident reports from VAOSHA, the city electrical inspector, and the local police were obtained. Photographs taken of the incident site immediately following the fatality were obtained from local sources.

The employer provided various HVACR maintenance services for commercial and industrial equipment. The company had been in operation for 30 years and employed 14 workers, including 4 refrigeration technicians. The company did not have a safety officer, but did have general written safety procedures. To qualify for employment, employees were required to have formal training in their specific discipline prior to hiring. It was assumed that safety training was received as part of the technical training. (In this case, the employee had an Associate's degree as an HVACR technician.) No weekly or lunch box safety meetings were held. This was the first fatality for the employer.

INVESTIGATION

The victim was one of four HVACR technicians assigned work orders to repair various pieces of HVACR equipment. On the day of the incident, the company received a 9:30 a.m. call from a local restaurant to repair a walk-in cooler. A restaurant representative met with the victim at 11:00 a.m. to discuss the problem. The victim then placed his vacuum pump, extension cord, and tools on top of the 7½-foot-high by 12-foot-wide, and 8-foot-deep cooler. After doing some preliminary work, he partially connected his vacuum pump lines to the refrigerant system without de-energizing the RU. At about 1:15 p.m. the restaurant representative decided to check the progress of the work. When he arrived at the cooler, he saw the victim lying on the roof, and began calling to him. Getting no response from the victim, he summoned the local emergency medical service (EMS). The EMS responded in less than 3 minutes. Once at the site, the paramedic demanded the power be disconnected from the cooler before he would approach the victim. Death was apparent, given the condition of the victim, and no emergency treatment was administered. The victim was pronounced dead at the site, and later taken to a local morgue for autopsy.

At about 2:15 p.m., the EMS personnel called a city electrical inspector to the site. By 3:05 p.m., two electrical inspectors had arrived. They observed that the RU starter had electrical burns where the 3-phase, 208-volt AC power conductors left the starter box via the conduit. One of the phase conductors had its insulation damaged and was arcing to the flexible conduit connector on the starter box. Further inspection revealed a discontinuous mechanical ground between the starter and the RU. A *separate* grounding conductor was not run from the starter box to the RU because the flexible conduit was a functional ground. The connection between the flexible conduit and the conduit connector had loosened enough to disrupt the grounding continuity between the starter box and the RU. Since the cooler was still connected to a power source, the starter must have closed and energized the frame of the RU. At some point, the technician touched the RU and completed a path to ground for electrical fault current.

CAUSE OF DEATH

The medical examiner ruled that a cardiac arrest due to electrical shock (electrocution) was the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should require that all electrical equipment be de-energized before any electrical repairs are performed.

Discussion: Before performing maintenance on electrical equipment, the unit should be de-energized. If the cooler had been de-energized, it would not have started before the technician was ready. When troubleshooting requires equipment to be energized for diagnostic tests, the employee should be electrically isolated or insulated from it. In this case, leaving the cooler energized while connecting the vacuum pump was not necessary.

Recommendation #2: Employers should provide a mechanical grounding conductor as part of the power feed to an appliance whenever possible and in compliance with applicable codes.

Discussion: The mechanical grounding of the RU was dependant on the flexible metal conduit and associated mechanical connections between the RU starter box and the RU. This type of grounding system is subject to discontinuity due to corrosion, vibration and metal fatigue. An alternative separate grounding conductor was not a part of the power feed to the RU nor required by applicable codes (1,2). Had a separate grounding conductor been brought to the RU, the arcing to the flexible conduit would have eventually caused a circuit protective device to open the power feed. Although this is not required by all state or local codes, it is an effective intervention to reduce occupational injury. Code promulgating authorities should consider making the use of a separate grounding conductor a requirement.

Recommendation #3: Employers should provide ground-fault protection as part of the power feed to an appliance whenever possible and in compliance with applicable codes.

Discussion: Walk-in cooler electrical circuits should be provided with ground-fault protection such as a ground-fault circuit interrupter (GFCI) or a ground-fault circuit breaker. Such a protective device would have removed power from the cooler when the first arc to the flexible conduit connector (ground fault) occurred. This would have reduced the amount of damage to the starter box, and promptly alerted the restaurant personnel to a problem. It may also have prevented the death of the HVACR technician. The operation, application, and protection afforded by GFCI's are well documented (3).

Recommendation #4: Employers should provide employees with ongoing education and training in the recognition, avoidance, and prevention of unsafe work conditions.

Discussion: In this case, the HVACR technician should have recognized the hazard of not having a readily accessible disconnecting device and used other means to de-energize the cooler prior to servicing. This is a code requirement for all such coolers (4). In this case, the employer assumed that appropriate safety training was provided as part of the employees' technical training. Even though de-energizing the cooler would not have eliminated the electrical problem, it would have eliminated the source of energy which electrocuted the victim. This recommendation emphasizes compliance with 29 CFR 1926.21(b)(2) of the OSHA Act (5) which requires the employer to "instruct each employee in the recognition and avoidance of unsafe conditions."

The company did have general written safety procedures, but it should also require weekly or monthly safety meetings. In addition, prior to each job there should be a review of the pertinent, safe work practices to remind employees of the hazards associated with the work.

REFERENCES

1. National Electrical Code, National Fire Protection Association, 1990 ed., Art. 250, Par. 250-91(b), p. 118.

2. National Electrical Code, National Fire Protection Association, 1990 ed., Art. 350, Par. 350-5, p. 234.

3. International Association of Electrical Inspectors News, International Association of Electrical Inspectors, Vol. 63, No. 5, p. 29-33, September/October 1991.

4. National Electrical Code, National Fire Protection Association, 1990 ed., Art. 440, part B, par. 440-11 p. 398. & par. 440-14 p. 399.

5. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.21(b)(2), p.20, July 1,1990.

FACE 92-01: **Electrical Contracting Company Line Mechanic Electrocuted After Contacting Energized Conductor While Working From an Aerial Bucket--Virginia**

SUMMARY

An electrical line mechanic (the victim) was electrocuted while attempting to attach an energized conductor to a crossarm-mounted insulator. The employer had been contracted by a local electric utility to install new power poles and relocate the existing three-phase, 19,900-volt powerline onto the new poles. On the day of the incident the weather was hot and humid. An electrical line mechanic and his foreman were working from separate aerial buckets fastening the 19,900-volt conductors to insulators on opposite sides of crossarms on the new wooden power poles. When the supervisor had positioned the conductor on the insulator on his side of the crossarm, he looked down the line away from the victim to see if the conductor was clear of tree limbs or other obstructions. The supervisor saw a flash out of the corner of his eye and turned to see current arcing across a crossarm bolt in contact with the victim's chest. The victim's arms were in a raised position, clearly not in contact with the conductor; however, the electric current was visibly arcing across the crossarm bolt from the victim's chest, and arcing sounds could be heard in the vicinity of the victim's arms. Sometimes linemen raise their hands and arms to drain perspiration from their protective gloves. Droplets of moisture were later seen on the conductor, insulator, and crossarm, suggesting that the current may have tracked the perspiration into the victim's glove, up his arm, and across his chest. The current then would have gone to ground through the crossarm bolt and down the wooden power pole, causing his electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- evaluate training and retraining programs to ensure that linemen are instructed and required to maintain the exterior surface of high voltage equipment in dry condition and to position themselves a safe distance from energized conductors before draining perspiration from their personal protective equipment (PPE)

- stress the importance of adherence to established safe work procedures, including covering conductors with insulating materials immediately upon access to the work area.

Manufacturers of PPE for linemen should:

- research and develop, if possible, more comfortable and flexible PPE.

INTRODUCTION

On September 17, 1991, an electrical line mechanic (the victim) was electrocuted while working from an aerial bucket. On September 25, 1991, officials of the Virginia Occupational Safety and Health Administration (VAOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On November 21, 1991, a DSR safety specialist traveled to the incident site to conduct an investigation. The investigator reviewed the incident with employer representatives and the county coroner. Photographs of the incident site taken immediately after the incident were viewed during the investigation.

The employer in this incident was an electrical contracting company that had been in operation for 46 years and employed 2,100 workers, including approximately 1,000 linemen. The company had a written safety policy and written safety rules and procedures which were administered by the safety director and supervisors, company owners, and jobsite foremen. The safety department was comprised of a safety director, three safety supervisors, a safety training supervisor, an equipment testing supervisor, and related clerical staff. The company maintained a video training library that covered all aspects of overhead and underground electrical power transmission and distribution. Monthly safety meetings were held and documented, and the company promoted safety through the use of safety evaluations, communications, and incentive programs. The victim had worked as a lineman for the company for 7 months, but had 31 documented years of experience as a lineman.

INVESTIGATION

The employer had been contracted by the local electric utility to install new power poles and relocate an existing three-phase, 19,900-volt (phase to ground) powerline onto these new poles, 50 feet above ground level. The new powerline was located 5 feet horizontally from the existing powerline, which was 40 feet above ground level and ran parallel to a four-lane highway.

On the day of the incident, a three-man crew consisting of a jobsite foreman, an electrical line mechanic (the victim), and a groundman were relocating and attaching existing powerline phases to crossarms on new power poles. The victim and the jobsite foreman both drove aerial bucket trucks to the worksite.

The trucks were positioned in a manner that would allow work to be performed on both sides of the crossarm. The victim and foreman could then attach the energized conductors to the insulators on their respective sides of the crossarm (Figure).

The two men raised the first conductor and positioned it on the insulators. Both men were wearing PPE (gloves and sleeves). The foreman then positioned the lip of his bucket slightly above the crossarm and covered the conductor with insulating line sleeves and the crossarm with an insulating blanket. The victim positioned the lip of his bucket below the opposite side of the crossarm. As the foreman wired the conductor to the insulator, he momentarily looked down the line, away from the victim, to see if the conductor was clear of tree limbs or other obstructions. The foreman saw a flash out of the corner of his eye and turned to see the victim slumped onto the crossarm. Although the victim's arms were in a raised position and not in contact with the conductor, electric current could be seen arcing across a crossarm bolt in contact with the victim's chest, and arcing sounds could be heard in the vicinity of the victim's arms. The foreman yelled to the groundman to call the electric utility from the truck radio and tell them to summon emergency medical service (EMS). The foreman positioned his bucket under the crossarm, reached out and pushed the victim away from the crossarm, then lowered himself to the ground. After exiting his bucket, the foreman went to the victim's truck controls and lowered him to the ground. A utility employee who heard the distress call over his radio, arrived at the scene and assisted the foreman to remove the victim from the bucket and place him on the back of the truck. The utility employee initiated cardiopulmonary resuscitation (CPR). The EMS arrived and transported the victim to the hospital where he was pronounced dead by the attending physician.

Because the temperature was 95 degrees Fahrenheit and the humidity was high, the workmen had been draining the perspiration out of their gloves every 15 to 20 minutes. The victim had not yet insulated his work area although insulating materials were present in the bucket.

It is possible that after the victim positioned the bucket, he raised his arms above his head to allow the perspiration to drain out of his gloves and sleeves. Perspiration may have contacted the energized conductor as it drained from his gloves. The current could have tracked the perspiration back into the victim's gloves, up his arms and across his chest, exiting his chest by arcing across the crossarm bolt and then to ground through the wooden power pole. The foreman stated that there were droplets of moisture present on the conductor, the insulator, and the crossarm at the time he pushed the victim away from the crossarm.

Electrical burns were present on the victim's chest (exit wounds), and the crossarm bolt and the crossarm were burned. The autopsy report did not identify entrance wounds.

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should evaluate training and retraining programs to ensure that linemen are instructed and required to maintain the exterior surface of high voltage equipment in dry condition and to position themselves a safe distance from energized conductors before draining perspiration from their PPE.

Discussion: Because of the high temperature and humidity it was routine for the linemen to periodically drain perspiration from their PPE (gloves and sleeves) by raising their arms over their heads. In this instance, the victim did this where direct or indirect contact with an energized conductor was possible. Linemen, and others performing similar work, should be instructed to position themselves where direct or indirect contact with an energized conductor would be impossible. PPE could then be drained, removed, and wiped dry in a safe manner.

Recommendation #2: Employers should stress the importance of adherence to established safe work procedures, including covering conductors with insulating materials immediately upon access to the work area.

Discussion: Established safe work procedures required current-carrying conductors to be covered with insulating materials immediately upon access to the work area. The victim had insulating materials in his bucket but did not install them immediately after positioning the bucket. Personnel responsible for safety at the worksite should enforce company policy and ensure that established safe work procedures regarding the insulation of conductors are followed. Had the insulating material been installed, the exposure to the energized conductor would have been greatly reduced.

Recommendation #3: Manufacturers of PPE for linemen should research and develop, if possible, more comfortable and flexible PPE.

Discussion: The rubber liners and heavy, leather outer gloves worn by linemen are uncomfortably hot, heavy, and inflexible. Manufacturers of this type of equipment should research and develop, if possible and feasible, lighter, cooler and/or more flexible materials. This might alleviate problems such as perspiration, heat stress, and the lack of dexterity associated with wearing the existing PPE in hot, humid weather.

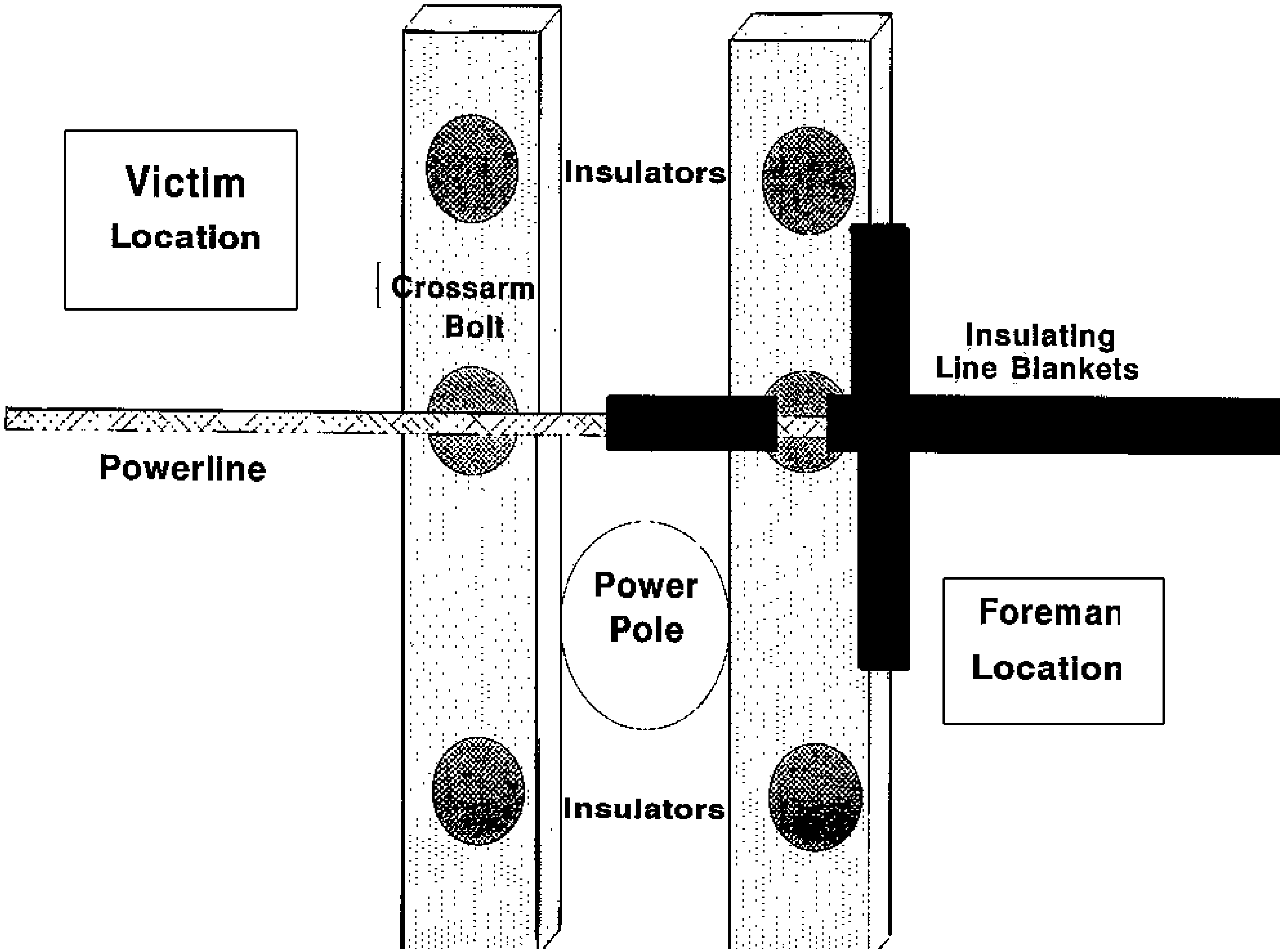
Victim
Location
Insulators
Crossarm
Bolt
Insulating
Line Blankets
Powerline
Power
Pole
Foreman
Location
Insulators

Figure.

FACE 92-02: **Lineman Electrocuted After Contacting Energized Conductor While Working From the Bucket of an Aerial Lift Truck in Virginia**

SUMMARY

A 35-year-old male lineman was electrocuted after he contacted an energized powerline while working from the bucket of an aerial lift truck. The victim was part of a five-man crew assigned to transfer a three-phase, 34,500-volt, overhead powerline system from one utility pole to a taller utility pole. The transfer of the powerlines had been completed, and insulating blankets and line sleeves still covered the powerlines, insulators, and crossarms. While removing the line sleeve from the middle powerline, the victim's rubber glove became caught on an aluminum wire securing the powerline to the insulator. When the victim pulled his arm back, the rubber glove was partially pulled off, and the victim's exposed right wrist contacted the powerline. Electrical current passed through the victim's right arm and exited the body at the left side of the lower abdomen, which had been in contact with the utility pole crossarm, causing his electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- stress the importance of adherence to established safe work procedures

- review and revise, where applicable, safe work procedures regarding the removal of insulating materials, the positioning of aerial buckets, and the procedure used in securing powerlines to insulators.

INTRODUCTION

On September 16, 1991, an electric utility lineman was electrocuted when he contacted an energized powerline while working from the bucket of an aerial lift truck. On September 25, 1991, officials of the Virginia Occupational Safety and Health Administration (VAOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On November 25, 1991, a DSR safety specialist traveled to the incident site to conduct an investigation. The investigator reviewed the incident with the corporate and construction safety managers, and with the VAOSHA compliance officer assigned to the case. Photographs of the incident site, and a copy of the medical examiner's report were obtained during the investigation.

The employer in this incident was an electrical utility company that had been in operation for 90 years and employed about 13,000 workers, including 1,800 linemen. The company had a written safety policy and written safety rules and procedures which were administered by the managers of the safety department, and by jobsite foremen. A corporate safety department and five divisional safety departments had been established and staffed with safety managers, safety engineers, industrial hygienists, fire safety personnel, and related clerical staff. The company maintained a video training library that covered all aspects of overhead and underground transmission and distribution. Weekly safety meetings were held and documented, and the company promoted safety through the use of written tests, work performance evaluations, communications, and incentive programs. Cardiopulmonary resuscitation and first aid training were mandatory for all field personnel. Also, prior to each job, the company conducted specific tailgate conferences at each job site. The victim had worked for the company for 15 years, including about 8 years as a lineman.

INVESTIGATION

The employer had received a request from a local communications company to install a number of new utility poles which would be 5 feet taller than the existing ones, and to transfer the three-phase, 34,500-volt (phase to phase) overhead powerline onto the new poles. The taller poles would provide additional clearance for the communications company transmission lines.

On the morning of the incident, a pole crew arrived at the job site, erected a taller utility pole about 4 feet away from the existing pole, and moved to the next job site. Later that morning a five-man crew consisting of a job site foreman, two linemen (including the victim), a lead lineman, and a groundsman arrived at the job site to make the transfer of the powerlines. Insulating line sleeves and blankets were positioned over the energized powerlines, ground wire, and insulators, and also over the crossarm attached to the shorter pole. The top section of the taller pole was further protected with an insulating blanket (Figure 1).

The victim proceeded to move the powerlines, one at a time, to the taller pole. First, the middle phase was transferred to an insulator attached to a ridge pin located at the top of the taller pole. An aluminum wire was used to secure the powerline to the insulator. Second, a crossarm was attached to the taller pole and covered with an insulating blanket. Next, the outside phases were transferred, one at a time, to the insulators located on opposite ends of the crossarm, and were secured in place. Finally, the victim began removing the insulating sleeves and blankets.

The line sleeves and insulating blanket were first removed from one of the outside phases. Next, the victim positioned the lip of the bucket next to the crossarm, between the other outside phase and middle phase. The insulating blanket was then removed from the crossarm and middle phase insulator. While trying to remove the middle phase line sleeve, located farthest away from the bucket, the victim's rubber glove became snagged on the aluminum wire which secured the powerline to the insulator (Figure 2). When he pulled his arm back, the rubber glove was pulled partially off, and his exposed right wrist contacted the powerline. Current passed through the victim's right arm and exited the body at the lower abdomen on the left side where he was in contact with the crossarm attached to the utility pole.

Although the incident was unwitnessed, the other crew members heard a buzzing sound, looked up toward the victim, and saw him slump down into the bucket. The groundsman immediately lowered the bucket while another lineman radioed the dispatcher to call the rescue squad. The crew members removed the victim from the bucket and began cardiopulmonary resuscitation. The rescue squad arrived in about 12 minutes, performed advanced cardiac life support, and transported the victim to the local hospital, which was approximately 20 minutes away. The victim was pronounced dead by the emergency room physician 80 minutes after the incident.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as acute cardiac arrhythmia due to electrocution.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should stress the importance of adherence to established safe work procedures.

