The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research

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

FACE 91-10

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.

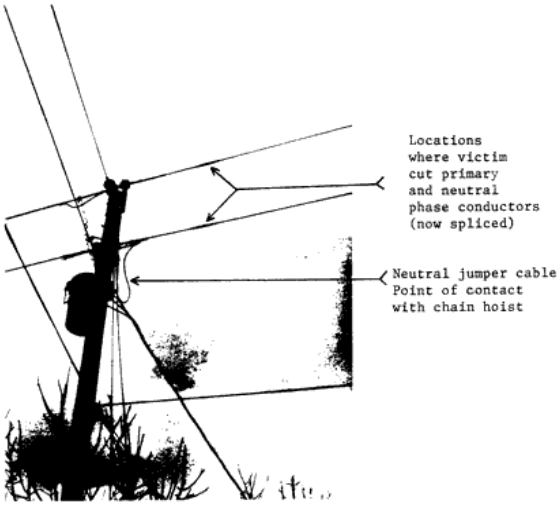

Figure 1.

Return to In-house FACE reports

Last Reviewed: November 18, 2015