Discussion: In addition to requiring the use of personal protective equipment (PPE), established safe work practices required employees to maintain adequate clearance between themselves and objects with ground potential while working with energized powerlines. Work was being performed from an insulated bucket and appropriate PPE was being worn. In addition, the powerlines, insulators, crossarms, and pole top were covered with insulating materials as required by applicable safe work procedures. Although the physical safeguards were being used, clearance from the grounded crossarm was not maintained; this factor allowed the incident to occur. Formulating safe work procedures is only the first step in injury prevention. For safe work procedures to be effective they must be clearly communicated to all employees and supervisors. Supervisors should ensure that established work procedures are followed at all times.

Recommendation #2: Employers should review and revise, where applicable, safe work procedures regarding the removal of insulating materials, the positioning of aerial buckets, and the procedure used in securing powerlines to insulators.

Discussion: Safe work procedures regarding the removal of the insulating blanket from the crossarm before the removal of the line sleeves and insulator blankets should be reviewed and revised, where appropriate. A work procedure which specifies leaving the crossarm insulating blanket in place until after the removal of line sleeves and insulator blankets may help to reduce inadvertent contact with energized conductors. Safe work procedures regarding the positioning and repositioning of the aerial bucket should be periodically reviewed and revised where indicated, to assure the procedure is appropriate in providing access to the middle powerline sleeves, while allowing adequate clearances from ground potential items. The procedure used in securing powerlines to utility pole insulators should be reviewed and revised, where applicable, to ensure the procedure adequately addresses the appropriate manner in which the powerline is secured to the insulator. The tie down (i.e., a piece of wire used to secure the powerline to the insulator), should be fastened to the powerline in such a manner that the ends of the tie down do not protrude from the powerline. This would minimize any snagging hazard.

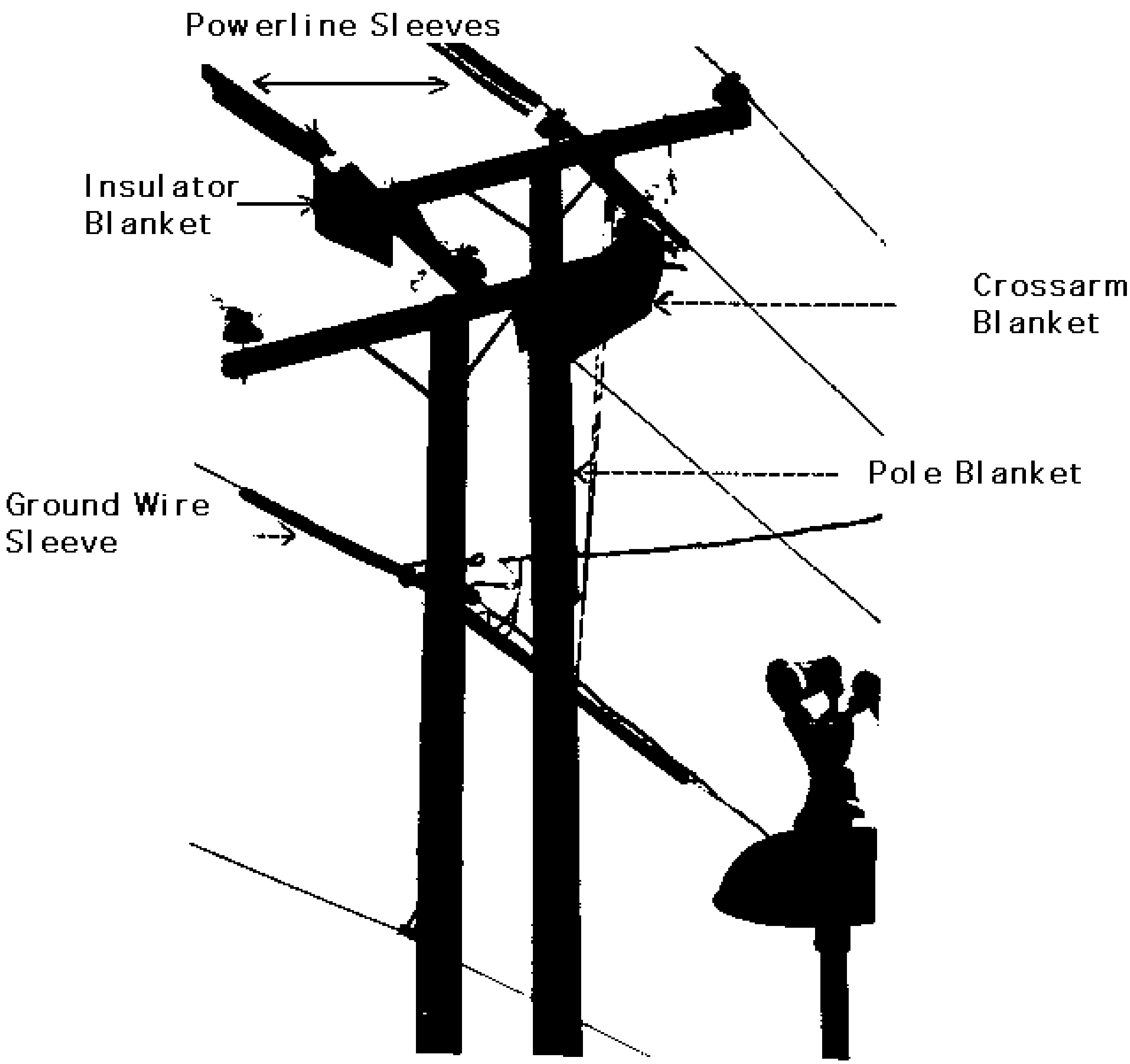

***Figure 1**. Insulating Materials*

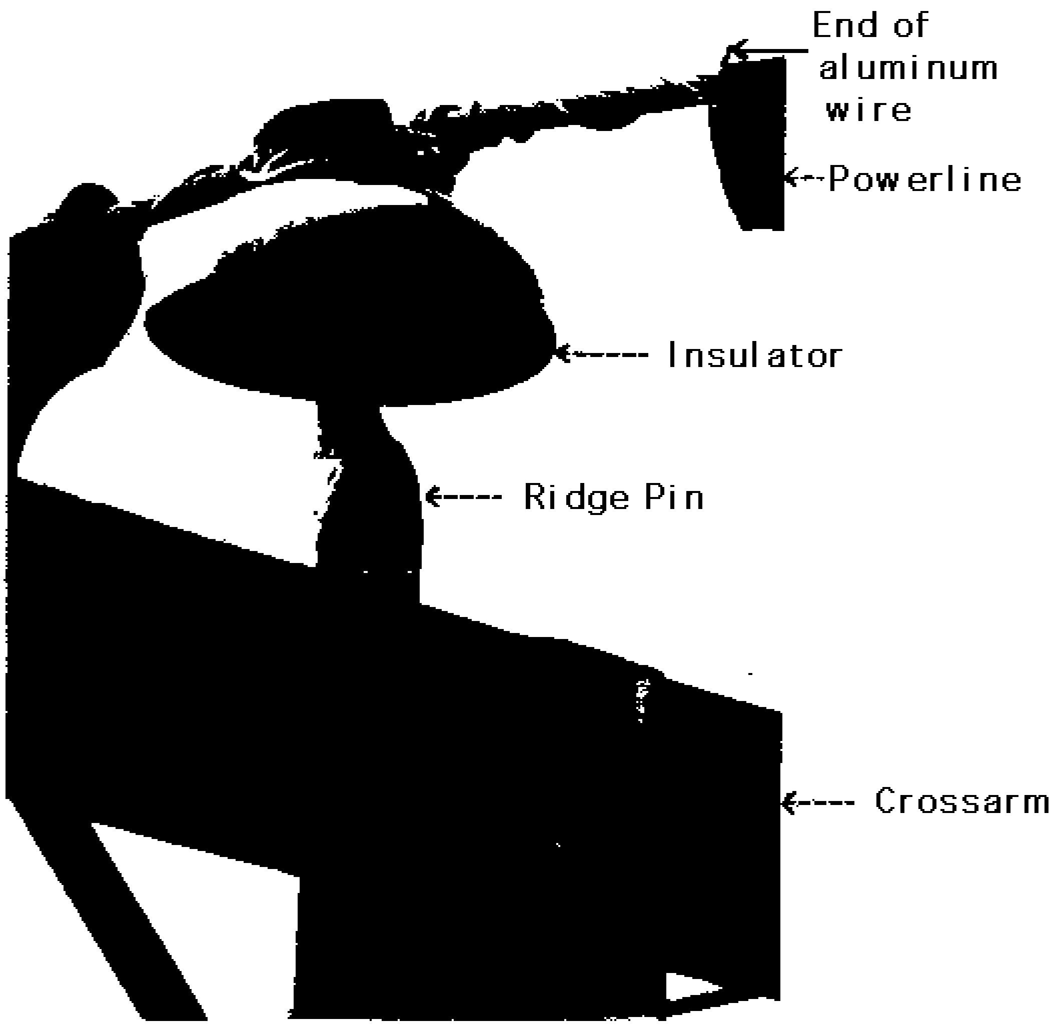

Figure 2. Insulator and Powerline Connection

FACE 92-06: **Roofing Mechanic Trainee Electrocuted in South Carolina**

SUMMARY

A 19-year-old roofing mechanic trainee (victim) was electrocuted after he inadvertently contacted an energized service entrance conductor. At the time of the incident, a crew of six workers, including the victim, was performing various tasks on the roof of a warehouse. The victim, in preparing to apply aluminum flashing around the perimeter of the roof, was kneeling on the corner of the roof, taking measurements along the roof's perimeter. Two electrical service entrances were located on the corner of the roof where the victim was working. When the victim completed his measurements and stood up, he contacted one of the energized electrical service entrance conductors (240-volts phase-to-phase) at his chest area. At the same time, his right forearm contacted the grounding wire for the service entrance which provided a path for the electrical current across the victim's chest through his right forearm to ground. Two co-workers knocked the victim away from the service entrance conductors and, without training, attempted CPR care until the local emergency medical service (EMS) arrived. The victim was pronounced dead at the emergency room of the local hospital approximately 25 minutes after the incident occurred. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- conduct initial jobsite surveys to identify all hazards associated with each specific jobsite, and develop specific methods of controlling the identified hazards
- establish procedures for the protection of employees exposed to electrical hazards and provide worker training in the recognition and avoidance of such hazards
- ensure that electrical service entrance conductors are insulated
- develop, implement, and enforce a written safety program which includes worker training in recognizing and avoiding hazards, especially electrical hazards
- train/certify workers in the use of cardiopulmonary resuscitation (CPR)
- contact the local utility company to de-energize or insulate energized conductors before the start of work.

INTRODUCTION

On September 30, 1991, a 19-year-old roofing mechanic trainee was electrocuted after contacting an energized electrical conductor. On October 3, 1991, officials of the South Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of the fatality, and requested technical assistance. On December 19, 1991, a DSR safety specialist traveled to the incident site to conduct an investigation. The incident was reviewed with the owner of the company and with the SCOSHA compliance officer assigned to the case. Photographs of the incident site were taken, and copies of the medical examiner's report and police report were obtained.

The employer in this incident was a residential and commercial roofing contractor who had been in operation for 18 years. The contractor employed seven workers, including two roofing mechanic trainees. The employer had no written safety program. General discussion of safety procedures was provided on an as-needed basis by the company owner, and the jobsite foreman was responsible for jobsite safety. The employer provided on-the-job training. The victim had worked for the employer for 3 months prior to the incident.

INVESTIGATION

A roofing company had been contracted to remove old roofing materials from the roof of a warehouse and to install a new roof system including roofing felt, rubber membrane, and aluminum flashing. The incident occurred on the first day at the site. At the time of the incident, the old roofing material had been removed, the roof's wooden deck had been repaired in several areas, and base roof felt had been installed on the roof deck. The roof was 50 feet wide by 80 feet long. Two electrical service entrances were located on the corner of the roof. One of the electrical service entrances had insulated conductors while the other did not. The roof had a 2:12 pitch (i.e., the roof rose 2 feet for every 12 feet in width.) (Figure).

On the day of the incident, six workers--two roof mechanic trainees (including the victim), foreman, laborer, and two roof mechanics--arrived at the job site to install a new roofing system. About 3:30 p.m. all work had been completed except for installing the flashing around the roof's perimeter and placing the membrane over the roof felt. The victim and a co-worker were instructed to measure the perimeter of the roof and to cut aluminum flashing to size. The victim, working on the corner of the roof, was cautioned by the foreman to be aware of the electrical conductors in that area. The victim knelt between the corner edge of the roof and the electrical service entrances (approximately a 2-feet by 2-feet working area) to take the measurement around the perimeter of the roof's corner. After taking the measurement, the victim stood up.

Upon standing upright, the victim either lost his balance and stepped into the electrical conductor, or misjudged his position in relation to the electrical conductors' location and stood upright into a conductor. The victim's chest contacted one of the uninsulated energized conductors and his right forearm simultaneously contacted the grounding wire for the electrical service entrance. Although no one saw the victim make contact with the conductor, the co-worker looked up and saw the victim in contact with the conductor and shaking violently. The co-worker shouted to the foreman for assistance.

The foreman and co-worker used a wooden board to push the victim away from the conductor, lowered him to the ground in the bucket of an aerial lift truck, and without formal training, attempted to administer CPR. In the interim, the foreman telephoned the local emergency medical service (EMS) for assistance. The EMS arrived in less than 5 minutes, continued CPR, and transported the victim to the emergency room of a local hospital where he was pronounced dead approximately 25 minutes after the incident occurred.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as ventricular arrhythmia from electrical shock.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct initial jobsite surveys to identify all hazards associated with each specific jobsite and develop specific methods of controlling the identified hazards.

Discussion: The surface of the roof, 50 feet by 80 feet, contained at least two identifiable hazards (i.e., two electrical service entrances located on the corner of the roof creating a tripping hazard, and exposed electrical conductors creating an electrical hazard). Before the start of any work, employers should comply with OSHA construction safety standard 29 CFR 1926.416 (a)(3) [1] by conducting initial jobsite surveys to identify potential situations for employee contact with energized electrical circuits. Employers should also comply with OSHA construction safety standard 29 CFR 1926.416 (a)(3) [1] by providing subsequent employee notification about protective measures (i.e., identification, testing, de-energization, locking/tagging of energized conductors, verification, posting and maintaining proper warning signs, or avoidance of that area of the roof) to be implemented to control the hazards.

Recommendation #2: Employers should establish required procedures for the protection of employees exposed to electrical hazards and provide worker training in the recognition and avoidance of such hazards.

Discussion: Employers should comply with OSHA construction safety standard 29 CFR 1926.416 (a)(1)[2] by prohibiting employees from working in close proximity to energized electrical circuits where employees could make contact in the course of work, unless employees are protected against electric shock by de-energizing and grounding the circuit and/or by effective guarding. Employers should provide worker training in the recognition of electrical hazards and in safe work procedures, including identifying circuits, testing circuits, de-energizing circuits, locking/tagging de-energized circuits, and verifying de-energization.

Recommendation #3: Employers should ensure that service entrance conductors are insulated.

Discussion: Two electrical service entrance conductors were attached to the service head and conduit located at the corner of the warehouse roof. One set of conductors was insulated while the other was not. Employers should comply with the National Electrical Code Article 230-41 which states that service entrance conductors entering or on the exterior of buildings or other structures shall be insulated.

Recommendation #4: Employers should develop, implement, and enforce a written safety program which includes worker training in recognizing and avoiding hazards, especially electrical hazards.

Discussion: In this incident, the victim had just completed taking a measurement along the perimeter of the roof. He stood up, contacted an energized conductor, and was electrocuted. Employers should evaluate tasks performed by workers; identify all potential hazards; and then develop, implement, and enforce a written safety program addressing these issues as required by OSHA standard 1926.21(b)(2) [3]. This safety program should include, but not be limited to, worker training in electrical hazard recognition.

Recommendation #5: Employees who work around electrical circuits/conductors should be trained in cardiopulmonary resuscitation (CPR).

Discussion: To optimize results, CPR should begin within 4 minutes (in accordance with American Heart Association guidelines). To meet this criterion, workers should be trained to support circulation and ventilation until trained medical personnel arrive. Because neither the co-workers nor the foreman were trained in CPR, potentially critical care could not be provided in a timely manner. All employees working on or in proximity to powerlines, electrical circuits, and electrical equipment should be trained in CPR.

Recommendation #6: When circumstances offer no alternative to working in close proximity to energized conductors, employers should contact the local utility company to de-energize or insulate the conductors before the start of any work.

Discussion: De-energizing or insulating electrical conductors in working areas provides a passive measure of protection to workers who might contact the conductors. When there is no alternative to working in close proximity to energized conductors, de-energizing or insulating provides a viable option.

REFERENCE

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 162. July 1, 1990.

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 162. July 1, 1990.

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 20. July 1, 1990.

National Fire Protection Association 70: National Electrical Code 230-41. p. 70. 1990.

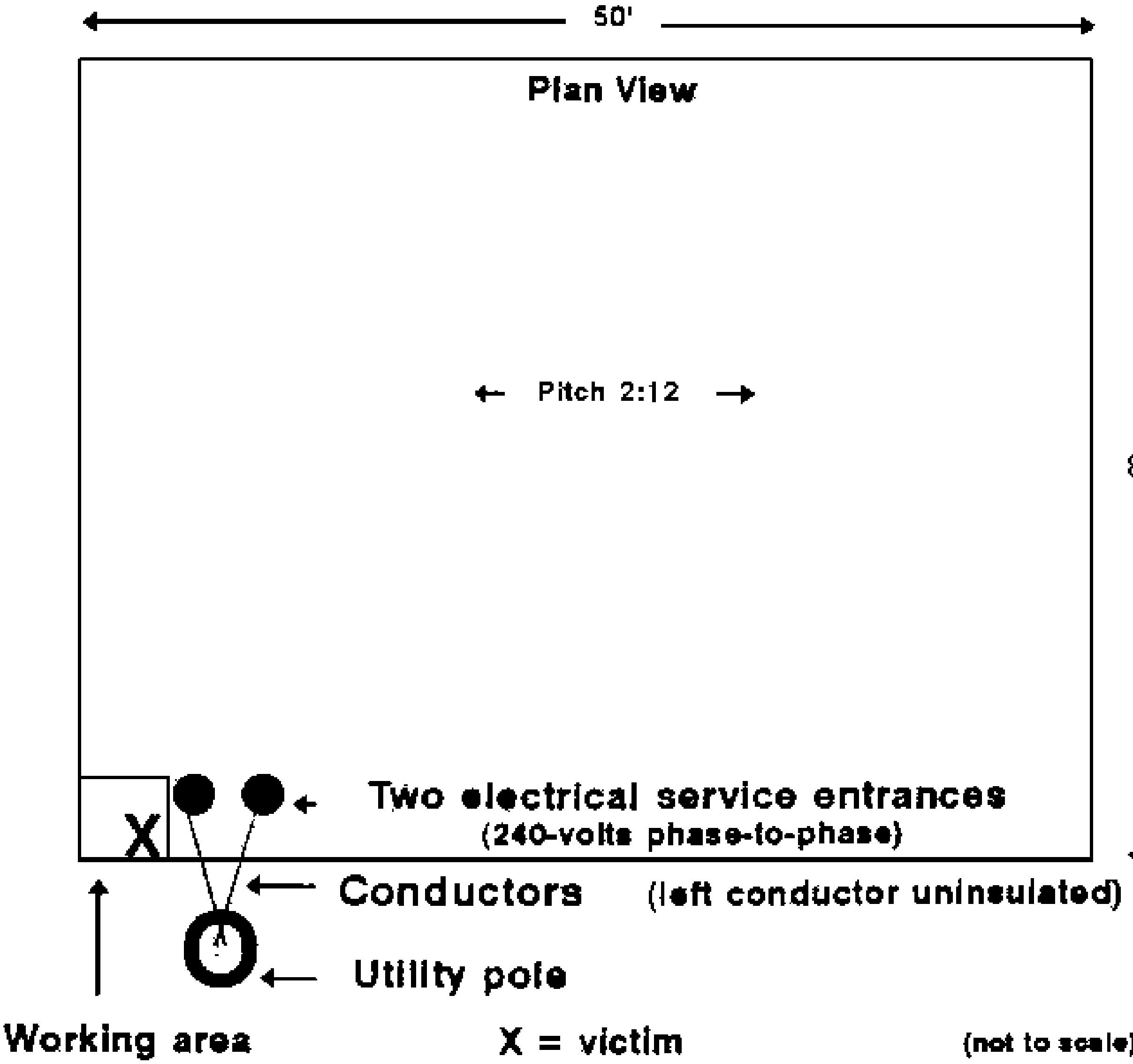

Figure. *Warehouse Roof and Utility Pole with Service Entrances*

FACE 92-07: **Electrical Technician Electrocuted after Contacting a 800-volt Conductor in South Carolina**

SUMMARY

An electrical technician (victim) was electrocuted while he and another worker were performing electrical testing inside a control panel cabinet. The victim was assisting a company service representative with testing the voltage regulating unit on a new high-temperature, steel-alloy rolling mill. After meeting at the new plant, the two men tested voltages on several low-voltage wires and determined that the unit was not regulating the correct amount of voltage. While the victim retrieved the equipment service manual, the service representative opened the panel cover for the voltage regulating control cabinet in preparation to trace the low-voltage wiring in question, as the wiring was not color-coded. The service representative climbed onto an adjacent cabinet in order to view the wires. The victim worked inside the control cabinet near exposed energized electrical conductors, tugging at the low-voltage wires as the service representative tried to identify them from above. The representative heard the victim making a gurgling sound, and looked down to see the victim shaking as though he were being shocked. Cardiopulmonary resuscitation (CPR) was administered to the victim approximately 10 minutes after the incident occurred. He was pronounced dead approximately one hour and forty-five minutes later as a result of his contact with an energized electrical conductor. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- review and revise, where applicable, the safe job procedure governing access into electrical control cabinets

- re-emphasize and reinforce the importance of following safe job procedures related to de-energizing electrical systems prior to performing repairs

- equip voltage regulating equipment with color-coded wiring

- train employees in cardiopulmonary resuscitation techniques.

INTRODUCTION

On September 19, 1991, a 30-year-old male electrical technician was electrocuted when he inadvertently contacted an energized conductor inside a control panel cabinet. On September 20, 1991, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On December 19, 1991, a safety specialist from DSR conducted an investigation of this incident. The safety specialist reviewed the incident with the company representative, and the SCOSHA compliance officer assigned to the case. A schematic of the equipment and the medical examiner's report were obtained.

The employer in this incident was a steel-alloy rolling mill that had been in business for 19 months. The company was in the process of starting-up a new plant where 35 personnel were employed which included 5 electrical technicians who installed and maintained the plant's electrical equipment. The company had a written safety policy, and comprehensive safety program including written safety procedures, and a full-time director of safety. The victim had worked for this employer for 16 months prior to the incident.

INVESTIGATION

The high-temperature, steel-alloy rolling mill was in the start-up mode at the time of the incident. The plant's buildings had been erected, rolling machines and all related equipment had been installed, and the employees were in the process of testing all equipment prior to the actual start-up of the rolling mill. On the day of the incident, the victim had been instructed to meet with and assist a service representative from the company that manufactured a piece of voltage regulating equipment. The equipment (a Mini-Comp system) was being used to control voltage surges and regulate voltages to different pieces of equipment throughout the plant (Figure).

On the day of the incident, the victim met the service representative and proceeded to the building within the plant that contained the Mini-Comp system. The two men discussed what had to be done, then began checking the voltages on the low-voltage (15-volts) wiring from the Mini-Comp system. They determined a problem existed within the equipment, as the correct amount of voltage was not being detected. The victim left the area to get the service manual for the equipment. Without de-energizing the Mini-Comp system, the service representative opened the panel cover on the system's control cabinet in preparation to trace out the low-voltage wires in question. The wires were not color-coded. He then climbed onto the compartment adjacent to the capacitor rack in order to view the wiring.

At that time the victim returned, kneeled in front of the opened control cabinet, and positioned his head and shoulders inside the 800-volt resistor compartment. As he began tugging on the wires inside the compartment, he was told by the service representative to be careful around the conductors. The service representative was watching to see which wire moved when he heard the victim making a gurgling noise. When he looked down he saw the victim shaking as though he were being shocked. He jumped down from the cabinet and although receiving a shock himself, knocked the victim away from contact with the energized conductor.

The service representative ran to his truck and called the plant's main office for assistance. Personnel from the main office called the emergency medical service (EMS) and proceeded to the incident site where cardiopulmonary resuscitation (CPR) was administered by one of the plant's managers. The EMS arrived approximately 15 minutes after being notified, continued CPR, and transported the victim to the local hospital's emergency room where he was pronounced dead one hour and forty-five minutes after the incident occurred.

CAUSE OF DEATH

The medical examiner's office reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should review and revise, where applicable, the safe job procedures associated with accessing electrical control panel cabinets.

Discussion: The control panel cabinet was located inside a building accessible only through a locked gate, but the cabinet itself was unlocked and accessible to anyone within the building. When the control panel was opened by an unauthorized person (the service representative), the returning victim may have assumed the incoming power had been shut off, and started work within the cabinet without first verifying de-energization. Cabinets of this nature should be locked and the key held only by persons authorized to enter. Workers should be trained to never enter into electrical cabinets without first determining which areas and equipment are de-energized and which are energized. Also, consultants and manufacturers representatives should be trained in company standard operating procedures before entrance into controlled access areas and servicing of electrical equipment is permitted.

Recommendation #2: Employers should re-emphasize and reinforce the importance of following established safe work procedures especially de-energizing electrical systems prior to any work being performed on them.

Discussion: Although the circuits had to remain energized during testing to determine if the circuits were sensing the proper voltage, it was not necessary to leave the circuits energized while tracing wiring. In spite of company safe work procedures requiring the de-energization of the control panel, the circuits were not de-energized as required by 29 CFR 1910.333 (a). For these procedures to be effective, they must be clearly communicated and fully understood by the effected employees and supervisors. The employees and supervisors must believe the company genuinely expects compliance with the guidelines, even if it means sacrificing production or other company goals.

Recommendation #3: Voltage regulating equipment should be wired with color-coded conductors.

Discussion: The victim was in the process of trying to identify non-color-coded wiring in the regulating unit when he contacted an energized conductor and was electrocuted. Color-coded insulation covering the wiring is unique to specific conductors, and can be readily identified and separated from all others in the same wiring harness or conduit. Voltage regulating equipment should be designed and manufactured with unique color-coded conductors for each separate circuit in the cabinet or compartment of electrical equipment. Also, electrical equipment purchase orders should require voltage regulating equipment conductors be color-coded, and electrical equipment deliveries should be inspected for compliance before delivery acceptance and before equipment installation.

Recommendation #4: Employers should train workers in cardiopulmonary resuscitation (CPR).

Discussion: Approximately 7-10 minutes lapsed before potentially critical CPR techniques were initiated. CPR was attempted after the incident by one of the plant managers from the main office located about 3 minutes from the incident site. To optimize results, CPR should begin within four minutes in accordance with American Heart Association guidelines. To meet this criteria, all workers should be trained to support circulation and ventilation until trained medical personnel arrive.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. July 1, 1989.

1985 National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). Standards and Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). JAMA 255(21):2905-2989 (June 1986).

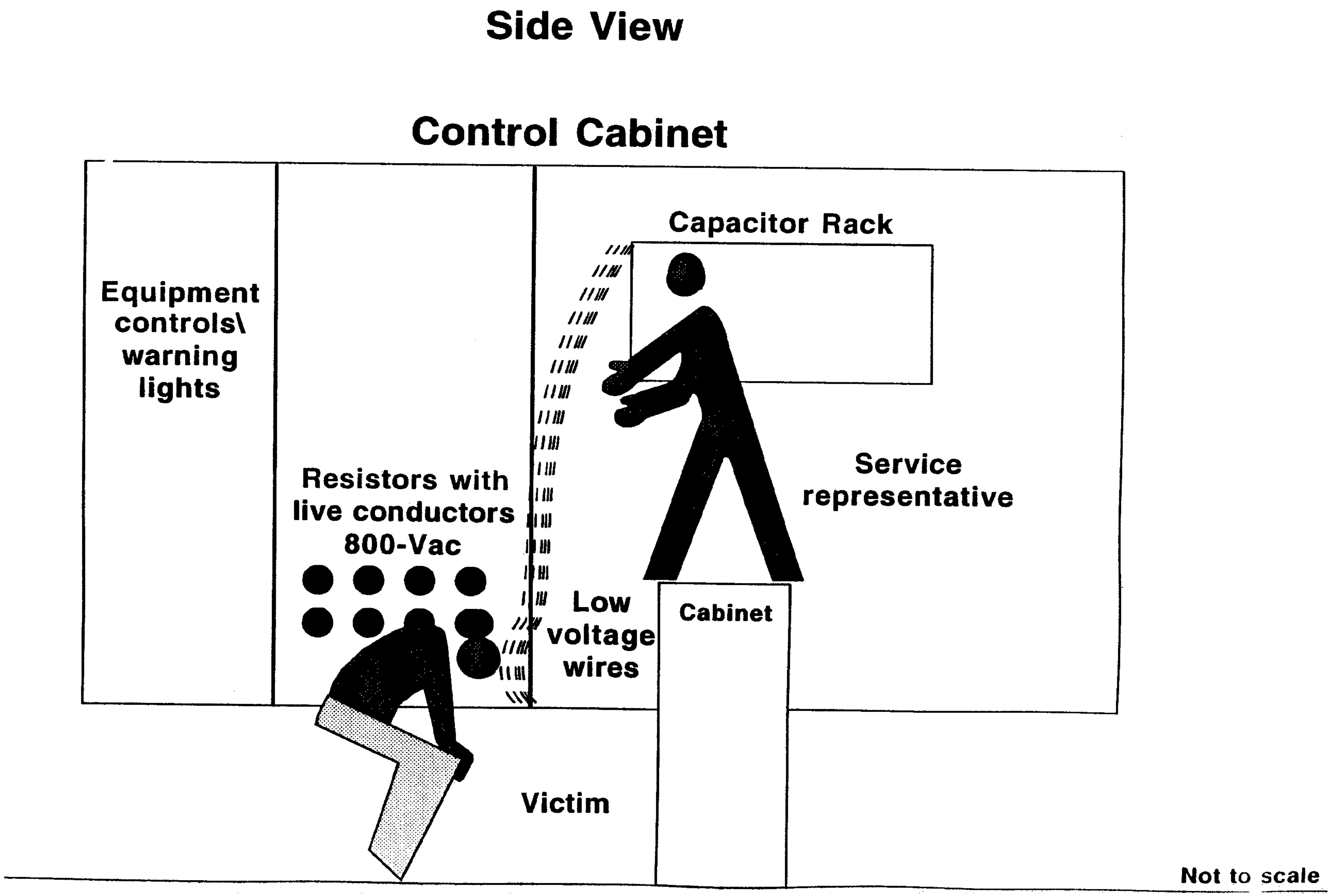

Figure. *Mini-Comp System*

FACE 92-12: **Powerline Worker Electrocuted While Performing Maintenance on Overhead Powerline--Alaska**

SUMMARY

A 37-year-old male electric utility powerline worker (the victim) was electrocuted while performing maintenance on a 7200-volt overhead powerline. The victim had been assigned by the electric utility to investigate and repair a problem involving intermittent power outages in a rural community. Two weeks before the incident, the victim isolated and replaced what he thought was the outage problem (an arcing electric service line) at a utility pole near a school. On the day of the incident the victim climbed the utility pole to adjust the primary phase jumper cable, which he apparently thought was another probable arcing source. He was not wearing his lineman gloves, or his protective helmet. At the moment of the incident, the victim had his left climbing boot gaff planted in the utility pole, his right climbing boot in contact with the pole guy wire, and his left arm/hand resting on the neutral phase. Thinking (presumably) that the powerline had been de-energized, the victim grabbed the energized primary phase jumper cable with his right hand. In doing so, he provided a path to ground (the electric current entered his right hand, and exited his left arm/hand and right foot), and the victim was electrocuted. The forensic pathologist stated in his report that the victim's judgement was probably impaired by the influence of marijuana which the victim may have used shortly before the incident. NIOSH and the Alaska Department of Health and Social Services investigators determined that in order to prevent future similar occurrences, employers should:

- implement measures to help ensure that powerline workers are free from the use of controlled substances, especially while on the job
- ensure that all workers who perform maintenance on overhead powerlines are properly trained in safe work procedures
- ensure that powerline workers follow State regulations and safe work procedures established by the electric utility industry
- ensure that powerline workers use all appropriate personal protective equipment before working on powerlines with energized circuits
- ensure that a comprehensive safety program which includes specific written procedures for all work near energized powerlines, is designed, developed and implemented.

Additionally, the Alaska State Legislature should:

- consider an amendment to Statute AS 18.62.010, to ensure that all hazardous powerline work is performed by or under the direction of qualified workers.

INTRODUCTION

On December 28, 1991, a 37-year-old male electric utility powerline worker (the victim) was electrocuted while performing maintenance on a 7200-volt overhead powerline. The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research, Alaska Activity began tracking this incident after it was initially reported in local newspapers on December 30, 1991. An investigation was initiated on this date, involving a safety specialist from the Alaska Activity and an injury prevention specialist candidate from the State of Alaska, Department of Health and Social Services, Division of Public Health, Section of Epidemiology. The incident was reviewed with the compliance officer assigned to this case from the State of Alaska, Department of Occupational Safety and Health (AKOSH), and a representative of the electric utility company. An investigation of the incident site was conducted, and photographs and reports were obtained from AKOSH, police, and the medical examiner.

The employer was a rural electric utility company that had been in operation for 32 years. The company had 52 employees, including 9 powerline workers. The company had a safety policy, safety program, and basic written safe work procedures. A company management official (company representative) was assigned as the safety manager as a collateral duty, and employee safety meetings were conducted on a weekly basis. The victim had worked for this employer for 6 weeks as a powerline worker, and did not have any previous powerline work experience or training.

INVESTIGATION

The victim had been assigned by the electric utility company (approximately 2 weeks before the incident) to investigate and repair a problem involving intermittent power outages at an elementary school in a rural community. The victim isolated and replaced what he thought was the outage problem (an arcing service line) at a utility pole near the school.

One day before the incident, the victim returned to the rural community to repair and replace several other electric service lines in the area. He was assisted by two local village laborers (co-workers) who had been hired by the electric utility on an as-needed basis. Before performing the maintenance work, the victim de-energized each electric service line by opening its corresponding cut-out fuse with a hot stick (a fiberglass pole, typically used for switching electrical circuits). However, he failed to "ground the line" by temporarily splicing a jumper cable between the primary phase and the neutral phase, as required by written company procedures.

At about 3 p.m. on the day of the incident, the victim phoned the on-duty supervisor of the company, and told him that he had completed the assigned repair work. Although the victim had met and conversed with the on-duty supervisor on several previous occasions, the on-duty supervisor was unable to convince the victim that they knew each other; he further commented that the victim seemed "out of it" on the phone. After the phone call, the victim returned to the utility pole near the school (where he had replaced the electric service line two weeks previously). According to the co-workers who were standing nearby, the victim apparently noticed another possible cause for the intermittent power outages that could develop between the primary phase jumper cable and the neutral phase, during windy conditions. Presumably, in an attempt to shorten or relocate the primary phase jumper cable, the victim climbed the utility pole. At this time he was wearing leather work gloves, but not his lineman gloves nor his protective helmet; the victim had left this personal protective equipment, hot stick, and other equipment at another location about 5 miles away. Although the two co-workers did not observe the victim at the moment of the incident, a resident, who was approximately 100 feet away, witnessed the entire incident from a window in his house. At the moment of the incident (about 3:30 p.m.), the victim had his left climbing boot gaff planted in the pole, his right boot in contact with the top of the guy wire, and his left arm and hand resting on the neutral phase (Figure). Presumably unaware that the powerline had not been de-energized at the cut-out fuse, the victim grabbed the primary phase jumper cable providing a path to ground (burn marks suggest the electric current entered his right hand, and exited his left arm/hand and right foot), and the victim was electrocuted. The two co-workers looked up at the victim after hearing "a burning sound," and saw sparks coming out of his right hand, and smoke coming out of his right pant leg.

One of the co-workers went to the school and yelled for help. The village police officer and two community health aids arrived at the scene in about 10 minutes. They found the victim unresponsive and hanging limp from his pole-climbing belt near the top of the utility pole, with his right hand no longer in contact with the primary phase jumper cable. The powerline was de-energized by a telephone line repairman [responding to an emergency call on his citizens band (CB) radio] about 20 minutes after the incident. The telephone line repairman climbed the utility pole, and lowered the victim with a rope. The community health aids administered cardiopulmonary resuscitation (CPR) at the scene, and during snowmobile/sled transport to the community health clinic. One of the community health aids continued CPR at this location, and during air transport to a regional hospital where the victim was pronounced dead on arrival (about 5 p.m.) by the attending physician.

A forensic pathologist at the hospital conducted a drug screen on the victim. His report stated, "The toxicologic screen revealed a level of marijuana and its metabolite which would indicate that he had smoked marijuana approximately thirty to forty-five minutes before his death. The fact that tetrahydrocannabinol, the active agent, was detected in his blood would suggest that he was under its influence and, therefore, his perception of his environment as well as his judgement were impaired."

CAUSE OF DEATH

The medical examiner listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should implement measures to help ensure that powerline workers are free from the use of controlled substances, especially while on the job.

Discussion: According to the forensic pathologist's report, the toxicologic screen showed a level of marijuana in the victim's blood which indicated that he had probably smoked marijuana 30 to 45 minutes before the incident occurred, suggesting that he was under its influence, possibly impairing his judgement and perception. Powerline workers are exposed to significant hazards, even under the most favorable working conditions. Performing work on energized powerlines while under the intoxicating influence of controlled substances (such as marijuana) increases the likelihood for serious injury. Section 111 of the American Public Power Association, Safety Manual for an Electric Utility, states "Use of intoxicating beverages or drugs ... on the job or during working hours is prohibited and shall be sufficient cause for disciplinary action." To deal with this problem, some companies have implemented the services of an Employee Assistance Program (EAP), whereby employees can receive free and confidential professional help in resolving personal problems (such as drug abuse). Some Alaskan employers, because of business size or geographic location, may not be inclined to implement an EAP. The manual entitled "Employer's Guide for Developing Employee Assistance in Alaska" has information which may be helpful to supervisors, in the absence of an established EAP.

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Recommendation #2: Employers should ensure that all workers who perform maintenance on overhead powerlines are properly trained in safe work procedures.

Discussion: The victim was a powerline maintenance worker with virtually no previous powerline maintenance experience or training. The AKOSH Electrical Code, Section EC 03.009, requires employees who face a risk of electric shock to be "... trained in and familiar with any electrically related safety practices ... which are necessary for their safety." Additionally, Section EC 03.010(c)(2) states, "Only qualified persons may work on electric circuit parts or equipment that have not been de-energized under the procedures of (b) of this subsection. Such persons must be capable of working safely on energized circuits and must be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools."

Recommendation #3: Employers should ensure that powerline workers follow State regulations and safe work procedures established by the electric utility industry.

Discussion: The victim climbed a utility pole to work on an energized line. AKOSH Electrical Code Section EC 03.010(a)(1) states, "Live parts to which an employee may be exposed must be de-energized before the employee works on or near them ...." Section 507 (a) of the American Public Power Association (APPA) Safety Manual for an Electric Utility states, "All conductors and equipment shall be treated as energized until tested or otherwise determined to be de-energized and grounded." A similar requirement is stated in AKOSH Construction Standard CC 05.220(a)(2)(B).

Recommendation #4: Employers should ensure that powerline workers use all appropriate personal protective equipment before working on powerlines with energized circuits.

Discussion: The victim did not don lineman gloves or a protective helmet before climbing the utility pole to work on an energized powerline. According to Section 502 (a) of the APPA Safety Manual, "Employees shall not touch or work on any exposed energized lines or apparatus except when wearing approved protective equipment approved for the voltage to be contacted. When work is to be done on or near energized lines, all energized and grounded conductors or guy wires within reach of any part of the body while working shall be covered with rubber protective equipment, except that part of the conductor on which the employee is to work." Also, section 504 (d) of the APPA safety manual states that employees shall wear rubber lineman gloves with the leather protectors, under the following conditions: (1) "When working on or within falling or reaching distance of conductors, electrical equipment, or metal surface (crossarms, crossarm braces or transformer cases) which are not effectively grounded and which may be or may become energized." A similar requirement is stated in AKOSH Construction Standard CC 05.220(a)(3).

Recommendation #5: Employers should ensure that a comprehensive safety program which includes specific written procedures for all work near energized powerlines, is designed, developed and implemented.

Discussion: The company had a safety program with written basic safe work procedures. However, these procedures did not specifically address training, tools, and protective equipment for routine hazardous jobs. Employers should design, develop and implement a comprehensive safety program which includes specific written procedures for all work to be performed on or near energized high voltage powerlines. These procedures should include, but not be limited to:

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1. Worker training.
2. Electrical hazard recognition.
3. Proper use and maintenance of personal protective equipment.
4. Supervisory jobsite surveys before starting work.
5. First aid and cardiopulmonary resuscitation (CPR) certification training.

Recommendation #6: The Alaska State Legislature should consider an amendment to Statute AS 18.62.010, to ensure that all hazardous powerline work is performed by or under the direction of qualified workers.

Discussion: For the type of powerline maintenance work the victim was doing, the current Alaska Statute (AS 18.62.010.) requires workers to obtain a "certificate of fitness," (which requires 4 years or 8,000 hours of powerline work experience) a prerequisite for taking a written examination to become a journeyman lineman. However, an exemption to this rule is also stated in the same Statute; "... except that a certificate of fitness may not be required of employees of an electric utility which does not have within its service area any portion of a city or unified municipality having more than 2,500 population." Most rural communities of Alaska have a population of less than 2,500; the community where this incident occurred had a population of less than 500. The Alaska State Legislature should therefore consider a change in this statute, requiring <u>all</u> powerline workers who do this type of powerline work to have a certificate of fitness, or to work under the direct supervision of an employee who either has a certificate of fitness, or who is a journeyman lineman.

REFERENCES

American Public Power Association, Safety Manual for an Electric Utility, 1983.

State of Alaska Alcoholism and Drug Abuse Plan for 1990-1992, Office of Alcoholism and Drug Abuse, April 1990.

Employer's Guide for Developing Employee Assistance in Alaska, Office of Alcoholism and Drug Abuse, 1989.

Electrical Code, Alaska Occupational Safety and Health Standards, July 1991.

Construction Code, Volume I, Alaska Occupational Safety and Health Standards, August, 1990.

Alaska Statute, AS 18.62.010., 1980.

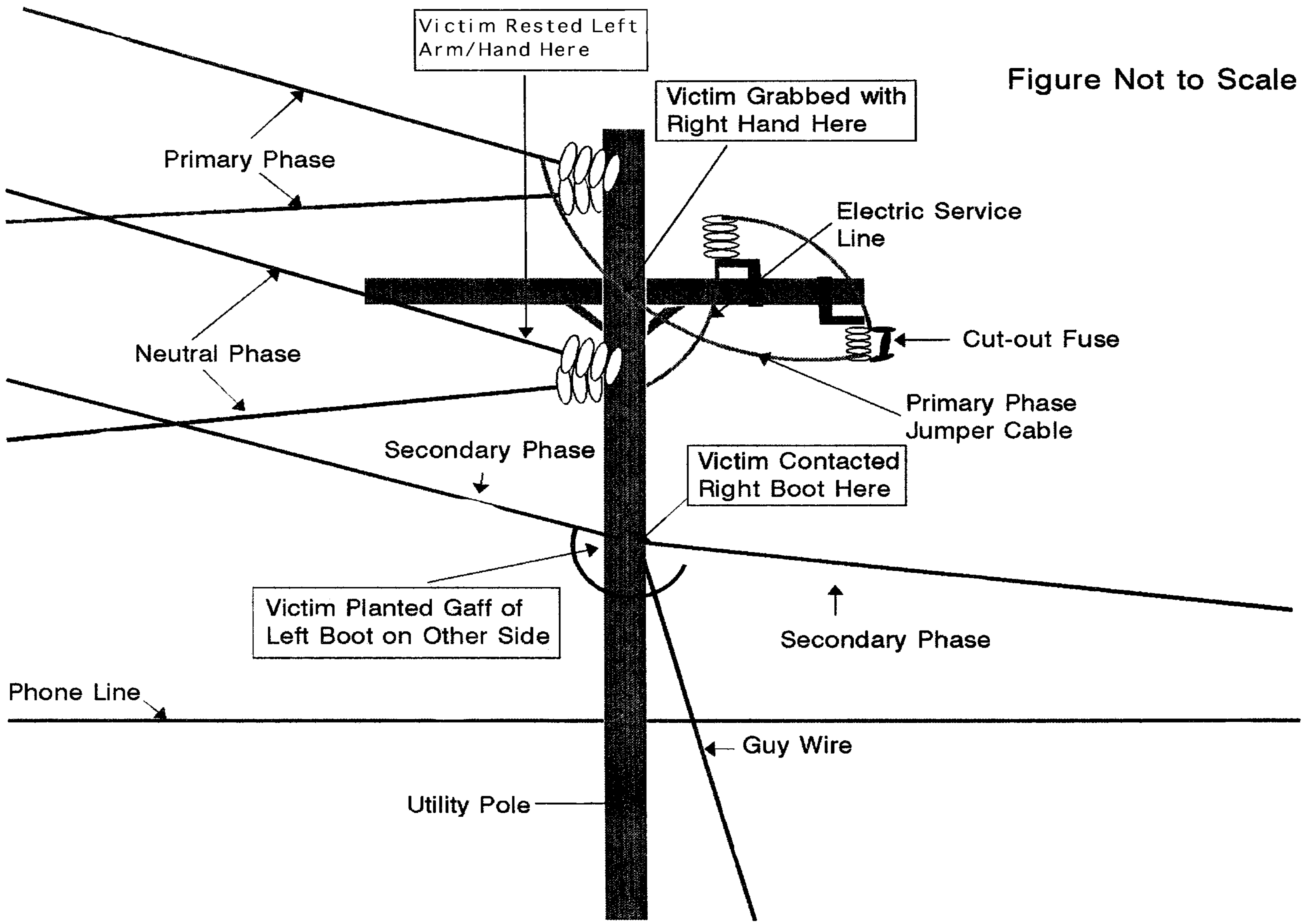

***Figure**. 7200-Volt Powerline*

FACE 92-16: **Textile Worker (Machine Operator) Electrocuted After Contacting an Energized Conductor--South Carolina**

SUMMARY

A 19-year-old machine operator (the victim) was electrocuted at a textile plant when he contacted an energized electrical conductor inside the 570-volt control panel of a sueder machine. Prior to the incident, the victim had been operating two sueder machines for approximately 9 to 10 hours. The 5- and 10-horsepower motors in the two machines had a regular tendency to overheat when heavy cloth was processed; heavier-weight material increased the tension on the machines' rollers, producing added friction and heat. Overheating of the motors would trip the overload relays and shut down the machines. The control panel covers on the two machines had previously been modified to increase heat dissipation; however, on the day preceding the incident, the cover had been removed altogether on machine #7, without authorization. On the day of the incident, the victim apparently attempted to cool the uncovered electrical equipment inside the control panel of machine #7 with a stream of compressed air from an air hose. The metal nozzle of the hose contacted an energized conductor inside the control panel. Current successively passed through the nozzle, the victim's hand, chest, and other hand to ground, through one of the other machines that the victim was touching. This caused his electrocution. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- ensure that all electrical control panel covers are secured (locked) against unauthorized removal, and only qualified/designated personnel have access to the control panel

- evaluate their current safety program and incorporate specific procedures and training designed to enable workers to recognize, report, and avoid hazards, especially electrical hazards (e.g., exposed energized conductors)

- review and implement engineering controls designed to prevent electrical motors from overheating, thereby eliminating the need for hand-held metal air nozzles to cool electrical conductors.

INTRODUCTION

On April 4, 1992, a 19-year-old male sueder machine operator (the victim) was electrocuted when he contacted an energized conductor inside the electrical control panel of a sueder machine. On April 9, 1992, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On April 23, 1992, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with the company's plant and personnel manager, and the SCOSHA compliance officer assigned to the case. The investigator visited and photographed the incident site, and obtained the medical examiner's report.

The employer in this incident was a textile manufacturer that had been in operation for 4 years. The company employed 900 workers at this plant, of whom 20 were sueder machine operators. The company had a written safety program with written safety procedures administered by the plant's safety officer. The company held monthly safety meetings with company and labor representatives attending. All department managers were responsible for safety within their departments. On-the-job and classroom training was provided to the employees, and drug screening was part of the pre-employment physical required of all new employees. The victim had received 3 weeks training on sueder machine operation, and had worked for this employer for 15 months, 6 months of which he worked as a sueder machine operator. This incident was the first fatality the company had experienced.

INVESTIGATION

On the day of the incident, the victim arrived at the plant before the start of the production shift (8:00 a.m. to 4:00 p.m.). He was scheduled to operate two sueder machines, #7 and #8, as he had done on previous shifts. Sueder machines, which process (sand) cloth to a plush finish (e.g., corduroy), are run in tandem.

The victim completed an 8-hour shift and was asked to work overtime (4:00 p.m. to 12:00 a.m.). The victim agreed and continued operating the machines normally until approximately 6:00 p.m. The 5- and 10-horsepower motors in the two machines had a regular tendency to overheat when heavy cloth was processed; heavier-weight material increased the tension on the machines' rollers, producing added friction and heat. Overheating of the motors would trip the overload relays and shut down the machines. The control panel covers on the two machines had previously been modified to increase heat dissipation; a number of holes had been drilled in the covers, to increase air flow and to vent heated air. However, this measure was apparently insufficient in itself to prevent overheating, because on the day preceding the incident, the cover had been removed altogether on machine #7. This had been done by another worker, acting without authorization from his supervisors. A consequence of this action was the exposure of numerous electrical conductors within the control panel. On the day of the incident, the victim apparently attempted to cool the uncovered electrical equipment within the control panel of machine #7 with a stream of compressed air from an air hose. The machine was adjacent to machine #8; the control panel was located at the bottom left front between the two machines. Inside the control panel there were numerous energized electrical conductors–transformers, relays, fuse holders, contacts, and so forth, carrying electrical charges between 12 and 575 volts. Access to the control panel could only be made from the front between the two machines; access was obstructed by a device located between the machines, which guided the cloth from one machine to the other. The opening between the control panel and the cloth guidance assembly was about 2 feet (Figure).

Although the incident was unwitnessed, evidence suggests that the victim obtained a 1/2" pressurized air hose equipped with an aluminum 23-inch-long trigger operated nozzle, to cool the electrical conductors. He crawled between the two machines with the air hose in hand. At some point, he supported himself with one hand on either the grounded frame of the sueder machine or the grounded cloth guidance assembly, and directed a stream of air into the control panel. The aluminum nozzle contacted an energized conductor inside the panel. The current successively passed through the nozzle, the victim's hand, chest, and other hand to ground, through one of the pieces of grounded equipment. The victim collapsed, face down, on the nozzle and pressurized hose.

A co-worker walking through the area noticed that machine #7 was not running, then saw the victim lying face down between the machines, with the pressurized air hose beneath him. He shut off power to the machine, pulled the victim away from the equipment, and contacted the department manager. The co-worker began cardiopulmonary resuscitation (CPR), while the manager called the emergency medical service (EMS). The EMS arrived in about 30 minutes, continued CPR, and transported the victim to the local hospital emergency room. The victim was pronounced dead about 65 minutes after the incident. The medical examiner's report did not identify entry or exit wounds but noted that both hands had electrical burns.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should ensure that all electrical control panel covers are secured (locked) against unauthorized removal, and only qualified/designated personnel have access to the control panel

Discussion: The control panel was located between the two sueder machines at the bottom left front of machine # 7. The control panel, equipped with two covers that could not be locked, were accessible to anyone within the building. When the control panel covers were removed by an unauthorized person (another operator) and not replaced, the victim may have assumed that using the aluminum nozzle to cool the conductors was a safe and accepted practice. If the covers had been locked the unauthorized worker or victim could not have accessed the energized components of the control panel enclosure. Qualified/ designated personnel would be more likely to understand the hazards of working inside an energized control panel in tight quarters and more likely to exercise special precautions such as de-energizing the control panel prior to working on it.

Recommendation #2: Employers should evaluate their current safety program and incorporate specific procedures and training designed to enable workers to recognize, report, and avoid hazards, especially electrical hazards (e.g., exposed energized conductors).

Discussion: OSHA standard 29 CFR 1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures. Evidence suggests that the victim did not realize the hazard created by using a metal object (aluminum air nozzle), in proximity to exposed energized electrical conductors. The safety program should be evaluated with particular emphasis on the development of detailed safety procedures (specific for all tasks and job categories) that are designed to recognize, report, and avoid potential hazards. For these procedures to be effective, they must be clearly communicated and fully understood by the affected employees and supervisors. All workers must believe the company genuinely expects compliance with the procedures, and is committed to preventing occupational injury.

Recommendation #3: Employees should review and implement engineering controls designed to prevent electrical motors from overheating, thereby eliminating the need for hand-held metal air nozzles to cool electrical conductors.

Discussion: The sueder machines' 5- and 10- horsepower electrical motors had a history of overheating and shutting down while processing heavy cloth material. The tension applied to the rollers by the heavy cloth (overloading) caused the motors to overheat which resulted in the electrical relays opening and the machines shutting down. An overload condition on a motor may cause it to draw more current than it is designed to use, causing the windings to overheat. Excessive current will flow to the motor if the load is too heavy (e.g., the driven machine becomes jammed or locked, a belt-driven machine has a belt that is too tight, the sheave on the motor is out of line with the sheave on the equipment, bearings are worn

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or in need of lubrication, electrical feeder wires from the service entrance to the motor are too small, resulting in low voltage, or the power supplier has trouble providing proper voltage), and eventual machine shutdown may be expected. Engineers should analyze and determine the factors associated with machine shutdowns, and provide applicable interventions (e.g., cooling fans), thereby eliminating the use of hand-held metal air nozzles to cool down electrical conductors.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 294. July 1, 1989.

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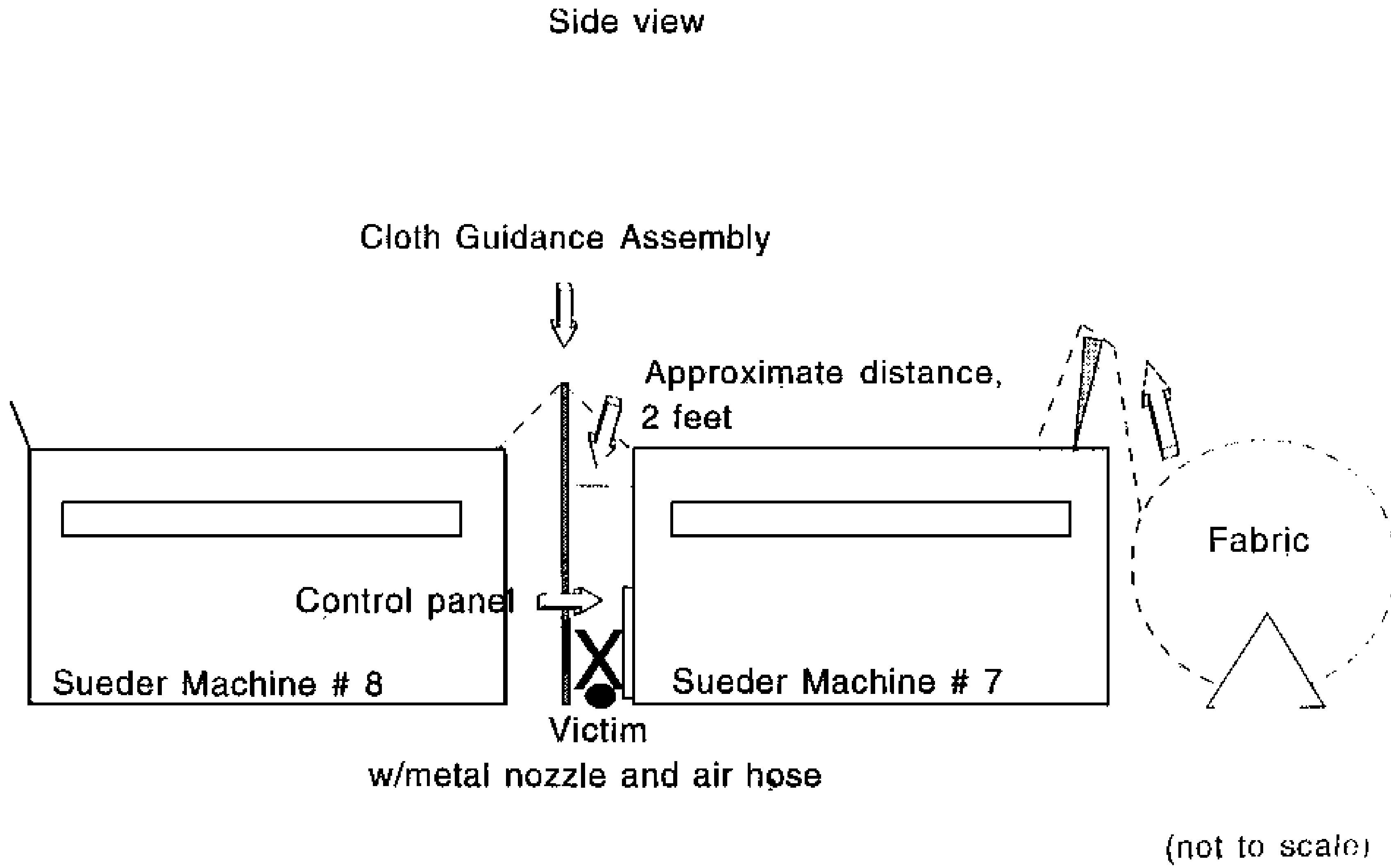

Figure.

FACE 92-20: Electrical Project Supervisor Dies After Contacting An Energized Conductor--South Carolina

SUMMARY

A 46-year-old electrical project supervisor (the victim) died at a plastic bottle packaging plant when he contacted an energized conductor inside a control panel. Before the incident occurred, the victim had installed a compressor motor starter inside a control panel and the associated wiring from the control panel to the main distribution panel. To check the starter's operation, the switch on the main distribution panel was turned to the "on" position, energizing the components inside the starter control panel. The starter indicator light activated, but the compressor motor did not start. The victim concluded that a problem existed inside the starter control panel, and he directed a co-worker to retrieve a voltmeter so he could check the continuity of the starter control panel wiring. In the interim, the victim, without de-energizing the unit, opened the starter control panel door and reached inside to trace the wiring and check the integrity of the electrical leads. In doing so, he contacted the 480-volt primary lead for the motor starter with his left hand. Current passed through the victim's left hand and exited through his feet to ground, electrocuting him. NIOSH investigators concluded that, to prevent future similar occurrences, employers should:

- stress and reinforce the importance of following established safe work procedures, with particular emphasis on de-energizing electrical systems before any work is performed
- routinely conduct scheduled and unscheduled worksite safety inspections
- encourage workers to actively participate in workplace safety.

INTRODUCTION

On May 16, 1992, a 46-year-old male electrical project supervisor (the victim) died when he contacted an energized conductor inside a control panel. On May 20, 1992, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research (DSR) of this fatality and requested technical assistance. On July 1, 1992, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with the president/CEO of the company, the SCOSHA compliance officer assigned to the case, and the coroner in the county where the incident occurred. Photographs taken of the incident site were obtained from local sources.

The employer was an industrial electrical contracting company that had been in operation for 10 years. The company employed 20 workers, including 3 electrical project supervisors. The company's written safety program, administered by the president/CEO and the project supervisors, included disciplinary procedures specifying that three reprimands would result in termination. The safety program mandated pre-employment drug screening and on-the-job random drug testing. The president/CEO served as safety officer on a collateral duty basis, and the supervisors held monthly safety meetings with all crew members. The victim had worked for this employer for 5 years and 3 months as a project supervisor, and had approximately 27 years of electrical experience. The company and victim had been working at the packaging plant for 6 months before the incident; this was the company's first fatality.

INVESTIGATION

The company had been contracted to install two control cabinets, conduit, wiring, and two solid-state compressor motor starters for two 400-horsepower air compressors used to supply air to plastic bottle blow mold machines. On the day of the incident, the victim and three co-workers (one electrician and two helpers) arrived at the plant at 7 a.m. They were scheduled to install the last starter and to complete the wiring from the compressor motor to the starter in the control panel, and from the starter control panel to the main distribution panel. Once installation was completed, they were to check the operation of the unit.

At approximately 3:15 p.m., the starter had been installed and all associated wiring had been completed. The victim directed a helper to turn the switch to the "on" position at the main distribution panel, approximately 6 feet away, to check the starter's operation. The helper turned the switch to the "on" position, energizing the components inside the starter control panel. The victim pushed the starter "start" button, and the starter indicator light activated, but the compressor motor did not start. When the compressor motor did not engage, the victim concluded that a problem existed inside the starter control panel. The victim directed the electrician to retrieve a voltmeter so that he could check the continuity of the wiring inside the starter control panel. In the interim, the victim opened the starter control panel door without de-energizing the unit and reached inside to trace the wiring and check the integrity of the electrical leads. In doing so, he contacted the 480-volt primary lead for the motor starter with his left hand. Current passed through the victim's left hand and body and exited through his feet to the ground. The victim yelled, and the helper immediately turned the main distribution switch to the "off" position as the victim collapsed to the floor. A plant maintenance supervisor walking by the area saw the event and called the emergency medical service (EMS). The helper checked the victim and immediately administered cardiopulmonary resuscitation (CPR). The EMS arrived in 10 to 15 minutes, continued CPR, and transported the victim to the local hospital where he was pronounced dead 1 hour and 20 minutes after the incident occurred.

CAUSE OF DEATH

The county coroner reported the cause of death as cardiac arrest due to electrical shock.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should stress and reinforce the importance of following established safe work procedures, with particular emphasis on de-energizing electrical systems before any work is performed.

Discussion: Although the circuits had to remain energized during testing of the starter, it was not necessary to leave the circuits energized while tracing and checking the integrity of the electrical leads. In spite of company safe work procedures, and as required by 29 CFR 1926.416(a)(1), the circuits were not de-energized within the control panel. For these procedures to be effective, they must be clearly communicated and fully understood by the affected employees and supervisors. The employees and supervisors must believe the company genuinely expects compliance with the guidelines.

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Recommendation #2: Employers should routinely conduct scheduled and unscheduled worksite safety inspections.

Discussion: Scheduled and unscheduled safety inspections should be conducted by competent individuals. No matter how comprehensive, a safety program cannot be effective unless implemented in the workplace. Although these inspections do not guarantee the elimination of occupational injury, they do demonstrate the employer's commitment to the enforcement of the safety program.

Recommendation #3: Employers should encourage workers to actively participate in workplace safety.

Discussion: In this incident, the victim, an electrical project supervisor with 27 years of electrical experience, accessed an energized control panel in violation of established safety rules. Employers must instruct workers of their responsibility to participate in making the workplace safer, and ensure that all workers understand the role they play in the prevention of occupational injury. Increased worker participation will aid in the prevention of occupational injury.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 162. July 1, 1989.

FACE 92-24: **Roofer's Helper Electrocuted When Ladder Platform Hoist Contacts a Powerline--South Carolina**

SUMMARY

A 21-year-old roofer's helper (the victim) was electrocuted, and a co-worker received serious electrical burns at a private residence when the metal ladder platform hoist they were positioning contacted a powerline. Prior to the incident, the victim and five co-workers had been removing old roofing materials from a single-story private residence in preparation for the application of new roofing materials. As new shingles were being applied to one side of the roof, the victim and a co-worker were instructed to set up the ladder platform hoist on the opposite side of the residence. The victim and a co-worker carried the ladder platform hoist around the side of the residence and stood it upright from ground level against the edge of the carport roof. As they positioned the ladder platform hoist, it contacted an overhead powerline, and electrical current passed through the ladder platform hoist and both workers, to ground. The victim was electrocuted and the co-worker was seriously burned. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- develop and implement safety programs that are designed to enable workers to recognize, report, and avoid hazards, especially electrical hazards (e.g., overhead powerlines)

- conduct initial jobsite surveys to identify all hazards associated with each specific jobsite, and develop and implement specific methods of controlling the identified hazards.

In addition, ladder manufacturers should:

- consider the use of non-conductive materials in the manufacture of ladder platform hoists.

INTRODUCTION

On June 24, 1992, a 21-year-old male roofer's helper (the victim) was electrocuted and a co-worker received serious electrical burns, when the ladder platform hoist they were positioning contacted an overhead powerline. On June 29, 1992, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On July 27, 1992, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with the two owners of the company, and the SCOSHA compliance officer assigned to the case. The investigator photographed the incident site, and obtained a copy of the coroners report.

The employer in this incident was a small family-owned roofing construction company that had been in business for 27 years. The company employed seven workers, including three roofer's helpers. The company had no formal safety program, however, safety warnings were given intermittently by the owners. The victim had worked for this employer for 2 years on a part-time basis as a roofer's helper. This incident was the second fatality the company had experienced.

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INVESTIGATION

On the day of the incident, the victim arrived at the office of the roofing company and was transported, along with five co-workers, to a private residence. The company had been contracted to remove old roofing materials (i.e., felt paper, asphalt shingles, nails, etc.) from a single-story private residence and apply new ones. The roofing job was to be completed in one day.

At the time of the incident, work had been in progress about 2 hours and 45 minutes. The old roofing material had been removed and new felt paper had been applied to the roof. Shingles were being applied to one side of the pitched roof when one of the company owners instructed the victim and his co-worker to reposition the ladder platform hoist from one side of the residence to the opposite side. The ladder platform hoist (i.e., a single aluminum ladder, 26-feet long, equipped with a 3 h.p. gasoline motor, pulleys, wire rope, and a metal hoist platform) was used to raise heavy loads to the rooftop. Material was placed on the platform at the bottom of the ladder and then hoisted to the rooftop by the gasoline-powered motor.
The victim and co-worker picked up the ladder platform hoist and carried it to the opposite side of the residence. A single-phase, 7,200-volt overhead powerline ran perpendicular to the house roof; it was located 15 feet above an attached carport and approximately 24 feet from ground level. The workers stood the hoist upright, leaning it against the edge of the carport roof while the feet of the ladder remained on the ground. At that time, the workers determined that the location of the hoist was incorrect and they repositioned it. It contacted the overhead powerline (Figure), electrical current passed down the ladder, and entered the victim's hands, passing through his chest and exiting his right foot to ground, causing his electrocution. The current simultaneously entered the co-worker's right side and exited his left foot to ground, causing serious electrical burns.

Seconds after the incident, one of the two company owners rounded the corner of the residence and saw the workers falling to the ground. A motorist driving by the residence also saw the incident, stopped his vehicle and ran to assist the workers. The company owner had the residence owner call the emergency medical service (EMS), then proceeded to give assistance to the injured co-worker, who was conscious but disoriented. The motorist checked the victim and administered cardiopulmonary resuscitation (CPR) until the arrival of the EMS, about 15 minutes later. The EMS continued CPR, and transported the victim and co-worker to the local hospital emergency room where the victim was pronounced dead on arrival, and the co-worker was admitted for treatment of electrical burns. The coroner's report identified an electrical exit wound to the victim's right foot.

CAUSE OF DEATH

The coroner's report listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should develop and implement safety programs designed to enable workers to recognize, report, and avoid hazards, especially electrical hazards (e.g., overhead powerlines).

Discussion: The danger of overhead powerlines appears to be obvious; however, contact with overhead powerlines and the subsequent occupationally-related fatalities continue. OSHA Standard 29 CFR

1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures. Evidence suggests that the workers did not realize the hazard created by using a metal object (aluminum ladder platform hoist), in proximity to over-head powerlines. A safety program should be developed and implemented with particular emphasis on detailed safety procedures (specific for all tasks and job categories) that are designed to recognize, report, and avoid potential hazards. For these procedures to be effective, they must be clearly communicated and fully understood by the affected employees and supervisors. All workers must believe the company genuinely expects compliance with the procedures, and is committed to preventing occupational injury.

Recommendation #2: Employers should conduct initial jobsite surveys to identify all hazards associated with each specific jobsite, and develop and implement specific methods of controlling the identified hazards.

Discussion: The jobsite had at least one identifiable electrocution hazard (i.e., a 7,200-volt overhead powerline in proximity to the roof of the carport where work was to be performed). Energized overhead powerlines in proximity to a work area constitute a safety hazard. Extra caution must be exercised when working near energized powerlines. A safe distance between powerlines and ladders, tools, or scaffolds should be maintained at all times. 29 CFR 1926.450(a)(11) states that "portable ladders shall not be used for electrical work or where they may contact electrical conductors." The powerline in this instance was within 15 feet of the carport roof. Before the start of any work, employers should identify any hazards that may put the worker at risk, and develop and implement specific methods of controlling the identified hazards [e.g., positioning the ladder platform hoist on the side of the residence where no possible contact with the overhead powerline could occur, or making arrangements with the local utility company to de-energize or cover the powerlines with insulating line hoses or blankets when the work must be performed within minimum safe distances as specified in 29 CFR 1926.450(a)(11)].

Recommendation #3: Manufacturers of ladder platform hoists should consider the use of non-conductive materials in the manufacture of these devices.

Discussion: The ladder platform hoist is comprised of a single aluminum ladder, 26-feet long, equipped with a 3 h.p. gasoline motor, pulleys, wire rope, and a metal hoist platform which is used to raise heavy loads. The use of non-conductive materials in the manufacture of extension ladders could provide a passive form of safety to all affected workers in the event of inadvertent contact with an energized electrical conductor (such as an overhead powerline. The use of passive safety interventions such as non-conductive materials in tools and equipment, may provide an additional level of worker protection.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. p. 20. July 1, 1989.

Bellegarde, M. L. Human Factors Analysis of Aluminum Ladders/Powerlines Electrocution Hazard. U.S. Consumer Product Safety Commission: p. 5-9, October 1988.

Not to Scale

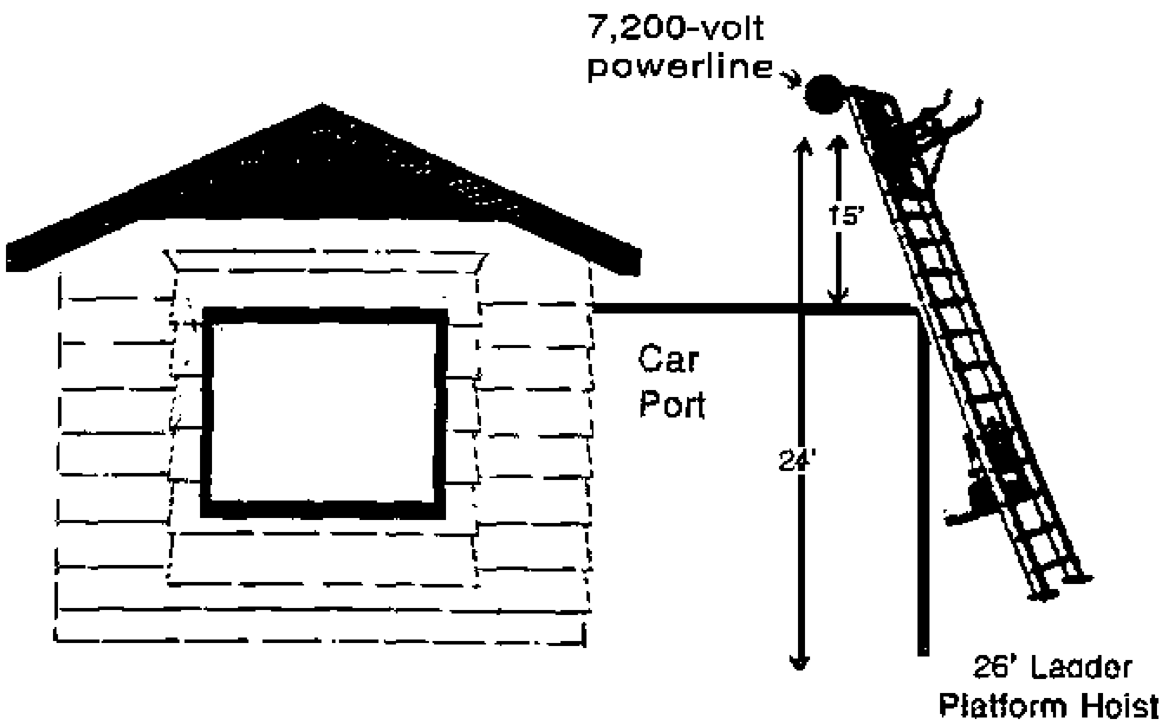

Figure. *Ladder Platform Hoist Contacting Overhead Powerline at Private Residence*

FACE 92-25: **Electrician Electrocuted After Contacting Energized Conductor While Working From the Bucket of an Aerial Lift Truck--Virginia**

SUMMARY

A 46-year-old male electrician (the victim) was electrocuted after he contacted an energized powerline while working from the bucket of an aerial lift truck. The victim was part of a two-man crew assigned to replace 12 fused electrical cutout switches located on utility poles at a housing project. The switches were located on the crossarms of the utility poles between the transformers and the powerline phases. Five switches had been replaced and work was in progress on the sixth switch. The victim, without wearing any personal protective equipment, and without covering the powerlines with insulating blankets or line sleeves, removed one of the bolts securing the switch to the crossarm. In his attempt either to remove the second bolt securing the switch or to reposition the bucket, the victim's left upper arm contacted the powerline. Electrical current travelled through the victim's left shoulder and exited his body through the right forearm which was in contact with the grounded bucket controller, electrocuting the victim. NIOSH investigators concluded that to prevent future similar occurrences, employers should:

- require that workers wear appropriate personal protective equipment when they are exposed to hazardous conditions and ensure that energized powerlines are insulated or guarded before work is performed on or near them

- develop and implement safety programs designed to enable workers to recognize and avoid hazards, especially electrical hazards

INTRODUCTION

On April 24, 1992, a 46-year-old electrician was electrocuted when he contacted an energized powerline while working from the bucket of an aerial lift truck. On August 21, 1992, officials of the Virginia Occupational Safety and Health Administration (VAOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On August 27, 1992, a DSR safety specialist travelled to the incident site to conduct an investigation. The investigator reviewed the incident with the company owner and the VAOSHA compliance officer assigned to the case. Photographs of the incident site, and copies of the medical examiner and police reports were obtained during the investigation.

The employer in this incident was an electrical contracting company that had been in operation for 17 years and employed 10 workers, all of whom were electricians. The company had no written safety or training programs. The victim had worked for the company for 17 years, and this incident was the first fatality the company had experienced.

INVESTIGATION

The employer had been contracted by a local redevelopment and housing authority to replace 12 fused electrical cutout switches at a housing project. The switches were located on the crossarms of the utility poles between the transformers and the two-phase 7,620-volt (phase to ground) energized powerlines. Workers had installed five switches the day before and had been at the site 1 hour on the day when the incident occurred.

On the morning of the incident, two workers (the victim and his co-worker), arrived at the work site to continue replacing switches. Five switches had been replaced the day before and work was to be performed on the sixth switch. It was determined that the victim would work from the bucket of the aerial lift truck (a double bucket Pitman Uni/dyne aerial lift mounted on a 1982 GMC Truck) while he replaced the switches and the co-worker would remain on the ground performing other tasks. The victim positioned himself in the bucket and maneuvered the bucket adjacent to the powerline in proximity to the switch. He used a "hot stick" to disconnect the jumper wire from the switch to the powerline, stopping the flow of electricity from the powerline to the switch and transformer. Without donning personal protective equipment (PPE) or covering the powerlines with insulating line sleeves or blankets, he removed one of the bolts securing the switch to the crossarm as the co-worker watched from the ground. At that time the company owner arrived and began a conversation with the co-worker. As the victim either began to remove another bolt or tried to reposition the bucket, he contacted the powerline (Figure). While the owner and co-worker were talking, they heard an arcing and popping sound, and looked up to see the victim slump down into the bucket. The company owner immediately jumped onto the truck and used the controls mounted on the pedestal to lower the bucket while the co-worker called 911 for assistance. The paramedics arrived within 6 minutes and determined the victim had died. The medical examiner was notified and he directed the paramedics to transport the body to a local mortuary.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should require that workers wear appropriate personal protective equipment when they are exposed to hazardous conditions and ensure that energized powerlines are insulated or guarded before work is performed on or near them.

Discussion: 29 CFR 1926.28 (a) states "The employer is responsible for requiring the wearing of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions or where this part indicates the need for using such equipment to reduce the hazards to the employees." Also, 29 CFR 1926.950 (c)(1)(ii) states "The energized part is insulated or guarded from him and any other conductive object at a different potential." Work was being performed from an aerial lift truck bucket near energized, unguarded or insulated powerlines and appropriate PPE was not being worn. The rubber gloves, sleeves, and line hoses used for this type of work were later found in the aerial bucket and bins of the truck.

Recommendation #2: Employers should develop and implement safety programs designed to enable workers to recognize and avoid hazards, especially electrical hazards.

Discussion: The danger of overhead powerlines appears to be obvious; however, contact with overhead powerlines and the subsequent occupationally-related fatalities continue. OSHA Standard 29 CFR 1926.21(b)(2) states that "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Employers should develop and implement comprehensive safety programs implemented with particular emphasis on detailed safety procedures specific for all tasks and job categories. Employers should also provide employees with adequate training to ensure that they can recognize potential hazardous exposures and are familiar with the company's safety program and procedures. Evidence suggests that the worker, although an experienced electrician, elected to work near energized overhead powerlines without using PPE and without insulating or guarding the powerlines.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. pp. 20-21, 311. July 1, 1989.

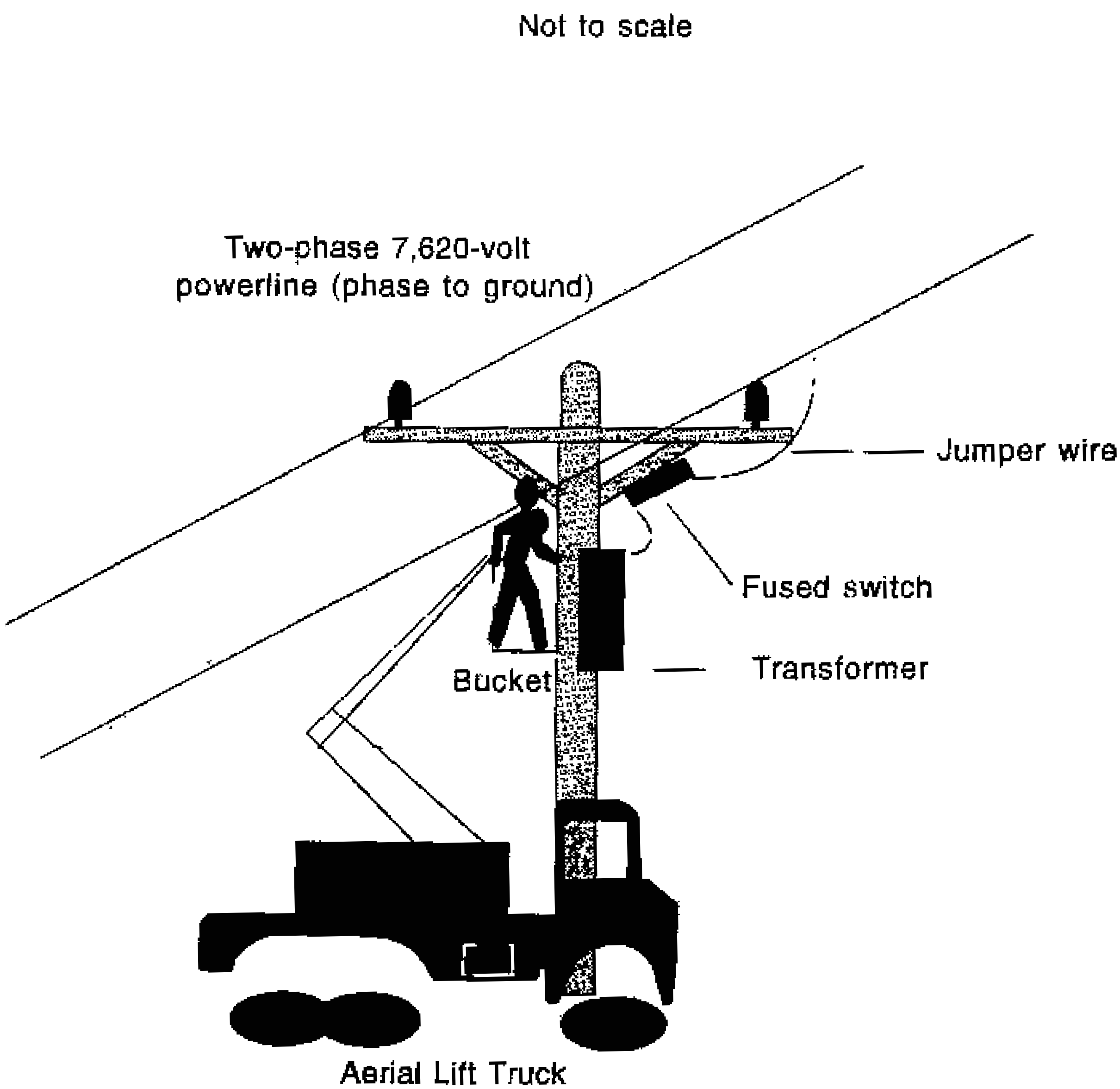

Figure. *Worker Contacting Overhead Powerline*

FACE 92-27: Painter Electrocuted When Metal Ladder Contacts a Powerline--Virginia

SUMMARY

A 21-year-old painter (the victim) was electrocuted when the metal ladder he was moving contacted an overhead powerline. Prior to the incident, the victim and two co-workers had been painting the exterior of a two-story private residence. Work had concluded at 9 p.m., and the workers were cleaning up the jobsite. The victim, for unknown reasons, walked around the side of the residence and began moving the ladder. The ladder had been positioned against the side of the residence and had been used to reach the upper level of the residence, when the workers were scraping and painting the structure. As the victim moved the ladder to a vertical position, it came into contact with an overhead powerline located about 24 feet above ground level and directly above the victim's position. Electrical current passed through the ladder and victim to ground, electrocuting the victim. NIOSH investigators concluded that to prevent future similar occurrences, employers should:

- eliminate the use of conductive ladders in proximity to energized electrical conductors
- make arrangements with local utility companies to de-energize or cover powerlines with insulating line hoses or blankets when work is to be performed in proximity to overhead powerlines
- develop and implement safety programs that are designed to enable workers to recognize, report, and avoid hazards, especially electrical hazards (e.g., overhead powerlines)
- conduct a jobsite survey to identify potential hazards and develop and implement appropriate control measures for these hazards
- have equipment (e.g., ladders) inspected on a regular basis by a competent person and remove any defective or damaged equipment from service

Additionally, ladder manufacturers should:

- consider the use of non-conductive materials in the manufacture of ladders.

INTRODUCTION

On July 9, 1992, a 21-year-old male painter (the victim) was electrocuted when the metal ladder he was moving contacted an overhead powerline. On August 21, 1992, officials of the Virginia Occupational Safety and Health Administration (VAOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On August 28, 1992, a safety specialist from DSR conducted an investigation of this incident. The investigator reviewed the incident with the VAOSHA compliance officer assigned to the case and visited and photographed the incident site. A copy of the medical examiner's report was obtained during the site visit.

The employer in this incident was a small general contracting company that had been in business for 13 years. The company employed four workers, including three painters. The company had no formal written safety or training programs; however, safety warnings were given intermittently by the owner.

The victim had worked for this employer for 2 days as a painter prior to the incident. This was the first fatality the company had experienced.

INVESTIGATION

The company had been contracted to repaint a two-story wooden private residence. Work had been in progress for 3 days prior to the incident, and this was the victim's second day of employment.

On the day of the incident, three workers (including the victim) and the company owner arrived at the residence to continue scraping and painting the residence. A 40-foot-long aluminum extension ladder, which was missing the rope used to raise and lower the upper ladder section, had been extended to 26 feet 2 inches and positioned on the east side of the residence in order to scrape and paint the second story of the residence. Additionally, a three-phase overhead powerline system (19,500 volts phase to ground), was located about 10 feet away from, and parallel to, the east side of the residence. The powerline was approximately 24 feet above ground level. At the time of the incident, work had been in progress about 12 hours, and at 9 p.m. the workers had completed the day's work and were in the process of cleaning up the jobsite and work materials. Earlier in the day the victim had been instructed not to move the ladder. However, at this time, for some unknown reason, he walked around the side of the residence and began moving it. The victim stood at the base (feet) of the ladder and pulled it away from the side of the building, standing it upright. The top section of the ladder, about 2 feet down from the top of the ladder, contacted the outside phase of the three-phase overhead powerline system (Figure). Electrical current passed through the ladder, entering the victim's hands and exiting through his feet. After a few seconds, the victim fell to the ground when a reclosure switch, located on a nearby utility pole, opened, stopping the flow of electricity.

When the incident occurred, one of the co-workers heard a loud noise and saw sparks at the point where the ladder was in contact with the powerline. He rounded the corner of the residence and saw the victim lying on the ground. Also, a neighbor heard two loud noises and her electricity went off. She ran out of her house and saw the victim lying on the ground with his clothes on fire. The co-worker and neighbor extinguished the fire as the company owner called the emergency medical service (EMS). The EMS arrived in about 10 minutes, and transported the victim to the local hospital emergency room where the victim was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Employers should eliminate the use of conductive ladders in proximity to energized electrical conductors.

Discussion: OSHA Standard 29 CFR 1926.450(a)(11) states that "portable metal ladders shall not be used for electrical work or where they may contact electrical conductors." Ladders made of non-conductive materials, e.g., fiberglass, should be substituted for work near energized electrical conductors.

Recommendation #2: Employers should make arrangements with local utility companies to de-energize or cover powerlines with insulating line hoses or blankets when work is to be performed in proximity to overhead powerlines.

Discussion: Energized overhead powerlines in proximity to a work area constitute a safety hazard. Extra caution must be exercised when working near energized powerlines. A safe distance between powerlines and ladders, tools, scaffolds and work materials should be maintained at all times. The powerline in this incident was within 10 feet of the residence. When this type of situation occurs, overhead powerlines should be de-energized or covered with insulating material.

Recommendation #3: Employers should develop and implement safety programs designed to enable workers to recognize, report, and avoid hazards, especially electrical hazards (e.g., overhead powerlines).

Discussion: The danger of overhead powerlines should be obvious; however, contact with overhead powerlines and subsequent occupationally-related fatalities continue to occur. OSHA Standard 29 CFR 1926.21(b)(2) states that "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Employers should provide employees with adequate training to ensure that they can recognize potential hazardous exposures. Evidence suggests that the worker, even though warned about moving the ladder, did not realize the hazard created by moving a metal object (aluminum ladder), in proximity to overhead powerlines. Safety programs should include detailed safety procedures (specific for all tasks and job categories) needed to prevent worker exposure to hazards. For these procedures to be effective, they must be clearly communicated and fully understood by the affected employees and supervisors. Additionally, a NIOSH Alert entitled "Request for Assistance in Preventing Electrocutions of Workers Using Portable Metal Ladders Near Overhead Power Lines" provides additional recommendations pertaining to work being performed in proximity to energized conductors.

Recommendation #4: Employers should conduct a jobsite survey to identify potential hazards and develop and implement appropriate measures for these hazards.

Discussion: Before beginning work at any site, a competent[1] person should evaluate the site to identify any potential hazards and ensure appropriate control measures are implemented. The jobsite had at least one identifiable hazard (i.e., a 19,500-volt overhead powerline in proximity to the east side of the residence where work was being performed). In this incident, control measures included using a non-conductive ladder and/or having the powerline de-energized or covered with insulating hoses or blankets by the utility company.

Recommendation #5: Employers should have tools and equipment (e.g., ladders) inspected on a regular basis by competent personnel and any defective or damaged equipment should be removed from service.

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[1]Competent person— one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them.

Discussion: The 40-foot aluminum extension ladder, which was being used at the jobsite, was missing the rope used to raise and lower the upper ladder section. If the ladder had been equipped with the rope, and the victim had been trained in the proper procedure of raising and lowering the ladder using the rope, the victim may have lowered the ladder to a safe height before attempting to move it. When tools or equipment are found to be defective, they should be removed from service or properly repaired.

Recommendation #6: Ladder manufacturers should consider incorporating non-conductive materials in the manufacture of aluminum ladders.

Discussion: The use of nonconductive materials in the manufacture of aluminum ladders could provide passive protection to all affected workers in the event of an inadvertent contact with an electrical conductor. One possibility to consider is the placement of a fiberglass link in the side rails of new aluminum ladders. This link would provide isolation so electricity does not have a path to ground. Additionally, incident data from the U.S. Consumer Product Safety Commission suggest that approximately 42% of ladder contact with powerlines occurs within the top 3 feet of the ladder. Therefore, consideration should be given to insulating the ladder's top few feet with a material that is non-conductive (e.g., heavy teflon). As human limitations and behaviors are known to contribute to risk (i.e., the human visual system is limited in its ability to estimate the clearance distances to powerlines, and warning labels are commonly disregarded), the use of passive safety interventions may be warranted.

REFERENCES

Office of the Federal Register: Code of Federal Regulations, Labor 29 Part 1926. pp. 20 and 171. July 1, 1989

Bellegarde, Marie L. Human Factors Analysis of Aluminum Ladders/ Powerlines Electrocution Hazard, U.S. Consumer Product Safety Commission: pp. 5-9, October 1988.

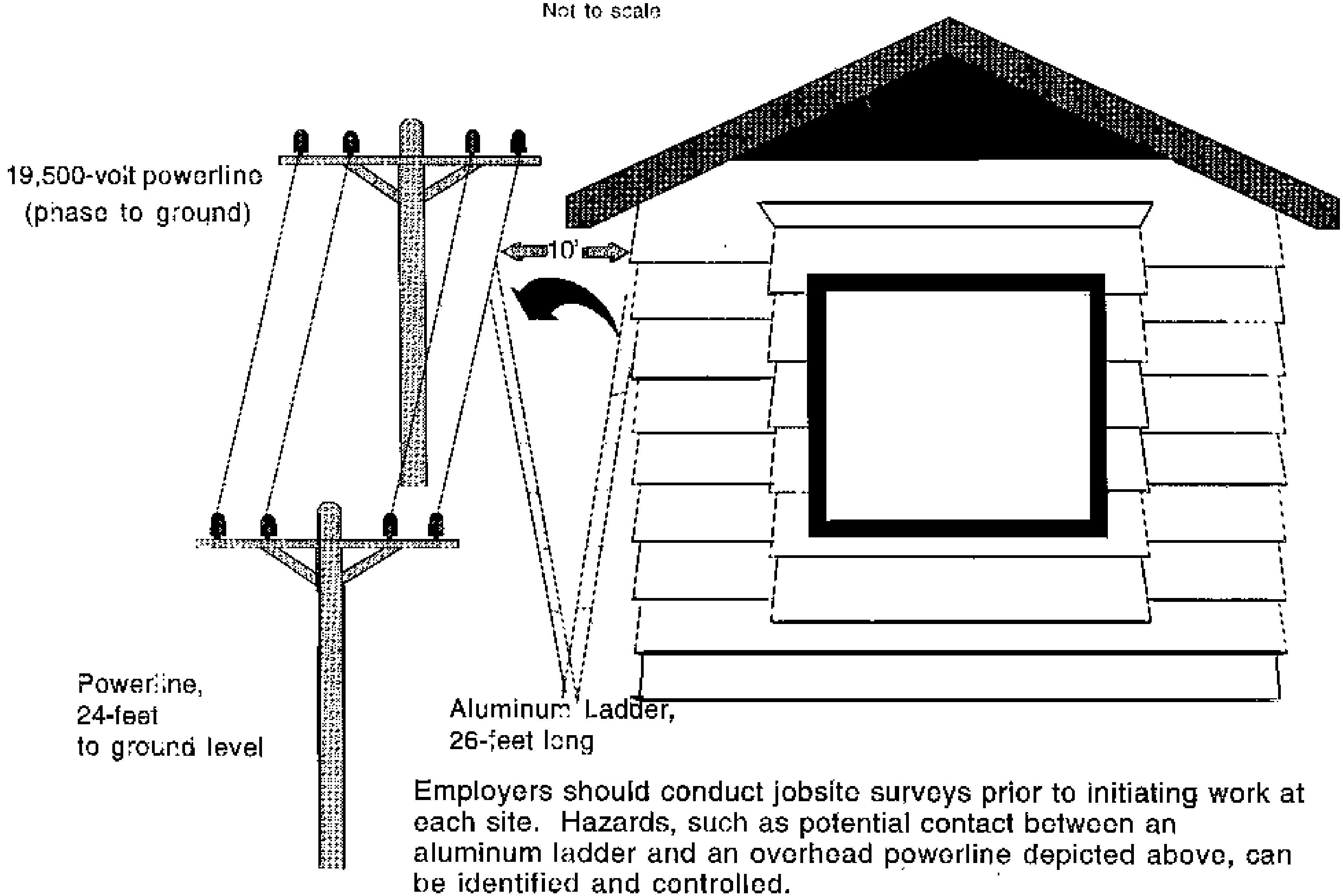

Figure. *Aluminum Ladder Contacting Overhead Powerline*

FACE 92-30: Apprentice Lineman Electrocuted While Setting Utility Pole--Virginia

SUMMARY

A 34-year-old male apprentice lineman (the victim) was electrocuted while assisting a co-worker in setting a wooden utility pole. The pole had been raised between two phases of a 34,500-volt overhead powerline and the victim was helping set the pole by steadying the butt over the hole. The victim slipped on the wet ground and his unprotected upper body fell against the pole while the top of the pole contacted one phase of the powerline (19,900-volt phase to ground). The victim was wearing rubber lineman's gloves as required by company policy. The wet connections allowed the current to travel down the pole, entering the victim's chest and exiting to ground through the victim's right elbow. The victim raised up, stepped back from the pole, and collapsed to the ground. Cardiopulmonary resuscitation was initiated immediately by the co-worker and a passing emergency medical technician; however, efforts to revive the victim were unsuccessful.

NIOSH investigators concluded that, to prevent similar occurrences, employers and utility companies should:

- consider de-energizing overhead powerlines when erecting replacement poles within existing powerline installations
- consider the use of redundant methods of protection when erecting replacement utility poles within existing energized overhead powerline installations
- ensure that, during pre-work site surveys, particular consideration is given to the hazards presented by existing environmental conditions and that additional control measures are implemented.

In addition, manufacturers of powerline maintenance equipment should:

- explore equipment designs which would allow complete "hands-off" erection of utility poles.

INTRODUCTION

On May 21, 1992, a 34-year-old male apprentice lineman (the victim) was electrocuted when the utility pole which he was helping to set contacted one phase of a 34,500 volt overhead powerline (19,900 volt phase to ground). On August 14, 1992, officials of the Virginia Occupational Safety and Health Administration (VAOSHA) notified the Division of Safety Research (DSR) of the incident and requested assistance. On September 2, 1992, a safety engineer from DSR accompanied the employer's safety director to the incident site and conducted an investigation. The investigator reviewed the incident with the safety director and the VAOSHA compliance officer assigned to the case. The incident site was photographed and the death certificate was obtained during the investigation.

The employer in this incident was a multi-state electrical contracting corporation employing a total of 500 employees, 50 of whom were apprentice linemen. The corporation had been in operation for 35 years. The company had a written safety policy and safe work procedures, as well as a full-time safety director who reported directly to the company president. The employer maintained a corporate safety committee which met every 4 months. In addition, the company participated with the local labor union in a joint safety committee. The company was conducting regular weekly safety talks and the journeyman lineman/foreman was holding toolbox safety talks on an unscheduled basis depending on the daily work assignments. The victim was classified as an apprentice lineman 3, with about 1½ years' total experience. He had successfully completed 3 weeks of formal apprenticeship training, including both classroom and hands-on sessions. This was the fourth work-related fatality experienced by the company, the last occurring in 1981.

INVESTIGATION

The employer had been contracted to perform various maintenance services for an electric utility company. On the day of the incident, the victim's crew (journeyman lineman/foreman, two journeyman linemen, and an apprentice lineman, [the victim]) had been assigned to replace a wooden utility pole located in the right-of-way along a state highway. Two of the crew members, however, had been excused from work to attend to personal business. The new pole had been placed at the jobsite 3 to 4 days before and had been lying on the ground in the powerline right-of-way. The weather had been rainy for several days before the incident and the ground at the work site was wet and muddy. The journeyman lineman/foreman (co-worker) and the victim arrived at the work site at about 2 p.m. They installed two guy wire anchors and were positioning their digging truck in preparation for installing two more anchors when the truck became stuck. They returned to the company headquarters and obtained another truck equipped with a winch. Returning to the jobsite, they freed the digging truck and installed the remaining anchors. They then positioned and grounded the digging truck and dug the hole for the replacement pole. After the hole was dug, the victim put on rubber lineman gloves as required by company policy. Using the boom and hoist of the digging truck to pick up the top end of the pole, the workers raised the pole between two phase conductors of the powerline. With his protective equipment consisting of gloves only, the victim assisted in positioning the pole by guiding and steadying the butt of the pole over the hole. The pole was almost in position so that the digging truck grabs could be closed when the victim apparently slipped on the wet ground. He fell against the pole as the top of it contacted one of the energized phase conductors. The journeyman lineman/foreman immediately looked toward the victim to check his location and saw him leaning against the pole. The victim then stood up, took a few steps backward, and fell over. The co-worker immediately moved the pole from contact with the phase conductor and dismounted the truck. He checked the victim for vital signs and immediately started cardiopulmonary resuscitation (CPR). After a few minutes the co-worker stopped a passing motorist for help, then returned to the victim and continued CPR. The motorist called the local emergency medical squad (EMS). A qualified emergency medical technician (EMT) learned of the incident when he stopped at a convenience store located across the highway from the jobsite. The EMT rushed to the scene and assisted the co-worker in administering CPR. The EMS arrived at the incident site in about 15 minutes and transported the victim to a local emergency room where he was pronounced dead.

CAUSE OF DEATH

The medical examiner determined the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers and utility companies should consider de-energizing overhead powerlines when erecting replacement poles within existing powerline installations.

Discussion: In this incident, the workers were positioning a utility pole near energized overhead transmission lines. Even though the victim was wearing rubber lineman gloves as directed by the employer's safety policy, the workers' protection ultimately depended on their own actions to avoid contact with energized conductors. De-energization of adjacent powerlines reduces the hazards of energy transfer during the erection of utility poles.

Recommendation #2: Employers and utility companies should consider the use of redundant methods of protection when erecting replacement utility poles within existing energized overhead powerline installations.

Discussion: The victim, whose only protective equipment was rubber lineman gloves, apparently slipped on the wet ground and loose dirt from the freshly dug hole, possibly swinging the pole into the energized phase conductor. Unprotected parts of his upper body made contact with the wet utility pole at the same time the pole contacted the energized phase conductor, completing a path to ground. Several types of protective equipment, in addition to gloves, could offer additional protection from contact with electricity while setting utility poles within existing energized installations. The phase conductors could be covered with insulating line hoses, or the end of the pole could be covered with a sleeve of insulating material. These methods could be used in addition to the personal protective equipment worn by individual workers to provide redundant protection against unforeseen occurrences.

Recommendation #3: Employers and utility companies should ensure that during pre-work site surveys, particular consideration is given to the hazards presented by environmental conditions and that additional control measures are implemented.

Discussion: In this incident, environmental factors may have increased the risk to workers. It had been rainy for several days before the incident. The ground was wet and muddy and freshly dug material had been placed in the immediate area around the new hole. In addition, the pole had been lying on the ground where it was exposed to the wet conditions. These factors increased the victim's risk of slip/trip falls. Had these factors been identified during the pre-work site survey, additional measures could have been implemented to control them. The freshly dug material could have been removed from the work area and dry canvas tarps spread on the ground to provide secure footing.

Recommendation #4: Manufacturers of powerline maintenance and construction equipment should explore equipment designs which would allow complete "hands off" erection of utility poles.

Discussion: The equipment used to erect the utility pole was a digging truck equipped with a boom mounted hoist and grab. It was necessary for the victim to manually assist the digging truck by guiding the butt of the pole into position over the hole before the pole could be secured in the grab. Equipment with the capability to securely grab the pole while on the ground, lift it, and position it in the hole without manual guidance, minimizes the need for worker contact.

FACE 93-14: **Truck Driver and Company President Electrocuted After Crane Boom Contacts Powerline--West Virginia**

SUMMARY

On March 31, 1993, a 20-year-old male truck driver (victim #1) and a 70-year-old male company president (victim #2) were electrocuted when the boom of a truck-mounted crane contacted an energized 7,200-volt conductor of a 3-phase overhead powerline while the driver was unloading concrete blocks at a residential construction site. The driver had backed the truck up the steeply sloped driveway at the residential construction site and was using the truck-mounted crane to unload a cube of concrete blocks while the company president and a masonry contractor watched. The driver, operating the crane by a hand-held remote control unit, was having difficulty unloading the cube of blocks because the truck was parked at a steep angle. While all three men watched the blocks, the tip of the crane boom contacted one of the conductors of the energized overhead powerline and completed a path to ground through the truck, the remote control unit, and the driver. The company president immediately attempted to render assistance and apparently contacted the truck, also completing a path to ground through his body. A passing motorist witnessed the incident, left the scene to summon help, and then returned to render assistance. The motorist successfully used a length of lumber to break the remote control unit tether from the crane, interrupting the path to ground through the driver. The motorist then provided first aid to the driver until relieved by local firemen and EMS personnel who responded within 16 minutes of notification. The driver was airlifted to a nearby burn center where he later died. The company president was pronounced dead at the scene.

NIOSH investigators concluded that, to prevent similar occurrences, employers should:

- ensure that employees comply with the relevant standards of 29 CFR 1926.550(a)(15) for safe use of cranes proximate to overhead powerlines
- ensure that pre-work site surveys include evaluation of alternative work procedures addressing site-specific hazards
- consider retrofitting truck-mounted cranes with electrically isolated crane control systems.

INTRODUCTION

On March 31, 1993, a 20-year-old male truck driver (victim #1) and the 70-year-old male president (victim #2) of a small concrete products company were electrocuted when the boom of a truck-mounted crane contacted a 7,200-volt conductor of a 3-phase overhead powerline at a residential building site. On April 1, 1993, the county medical examiner contacted the Division of Safety Research (DSR) and requested technical assistance. On April 1, 1993, a DSR safety engineer investigated the incident at the site. The DSR representative interviewed the investigating officer from the county sheriff's office, the plant manager for the concrete products company, the masonry contractor, and the passing motorist. The DSR representative photographed the incident site and the truck, obtained measurements of the incident site and requested the medical examiner's report.

The employer was a concrete products company that had been in business for approximately 11 years, employing 14 workers, 3 of whom were truck drivers. Safety responsibilities were assigned to the plant manager as a collateral duty. The company had a written safety program which included general policies for truck drivers. Victim #1, the truck driver, had been driving for eight months; before that he had been employed in the company's concrete block plant. When first assigned as a truck driver, he received training from an experienced driver, which included supervised practice unloading trucks in the plant yard. The driver was accompanied by an experienced driver on several deliveries until he was judged knowledgeable to work alone. He made his first delivery to the construction site on the day of the incident. Victim #2, the company president, had about 11 years' experience in the concrete products industry and had been associated with the construction and mining industries during his entire working career. These were the first fatalities experienced by the company.

INVESTIGATION

The residential building site in this incident, located on a hillside, was accessed from a state road by a steeply pitched (15% grade) rough-cut driveway. The state road was 17½ feet wide and protected by a guardrail about 5 feet from the road edge opposite the entrance to the driveway. The energized overhead powerlines were located 25 feet above ground and 6 to 8 feet from the edge of the state road. Several days before the incident, the plant manager had examined the site because the company was aware of the limited operating space available for delivery trucks. The plant manager cautioned drivers, who were assigned to deliver to the site, including victim #1, about the limited space available for parking delivery trucks, the steep grade of the driveway, and the proximity to the overhead powerlines.

On the day of the incident, the company president arrived at the site shortly after 2:30 p.m. to meet with the masonry contractor and to observe the delivery. The driver, who had been dispatched to the site at 2:15 p.m. with 28,490 pounds of concrete blocks, arrived at about 2:45 p.m. The driver, directed into the driveway by the company president, backed the truck up the driveway until the rear wheels reached the upper end. He set the crane outriggers, positioned himself 20 to 30 feet from the truck's left side, and operated the crane by the tethered remote control unit. The company president and the masonry contractor walked to the rear of the truck to watch the driver unload the blocks. Because the truck was parked on the steeply sloped drive, when the driver lifted the first cube of blocks (i.e., a quantity of concrete blocks stacked so that they can be readily removed from the truck by the crane), it swung forward against an adjacent cube. The driver had difficulty maneuvering the cube of blocks away from the truck bed because the truck was parked at an angle on the steep slope causing the cube to contact an adjacent cube. The driver, the company president, and the masonry contractor were focusing their attention on the cube of blocks. While the driver attempted to unload the cube, the masonry contractor saw a ball of fire travel down the remote control tether and ignite the driver's clothing in his chest area. As the driver fell backward in flames, the masonry contractor saw the company president run to the driver's assistance. Approaching the driver, the company president slid down the steep bank then climbed to his feet and ran toward the open door of the truck cab (Figure). Because the masonry contractor was standing behind the truck, he did not see the company president contact the truck.

During the incident, a motorist driving on the state road, approached the site and saw arcing between the powerlines and the crane boom. According to the motorist, he stopped his car some distance from the site, waited until the arcing stopped, then drove by the site. As he drove by, the masonry contractor called to him to summon help. The motorist drove to a nearby office and asked the workers to call 911 for emergency help. He then returned to the site where he simultaneously noticed a small fire at the rear of the truck, the driver about 20 feet away from the truck holding the remote control unit, and the masonry contractor shoveling dirt on the fire. He stopped his vehicle and called to both men to abandon the area. At that instant, another arc occurred between the crane boom and the 7,200-volt powerline and the motorist saw flame travel down through the tether to the driver. The grass and brush around the driver caught fire, and the motorist called again to the masonry contractor to leave the area. The motorist then climbed the bank towards the truck. Picking up a length of 2 by 4 lumber, he approached the truck from uphill until he was close enough to break the remote control tether connection to the crane with the 2 by 4 board. While the masonry contractor shoveled dirt on the fire, the motorist picked up a water hose used at the site and doused the fire. Once the fire was extinguished, the motorist went to the driver, who was on the ground gasping for air. The local fire department arrived within 16 minutes of being notified and took charge of the scene, followed shortly by the EMS. The driver was airlifted from the site to a burn center approximately 70 miles away where he later died. The company president was pronounced dead at the scene.

The masonry contractor stated during interviews that when he first observed the flame traveling along the tether, he thought the truck's electrical system had malfunctioned. He last observed the company president running toward the open door of the truck cab, but because the company president was out of his line of sight, the masonry contractor did not see him contact the truck.

CAUSE OF DEATH

The medical examiner's office determined the cause of death for the company president as electrocution. The driver died as a result of 98% total body burns, third degree electrical.

RECOMMENDATIONS/DISCUSSION

Recommendation No. 1: Employers should ensure that employees comply with the relevant standards of 29 CFR 1926.550(a)(15) for safe use of cranes proximate to overhead powerlines.

Discussion: Of particular importance in this incident are the provisions of 29 CFR 550(a)(15)(i) which require that for power lines rated at 50 kV or less, 10 feet of clearance be maintained between the lines and the equipment and any part of the load. Additionally, 29 CFR 550(a)(15)(iv) requires that a person be designated to observe the clearance between the lines and the equipment, and to give timely warning for all operations where it is difficult for the operator to maintain desired clearance by visual means. The powerline in this incident, part of a 3-phase distribution system of 7,200-volts phase to ground, ran parallel to the county road with the center conductor 6 to 8 feet from the road's edge and 25 feet above ground level. During the incident the crane boom contacted the field (or site side) conductor which was located 10 to 12 feet from the road edge. The truck boom was 10½ feet above ground level when in the transport position, and accounting for the 15% grade on which the truck was parked, would have been about 12 to 14 feet below and about 6 feet away from the field side conductor before being elevated to unload the cube of blocks (Figure). To unload the blocks, the crane had to be raised out of its cradle and swung to the side, placing it under the field conductor and eliminating safe clearance between the crane boom and the energized conductor. The driver experienced difficulty unloading the blocks, and had to divide his attention on the clearance between the lines and the boom, and the movement of the cube of blocks, which was taking place in another direction and at a lower elevation. Designating a person to monitor the clearance between the boom and the energized lines, and to give timely warnings, provides equipment operators with additional assistance in maintaining safe line clearances.

Recommendation No. 2: Employers should ensure that pre-work site surveys include evaluation of alternative work procedures addressing site-specific hazards.

Discussion: Several days before the incident, a worksite survey was conducted which revealed several potential hazards that might affect the safe delivery of the building materials. All drivers assigned to deliver to the site had been cautioned about the hazards. Such pre-work site surveys can also include evaluation of work procedures other than delivering the materials directly to the site. One alternative might have been to unload the materials at another location and transfer them to a smaller vehicle for delivery to the site. Although such an operation may have been more labor intensive and time consuming than direct delivery using the truck-mounted crane, use of a smaller vehicle at the site could have provided additional space for maintenance of safe clearance between the unloading operation and the energized powerlines. Another alternative could have been to request the utility company to de-energize or insulate the overhead powerlines. De-energization and visible grounding of the powerlines would eliminate the source of hazardous energy. Where it is not possible or desirable to interrupt power transmission, overhead lines could be temporarily insulated to provide additional protection during crane use. While temporary insulation of powerlines using line hose or blankets cannot be viewed as an alternative to maintaining safe clearance, such insulation could provide redundant protection when energized powerlines are inadvertently contacted during difficult maneuvering of crane booms and loads.

Recommendation No. 3: Employers should consider retrofitting truck-mounted cranes with electrically isolated crane control systems.

Discussion: The remote control unit used on the crane was electrically connected to the crane. This unit provided a path to ground when held by the driver. A system which is isolated electrically could protect the crane operator in the event of inadvertent contact with energized electrical conductors. Such a system might employ the use of radio or fiber optics to transmit control signals, eliminating the path to ground through electrical conductors.

REFERENCE

29 CFR 1926.550(15) Code of Federal Regulations, U.S. Government Printing Office, Office of Federal Register, page 204, July 1, 1990.

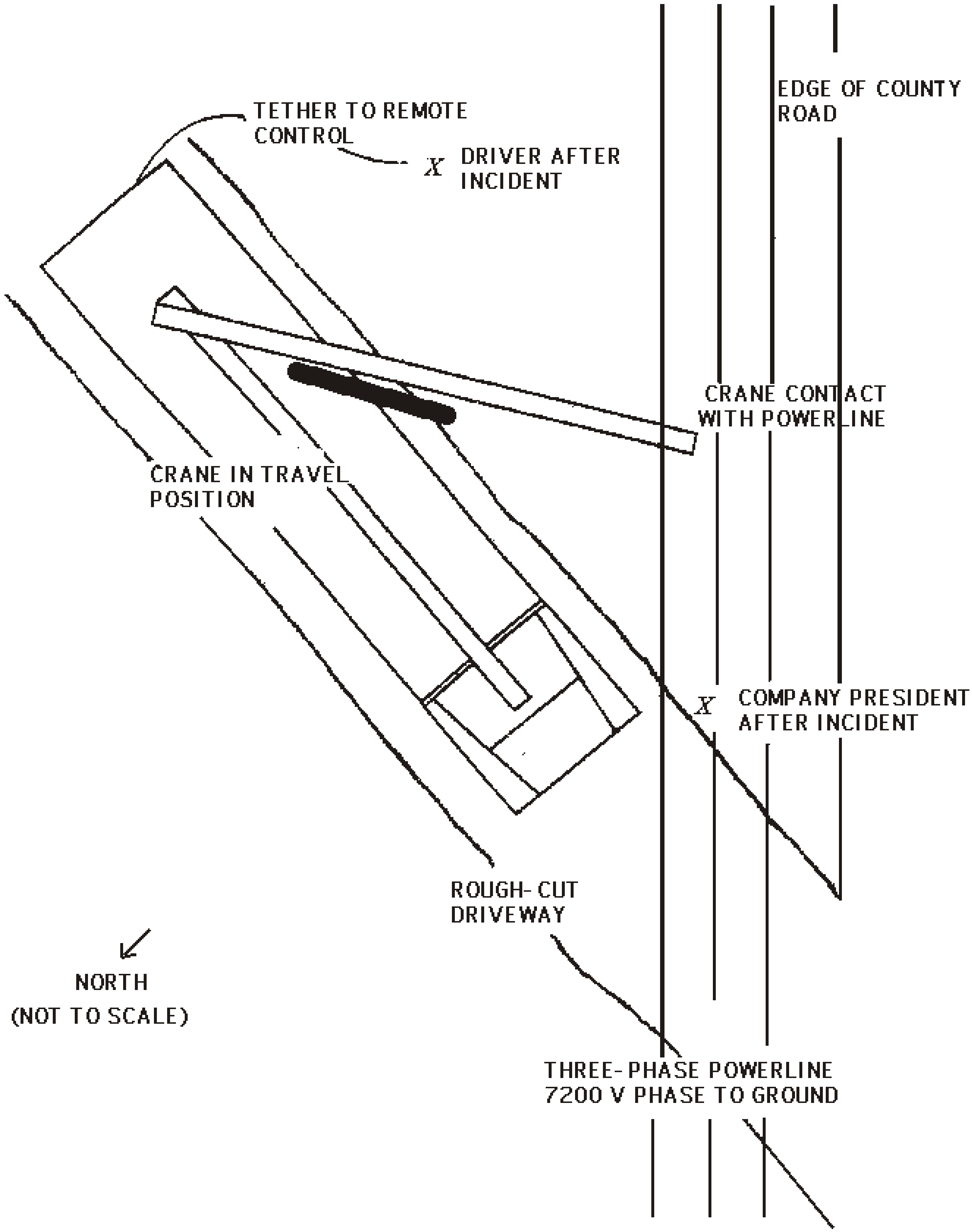

Figure. *Location of Truck Relative to Powerline*

FACE 93-18: **Electrician Apprentice Electrocuted after Contacting a 480-volt Conductor in South Carolina**

SUMMARY

A 42-year-old male electrician apprentice (the victim) was electrocuted when he contacted an unguarded energized 480-volt overhead crane contact conductor. The victim and two co-workers had just performed electrical maintenance on the hoisting motor of the overhead crane, and the crane was moved approximately 200 feet in order to access another overhead crane. The two co-workers were positioned on top of the bridge of the crane, while the victim operated the controls inside the operator's cab to move the crane. After the crane was stopped alongside the second overhead crane, the victim exited the cab and proceeded to climb a metal ladder attached to the cab, which led to the top of the bridge where the other workers were located. Approximately halfway up the 7-foot metal ladder, the victim apparently partially lost his footing and grip on the ladder. As he began to fall, he extended his left arm to catch himself and his left hand contacted one conductor of the energized, three-phase, 480-volt overhead crane contact conductors. The electrical current passed through the victim's body to ground through his right hand, which was grasping the metal ladder. When the victim's hard hat fell to the ground, another worker located on the ground beneath the crane looked up and saw the victim dangling from the ladder. He alerted the workers on the bridge, and they moved to assist the victim. One of the workers administered cardiopulmonary resuscitation (CPR), while another worker ran to call for medical assistance. An ambulance arrived in about 15 minutes and paramedics continued CPR and transported the victim to a local hospital where he was pronounced dead on arrival. NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- implement Article 610-21(a) of the National Electrical Code entitled "Locating or Guarding Contact Conductors"

- identify potential hazards and appropriate safety interventions in the planning phase of maintenance projects

- routinely conduct plant surveys to identify potential and/or existing hazards and develop and implement appropriate intervention measures for these hazards.

INTRODUCTION

On June 21, 1993, a 42-year-old male electrician apprentice (the victim) was electrocuted when he inadvertently contacted an unguarded energized overhead crane contact conductor. On June 24, 1993, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On July 26, 1993, a safety specialist from DSR conducted an investigation of this incident. The safety specialist reviewed the incident with a company representative and the SCOSHA compliance officer assigned to the case. Photographs of the incident site were taken, and the medical examiner's report was requested.

The employer in this incident was a steel-alloy rolling mill that had been in operation for 31 years. The company had 300 employees, including 4 electrician apprentices who helped install and maintain the plant's electrical systems and equipment. The company had a full-time director of safety and a comprehensive safety program including written safety policies and procedures. Monthly employee and supervisor safety meetings were held, and CPR and first aid training were provided to all supervisors. The victim had worked for this employer for 4 months prior to the incident, but had about 4 years' experience as an electrician apprentice. This was the second fatality the company had experienced.

INVESTIGATION

The steel-alloy rolling mill was conducting normal operations on the day of the incident. The mill operates 24 hours a day producing steel bars, plates, and billets from recycled materials, such as motor vehicles and appliances. At the time of the incident, the victim had completed his normal work shift (3 a.m. to 11 a.m.), and was working overtime. He was helping to repair the hoisting motor located on a 10-ton overhead cab-operated crane in a building that was being used to warehouse the steel products.

The victim and two co-workers (one foreman and another electrician apprentice) proceeded to the warehouse and accessed the overhead crane by climbing a permanent metal stairway. The crane was one of two rail-mounted, cab-operated, overhead-traveling cranes which ran the length of the 800-foot building.

Power for the cranes was provided, via collector leads, by a three-phase, 480-volt circuit composed of three bare steel contact conductors which ran adjacent to the operator's cab/crane bridge (Figure) for the entire length of the building.

After repairing the speed controls on the crane's hoist motor, the foreman instructed the victim to move the crane down the warehouse and park it alongside the other overhead crane in preparation to check the brakes on the other crane. The co-workers were located on top of the bridge of the crane, while the victim operated the controls inside the operator's cab to move the crane. After stopping the crane, the victim exited the cab and started to climb a 7-foot steel ladder attached to the outside of the cab and adjacent to the unguarded energized contact conductors. Approximately halfway up the ladder, the victim apparently lost his footing and grip on the ladder. As he began to fall, he extended his left arm to catch himself and his left hand contacted one conductor of the energized, three-phase, 480-volt overhead crane contact conductors. The current (277 volts phase-to-ground) passed through the victim's left arm and chest, and exited to ground through the victim's right hand, which was grasping the metal ladder. The victim slumped over backwards with his foot and leg still hanging over the rung of the ladder. When his hard hat fell to the ground, another employee working on the ground beneath the crane looked up and saw the victim dangling from the ladder. He alerted the workers on the bridge and they moved to assist the victim. One of the workers administered CPR, while the worker on the ground ran to call for medical assistance. The co-workers moved the victim to ground level, and an ambulance arrived in about 15 minutes. Paramedics continued CPR and transported the victim to a local hospital where he was pronounced dead on arrival.

CAUSE OF DEATH

The medical examiner reported the cause of death as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should implement Article 610-21(a) of the National Electrical Code, which is entitled "Locating or Guarding Contact Conductors."

Discussion: This article states that "Runway contact conductors shall be guarded, and bridge contact conductors shall be located or guarded in a manner that persons cannot inadvertently touch energized current-carrying parts." The National Electrical Code defines guarded as "covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger." The crane runway conductors were not guarded when this incident occurred. [Note: Subsequent to the incident, metal screen guards were welded around the operator's cab/bridge area that is in proximity to the contact conductors.]

Recommendation #2: Employers should identify potential hazards and appropriate safety interventions in the planning phase of maintenance projects.

Discussion: Worker safety should be addressed and incorporated into all maintenance projects during both the planning and operational phases of a project. The planning phase should identify all hazards that may be encountered, and implement procedures and safety interventions to control or eliminate such hazards. These procedures should include, but not be limited to, inspecting the work environment prior to initiating work, developing safe work practices and procedures, selecting qualified personnel, providing training in hazard recognition and abatement, and identifying and addressing personal protective equipment needs.

Recommendation #3: Employers should routinely conduct plant surveys to identify potential and/or existing hazards and develop and implement appropriate intervention measures for these hazards.

Discussion: The building where the incident occurred was the previous site of the melt shop/rolling mill. The melting furnaces and rolling mill had been shut down and the building partially abandoned. At the time of the incident, the building was used to warehouse the steel products, and was accessed on a limited basis for operation and maintenance of the overhead cranes. Employers should routinely conduct plant surveys throughout all work areas, including those areas of limited usage, to identify any hazards and develop and implement appropriate measures to control or eliminate these hazards. [Note: The contact conductors used to power the newer overhead cranes in the new melt shop/rolling mill were installed on the opposite side of the crane bridge, thus eliminating operator exposure to the conductors during entry to, or egress from, the crane cab.]

REFERENCES

National Fire Protection Association: National Electrical Code Handbook, p. 740, 1993.

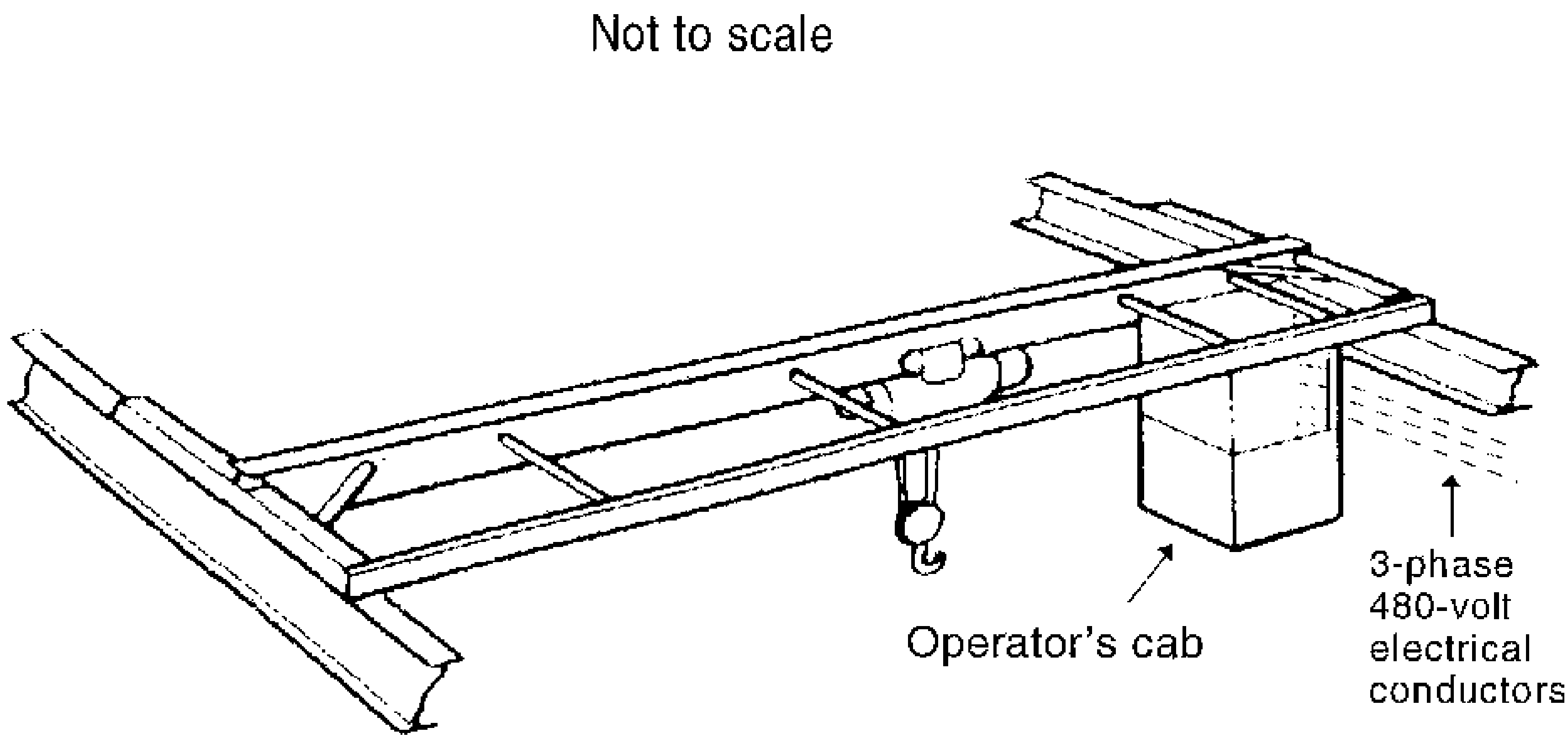

Figure. *Overhead Cab-operated Crane*

FACE 94-08: **Department of Transportation Maintenance Foreman is Electrocuted and a Highway Maintenance Worker Severely Burned When Truck Bed Contacts Overhead 7,200-volt Powerline--South Carolina**

SUMMARY

A 46-year-old male road maintenance foreman (the victim) died and a 20-year-old male road worker was severely burned when the 20-foot-long dump bed of a truck, which was backed against a paving machine they were leaning on, contacted an overhead 7,200-volt powerline. The victim and the road worker were members of a 5-man crew that was paving a 2-lane highway frontage road and an interstate exit ramp. An overhead 7,200-volt powerline ran in a direction perpendicular to the frontage road. One lane of the frontage road had been paved, and the crew was paving the second lane at the time of the incident. The victim was leaning on the paving machine, a road worker was operating the asphalt depth screw regulator while standing on the ground, and two other road workers were positioned at the operator station on the paving machine. The truck was backed up against the paving machine and the victim motioned for the driver to raise the truck bed to allow the asphalt material to flow into the paving machine. As the bed raised, the warning alarm flasher at the left top corner of the truck bed sounded and flashed, then the truck bed contacted the 7,200-volt powerline. The electric current traveled through the truck body and paving machine to the ground through the victim and the road worker. The victim was electrocuted and the road worker received severe electrical burns. The truck driver lowered the bed away from the powerline, and neither he nor the two road workers on the paving machine was injured. NIOSH investigators concluded that, in order to prevent similar circumstances, employer should:

- conduct a jobsite survey before starting any work to identify any hazards, implement appropriate control measures, and provide subsequent training to employees specific to all identified site hazards

- contact the local utility company to de-energize or insulate the powerlines when circumstances offer no alternative to operating a dump truck in proximity to powerlines

- conduct safety meetings at frequent intervals.

In addition, utility companies should:

- ensure that the vertical clearance of their supply cables complies with applicable rules of the National Electrical Safety Code.

INTRODUCTION

On March 15, 1994, a 46-year-old highway maintenance foreman (the victim) was electrocuted and a 20-year-old highway maintenance worker received severe electrical and thermal burns over 35 percent of his body when the raised bed of a dump truck, which was backed against the paving machine they were leaning on, contacted an overhead powerline. On March 18, 1994, officials of the South Carolina Occupational Safety and Health Administration (SCOSHA) notified the Division of Safety Research of this fatality, and requested technical assistance. On March 24, 1994, a DSR safety specialist conducted an investigation of this incident. The incident was reviewed with the SCOSHA compliance officer, the highway patrol, and the county coroner. Photographs of the incident site were taken.

The victim was employed by the state department of transportation (DOT). The DOT had 5,000 employees, 15 of whom worked in the regional highway maintenance section where the victim was employed. The DOT had a written safety program and written safety rules. Weekly tailgate safety meetings were conducted at the jobsite by the crew foreman, and training was conducted on the job. The workers had received basic training regarding work around overhead powerlines. For example, powerlines are uninsulated, and the crew supervisor would serve as an observer to ensure that safe clearance would be maintained away from overhead powerlines.

The victim had worked for the DOT for 20 years. This was the first fatality the DOT had experienced in the past 3 years.

INVESTIGATION

A 5-man DOT road maintenance crew (the foreman [the victim], two paving machine operators, truck driver, laborer [injured co-worker]) had been assigned the task of repairing and repaving an interstate highway exit ramp and a section of a 2-lane highway frontage road that ran parallel to the interstate. An overhead 7,200-volt powerline ran perpendicular to the frontage road (Figure). The crew had discussed the presence of the overhead powerline, and the crew foreman said that he would monitor the clearance between the asphalt truck and the powerline. Three weeks prior to the day of the incident, the crew had been at the same site repairing the exit ramp and the frontage road.

On the day of the incident, the crew was repaving a section of the frontage road. By 2:30 p.m., one lane of the section of frontage had been repaved and the crew had begun repaving the second lane. The foreman was leaning against the paving machine, one road worker was operating the asphalt depth screw regulator while standing on the ground at the rear of the paving machine, and two workers were seated at the operator's station on the paving machine. The crew foreman directed the truck as it backed against the paving machine. When the truck was against the paving machine, the foreman directed the truck driver to raise the bed to allow the asphalt to flow into the paving machine. As the bed was raised, the proximity warning flasher at the top left corner of the truck bed sounded and flashed. The truck bed then contacted the 7,200-volt powerline. The current traveled through the truck bed and paving machine to ground through the foreman and the road worker at the rear of the machine. The road worker's clothes ignited. The truck driver heard the arc when the truck bed contacted the powerline and immediately lowered the bed. Neither he nor the two workers on the paving machine was injured. The driver radioed the office and requested the emergency medical service (EMS). The crew members immediately initiated cardiopulmonary resuscitation (CPR) on the foreman. Although the road worker at the rear of the machine had received severe burns to 35% of his body, he was breathing and conscious. The men were lifeflighted to the hospital, where the foreman was pronounced dead by the attending physician.

Measurements taken at the site revealed that the powerline was located 15 feet, 10 inches above the roadway. The truck bed could be raised to a maximum height of 17 feet, 3 inches. Since the incident, the utility company raised the powerline to a height of 20 feet.

CAUSE OF DEATH

The coroner listed the cause of death as electrocution.

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RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct a jobsite survey before starting any work to identify any hazards, implement appropriate control measures, and provide subsequent training to employees specific to all identified site hazards.

Discussion: Prior to any work being undertaken, a jobsite evaluation should be performed by a competent person[1] to identify potential hazards: the uninsulated overhead powerline, work being performed underneath and in proximity to an overhead powerline, and the dump truck with a 20-foot bed that could be elevated to a height of 17 feet 3 inches. Once potential hazards are identified, appropriate control measures can be implemented and corresponding employee training provided. For example, all employees at the site could have been instructed to monitor the clearance between the overhead powerline and the truck bed.

Recommendation #2: Employers should contact the local utility company to de-energize or insulate the powerlines when circumstances offer no alternative to operating a dump truck in close proximity to powerlines.

Discussion: De-energizing powerlines in work areas will provide workers protection as long as clear communication among the utility company, the employer, and the workers is maintained. All parties involved must be aware of when the powerlines will be de-energized, the period of time the powerlines will be de-energized, and the exact time power will be restored so that workers are not exposed to energized conductors. Insulating powerlines by installing line sleeves, or hoses, will offer a measure of protection, but should not be the only means utilized to prevent contact with electrical energy. When there is no alternative to operating a dump truck near overhead energized powerlines, these procedures may provide basic viable options.

Recommendation #3: Employers should conduct safety meetings at frequent intervals.

Discussion: Although weekly tailgate meetings were held, the length of time that individuals retain such information varies considerably. Safety meetings conducted at frequent intervals (even daily when workers are exposed to hazardous conditions) should help ensure that more workers retain important safety information and are provided an opportunity to discuss relevant safety concerns and issues.

Recommendation #4: Utility companies should ensure that the vertical clearance of their supply cables complies with applicable rules of the National Electrical Safety Code.

Discussion: National Electrical Safety Code Rule 232B1 requires that for open supply conductors over 750 volts to 22 kilovolts, an 18½-foot clearance between the supply conductor and roads, streets, and other areas subject to truck traffic must be maintained. It is possible that the truck bed may have stretched the conductor slightly in this case; however, utility companies should ensure that required clearance distances are maintained.

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[1]Competent person: One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them.

REFERENCES

IEEE [1992]. The National Electrical Safety Code, The Institute of Electrical and Electronic Engineers, Inc., August 3, 1992, 1993 Edition, p. 75.

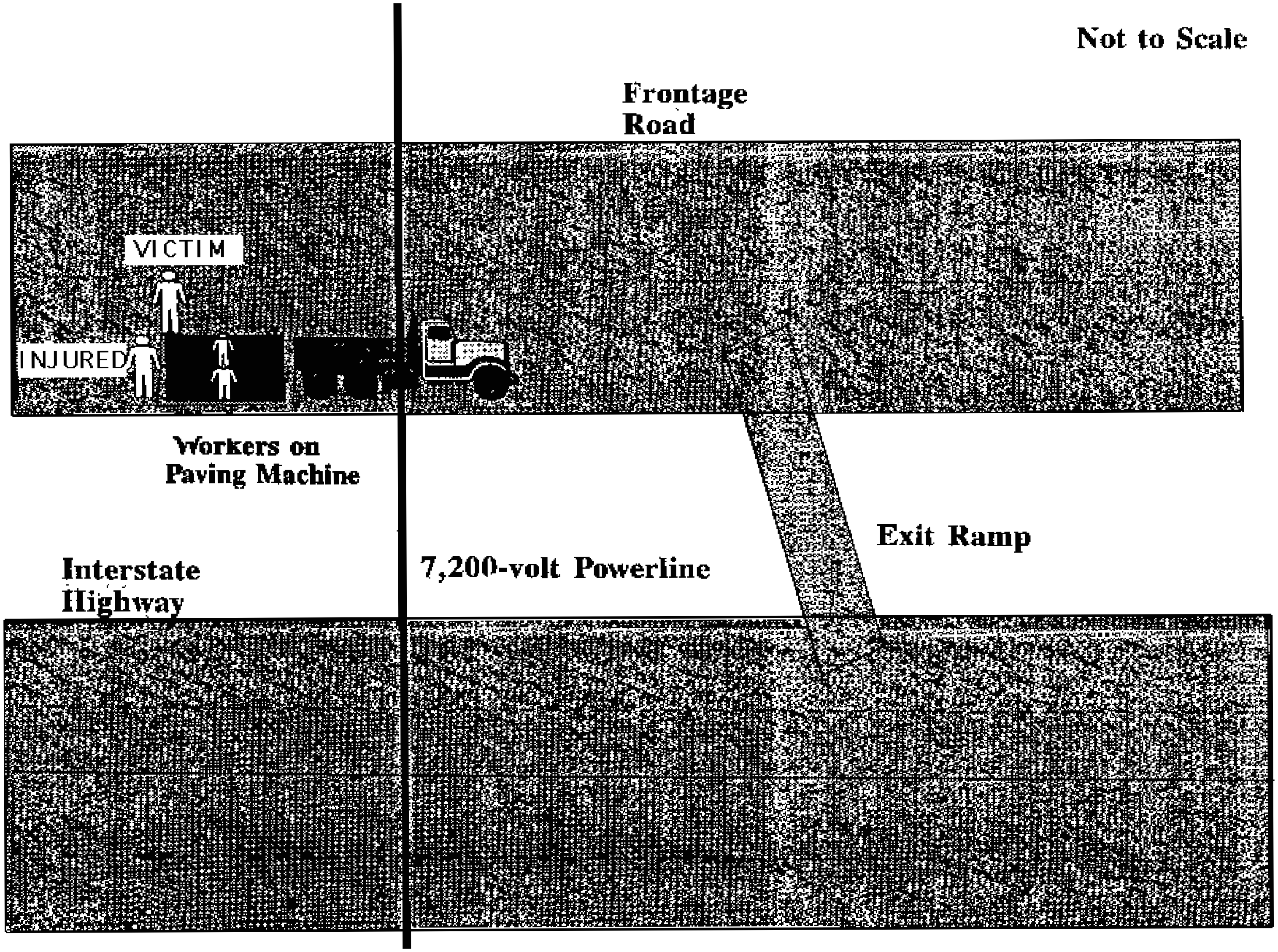

Figure.

FACE 94-10: **Journeyman Wireman Electrocuted After Contacting Energized Switchgear Components at Power Plant--West Virginia**

SUMMARY

On March 14, 1994 a 53-year-old male journeyman wireman (the victim) was electrocuted when he contacted two energized 6.9 kV buss terminals at a power plant. The victim and two co-workers had been engaged in final installation of electrical components associated with a sulfur dioxide emissions control system. These components were being installed in a 14-compartment switchhouse. The circuit breaker protecting the switchhouse's internal buss had been isolated according to the power plant tagout procedures. The victim and co-workers were wiping down the individual compartments in preparation for a pre-startup inspection by power plant personnel. Without the knowledge of the victim and co-workers, the switchhouse's internal buss had been energized by power plant personnel; when the victim attempted to wipe down one of the compartments at the south end of the switchhouse, he contacted the A phase buss terminal with his right hand and the C phase buss terminal with his left hand. This completed a path between phases for 6.9 kV and he was electrocuted. One co-worker was walking past the victim when the incident occurred; he was blown backward from the resulting explosion, and received first degree flash burns on the face and neck. The second co-worker, at the north end of the switchhouse, heard the explosion and came to render assistance. The contractor's safety coordinator was notified by radio and EMS assistance was requested. The EMS responded in approximately 15 minutes and transported the victim to a local hospital emergency room where he was pronounced dead.

NIOSH investigators concluded that, to prevent similar occurrences, employers should:

- develop and implement procedures to control hazardous electrical energy which include both lockout and tagout provisions

- provide employees with voltage sensors and implement their use prior to and during workers' entrance into enclosures containing electrical components.

In addition, power plant owners and supervisory personnel should:

- consider installing hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization

- ensure that employees follow all safety procedures established for control of hazardous electrical energy.

INTRODUCTION

On March 14, 1994, a 53-year-old male journeyman wireman (the victim) was electrocuted when he contacted the 2 phases (A and C) of an energized buss inside a swithchhouse at a power plant. The following day the Division of Safety Research (DSR), National Institute of Occupational Safety and Health, learned of the incident through a newspaper article and contacted the employer to offer technical assistance. A DSR safety engineer investigated the incident at the site on March 25, 1994. The DSR representative interviewed a vice president of the electrical contracting company and the company's on-site safety coordinator, took measurements of the site and requested the medical examiner's report.

The employer had been in business for 76 years and employed 10,000 workers nationwide, about half of whom were journeymen wiremen. The employer was one of two contractors installing a sulfur dioxide emissions control system for the utility company which owned the power plant and had been on site for 1 year. The company maintained a full-time corporate safety director and an on-site safety coordinator. The company normally adhered to a company-wide lockout and tagout procedure; however, for this particular job, the company had adopted the utility company's procedure, a tagout-only policy. Employees of the contractor received on-the-job training in addition to safety-manual and new-hire orientation. Weekly safety meetings were held at the jobsite and safety talks were given each time a job task was changed.

INVESTIGATION

The incident occurred on the third floor of the power plant electrical equipment building where workers were in the final stages of installing electrical components inside a 14-compartment switchhouse. The switchhouse and associated switchgear were part of a newly installed sulfur dioxide emissions control system for the power plant and had never been energized.

On March 14, 1994, employees of the contractor began work at 7 a.m. The victim and two co-workers went to the third floor of the electrical equipment building where they had been installing electrical components inside the switchhouse. The workers were completing the installation which included making the final connections to the ground circuit, checking electrical connections for proper tightness, and cleaning the inside of the switchhouse compartments prior to pre-startup inspection by power plant personnel. They were engaged in this activity during the morning and most of the afternoon. The switchgear had been isolated according to the tagout procedure in effect at the power plant but was not physically locked against energization. All of the circuit breakers inside the switchhouse had been isolated by placing the panel-mounted circuit breaker operating handles in the remote position and tagging out (red tag). The circuit breakers can be opened in two ways remotely or manually depending on which mode of operation is selected at the switch handle on the front panel of each compartment. In the remote position, the breakers can be operated from outside the electrical equipment room. When manual operation is selected, the circuit breakers can only be closed from the front panel. Power (6.9 kV) is supplied to the north end of the switchhouse by insulated conductors which are connected to an internal buss running the length of the switchhouse. Power is then distributed from the enclosure to various areas of the facility.

At about 3:30 p.m. without the knowledge of the workers, the red tag posted on the circuit breaker protecting the internal buss was replaced by a green tag and the breaker was closed by power plant personnel. This energized the internal buss of the switchhouse. The workers continued working, unaware that the switchhouse buss was energized. At about 4:40 p.m. the victim reached inside the upper part of the second compartment from the south end of the switchhouse to wipe it down. This compartment contained three buss terminals, A, B, and C phases, where a jumper had been connected to carry power to an adjacent switchhouse. As he reached inside the compartment, he contacted the A phase terminal with his right hand and the C phase terminal with his left hand and was electrocuted. One of the co-workers had been walking past the victim at the time of contact, was knocked down to the floor by the blast and suffered first degree burns on his neck and face. A second co-worker, at the north end of the switchhouse, heard the explosion and went to render assistance to the victim, who had fallen to the floor and whose clothes were on fire. The second co-worker suffered burns to his hands when he tried to beat out the flames. The contractor's safety coordinator was notified by the operator of a cherry picker, who had witnessed the flash of the explosion from outside the building. The safety coordinator notified plant security to request emergency medical services (EMS) and then went to the third floor. He checked the victim for a pulse and finding none, started CPR. In approximately 15 minutes, the EMS arrived and transported the victim to a local hospital emergency room where he was pronounced dead.

CAUSE OF DEATH

The cause of death was established by the deputy medical examiner as electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop and implement procedures to control hazardous electrical energy which include both lockout and tagout provisions.

Discussion: The tagout procedure established by the power plant did not include physically locking out the switchgear. The procedure allowed the switchgear to be placed in the remote position and a red tag (known as a "release" tag) placed on the panel-mounted breaker control handle on the front panel of the compartment and a corresponding red tag placed on the appropriate controls located in the power plant control room. It was intended by the procedure that this tag had the same effect as physically locking out the switchgear compartment. However, because the handle was placed in the remote position, it was possible to operate and energize the compartment remotely from outside the equipment room. While lockout procedures are not fail-safe, physically isolating electrical components with locks whose keys are controlled by the workers performing the work in the compartment would provide an additional level of protection.

Recommendation #2: Employers should provide employees with voltage sensors and implement their use prior to and during workers' entrance into enclosures containing electrical components.

Discussion: Voltage-sensing instruments are available which when used, can detect the presence of energized electrical components. These hand-held instruments could be provided to anyone prior to entry into enclosures such as switchhouses containing electrical components and could be used to provide a final check and warning of the presence of hazardous electrical energy. Use of these detectors should not be considered a first-line defense against exposure to energized electrical components; however, their use could offer a back-up to a lockout/tagout isolation policy.

Recommendation #3: Owners of power plants should consider installing hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization.

Discussion: Additional protection against contact with energized components could be provided by installing warning lights inside compartments which contain electrical equipment not under the direct control of the workers. Such a light could be connected to the control circuit for the switchgear to indicate that the equipment is energized. Multicompartment switchouses should have a separate light mounted inside each compartment where it is readily visible to workers.

Recommendation #4: In addition, power plant supervisory personnel should ensure that employees follow all safety procedures established for control of hazardous electrical energy.

Discussion: The tagout procedure in effect at the power plant required that prior to energizing electrical equipment which had been isolated by red tagging, an inspection of the equipment and area should be performed by qualified persons; the switchhouse doors and access panels should be closed; and the area cleared of all persons. The person authorized to red tag the equipment then removes the tag and places a green tag on the equipment, indicating that the equipment is to be operated for test purposes only. The equipment can then be energized. On the day of the incident, this procedure was bypassed when the red tag isolating the circuit breaker protecting the internal buss was replaced with a green tag while work was being performed inside the open switchhouse compartments.

FACE 94-17: HVAC Contractor and Employee Electrocuted in Crawlspace--North Carolina

SUMMARY

A 46-year-old male HVAC contractor and his 23-year-old employee (the victims) were electrocuted while installing air conditioning duct work in a crawlspace. The contractor and employee were installing a combination heating, ventilating, and air conditioning unit at a private residence. The employee was under a 38-inch-high crawlspace installing aluminum straps around the new duct work, using an electric drill to install screws through the straps. As the employee drilled a hole, the sharp edge of the strap contacted house wiring attached to a floor joist above him, damaging its insulation. This action allowed the drill bit and strap, which the employee was holding, to become energized. The current passed through the employee to ground, either through a cast iron sewer drain pipe or through cold water pipes in the immediate working area of the victim. The contractor, installing duct work in the attic, was summoned to the crawlspace by the residence owner, who had heard noise in the crawlspace. The contractor called into the crawl space for the employee, but did not receive an answer. The contractor entered the crawlspace and grabbed the victim while leaning against the same water pipe as the victim, allowing the current to flow through him to the ground. The owner of the residence pulled the main circuit breaker for the house and called 911. Police, fire, and emergency medical service personnel responded to the scene and, finding both men in cardiac arrest, initiated cardiopulmonary resuscitation. The victims were transported to the local hospital, where they were pronounced dead by the attending physician. NIOSH investigators determined that, in order to prevent similar incidents, employers should:

- conduct a jobsite survey before starting any work to identify any hazards, implement appropriate control measures, and provide subsequent training to employees specific to all identified hazards

- develop, implement and enforce a comprehensive written safety program

- provide additional electrical safety training to those workers working with or around electrical current, including proper rescue procedures.

INTRODUCTION

On August 30, 1994, a 46-year-old male HVAC contractor and his 23-year-old employee (the victims) were electrocuted while installing air conditioning duct work in a crawlspace. On August 31, 1994, officials of the North Carolina Occupational Safety and Health Administration notified the Division of Safety Research (DSR) of this fatality, and requested technical assistance. On September 22, 1994 a DSR safety specialist conducted an investigation of the incident. The incident was reviewed with the NCOSHA compliance officer, the city police, and the county electrical and mechanical inspectors.

The employer in this incident was a heating, ventilation, and air conditioning (HVAC) contractor that had been certified by the county as an HVAC technician since 1965. The contractor employed one other worker on an as-needed basis the past few years. The contractor had no written safety policy or safety program. Training was completed on the job. These were the first fatalities experienced by the contractor.

INVESTIGATION

The employer had been contracted to install a new combination heating, ventilation, and air conditioning unit at a private residence, and had hired a part-time employee that had worked for him in the past. The job consisted of installing ductwork throughout the residence and setting the unit in place in a 38-inch-high crawlspace under one end of the house.

On the day of the incident, the contractor was in the attic of the residence installing ductwork, while the employee was installing aluminum straps around the ductwork in the crawlspace. An iron sewer drain pipe was located in the sandy-soil floor of the crawlspace in the employee's immediate work area. Wiring from some of the house's electrical circuits was also attached to the floor joists.

The employee was using an electric drill, powered by an extension cord that was plugged into a 110-volt outlet, to power drive the screws through the aluminum straps into the floor joists. As the employee began to drill one of the screws through the aluminum strap, the sharp edge of the strap contacted the house wiring, damaging its insulation. The edge of the strap contacted an energized conductor, and the electrical current flowed through the strap and drill bit, then through the victims' hand and body, going to ground through the iron sewer drain pipe. The victim did not fall away from the energized strap and the electrical circuit remained complete.

The home owner heard noise from in the crawlspace and summoned the contractor from the attic. Upon arriving at the crawlspace and receiving no response from the employee, the contractor entered the crawlspace. In an attempt to pull the employee from under the crawlspace, the contractor grabbed the victim and became part of the electrical circuit and path to ground.

The homeowner immediately entered the house and pulled the main circuit breaker, then called 911. Police, fire, and emergency medical service (EMS) personnel were dispatched to the scene. The EMS personnel found both victims in cardiac arrest. They were removed from the crawlspace and CPR was initiated. The two victims were transported to the local hospital where they were pronounced dead by the attending physician.

CAUSE OF DEATH

The attending physician listed the cause of death for both victims as accidental electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should conduct a jobsite survey before starting any work to identify any hazards, implement appropriate control measures, and provide subsequent training to employees specific to all identified hazards.

Discussion: Prior to any work being undertaken, a jobsite evaluation should be performed by a competent person[1] to identify potential hazards - such as the house wiring in proximity to the area where drilling was being performed. Once potential hazards are identified, appropriate control measures can be

[1]Competent person: One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them.

implemented and corresponding employee training provided. For example, the employee could have been instructed to anchor the ductwork in areas where no house wiring was present and to keep the sharp strap edges away form the house wiring.

Recommendation #2: Employers should develop, implement and enforce a comprehensive written safety program.

Discussion: The employer did not have a written safety program. The development, implementation, and enforcement of a comprehensive safety program should reduce and/or eliminate worker exposures to hazardous situations. The safety program should include, but not be limited to, electrical safety training, hand tool safety, and training in the identification and control of work-related hazards.

Recommendation #3: Employers should provide additional electrical safety training to those workers working with or around electrical current, including proper rescue procedures.

Discussion: Employees whose duties include working on or near electrical circuits should receive training in electrical theory, identification and control of the hazards associated with electrical energy, and proper rescue procedures in the event of worker contact with electrical energy. In this incident, the contractor unintentionally became part of the electrical circuit and path to ground by grabbing the victim without first either de-energizing the circuit or using a non-conductive object to push the employee away from the energy source.