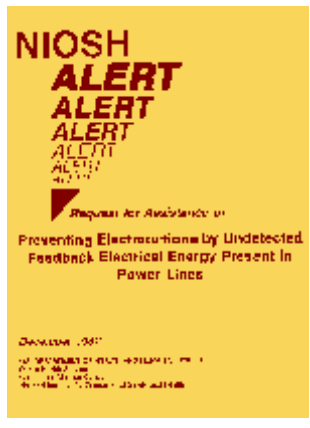
Preventing Electrocutions by Undetected Feedback Electrical Energy Present in Power Lines

DHHS (NIOSH) Publication Number 88-104 December 1987

WARNING! Workers and employers are cautioned that undetected feedback electrical energy in power lines is a constant hazard.



Summary

The National Institute for Occupational Safety and Health (NIOSH) is requesting assistance to prevent the electrocution of workers by undetected feedback electrical energy in power lines. Electrocutions are the third leading cause of occupational deaths in the United States. In 1984, electrocutions accounted for 9.5% (618 of 6491) of all reported occupational deaths. This Alert describes two recent cases of workers who died as a result of feedback electrical energy, which is one cause of occupational electrocutions. Additional case reports are referenced whose circumstances are almost identical to those described. Evaluation of these cases identified three major areas of concern to prevent future incidents: (1) training in proper electrical procedures, (2) verification that power lines are deenergized before work is performed on them, and (3) detection of feedback electrical energy. Editors of appropriate trade journals, safety and health officials, and especially those who work on or in the vicinity of power lines are requested to bring these recommendations to the attention of the general public, managers of electrical utilities, and workers.

Background

This Alert describes one important cause of occupational electrocutions– undetected feedback electrical energy present in power lines. National Institute for Occupational Safety and Health (NIOSH) investigations have documented a number of fatalities whose circumstances suggest that the victims were unaware of the electrocution hazard from feedback electrical energy in power lines that were assumed to be deenergized. Occupational electrocutions from all causes continue to be a serious problem and take a very large toll on the workforce of the United States. In fact, the NIOSH Traumatic Occupational Fatality Data Base for 1984 listed electrocution as the third leading cause of occupational deaths, accounting for 9.5% (618 of 6491 deaths) of all such fatalities.

Case Reports of Fatal Incidents

Case No. 1–ONE FATALITY

On June 6, 1985, a 38-year-old lineman standing in an aerial bucket was electrocuted while repairing a 13.2-kilovolt power line that had been damaged during an electrical storm. The damaged line was one of two power lines that served a residential area. A third power line supplied a three-phase transformer that served a store and was also internally connected with the other two power lines (Figure 1). To repair the damaged line, both of the residential power lines were presumed deenergized by opening their respective fused disconnects. However, the third line remained energized to provide power to the store. Voltage back-fed through the transformer on this line and inadvertently energized the line on which a splice was to be made. Though the lineman presumed that the line to be spliced had been deenergized, he “fuzzed” it (tested it for voltage) by touching it with pliers held in his gloved hand. When the lineman did not see an arc or hear a buzzing sound, he presumed

the line was deenergized, removed his glove, and began to splice the line. Because “fuzzing” does not adequately detect low voltages, it did not detect the voltage created by the back-feed circuit. Power company engineers later estimated that the line carried 4000 to 7000 volts. The lineman inserted the supply side of the line into the splice tube and crimped it. When he grasped the load side of the line, he completed an electrical circuit between the supply and load sides of the line, causing the current to pass through his arms and chest and resulting in his electrocution. Grounds had not been placed on the line, and lineman’s gloves had not been utilized, in direct violation of company procedures.

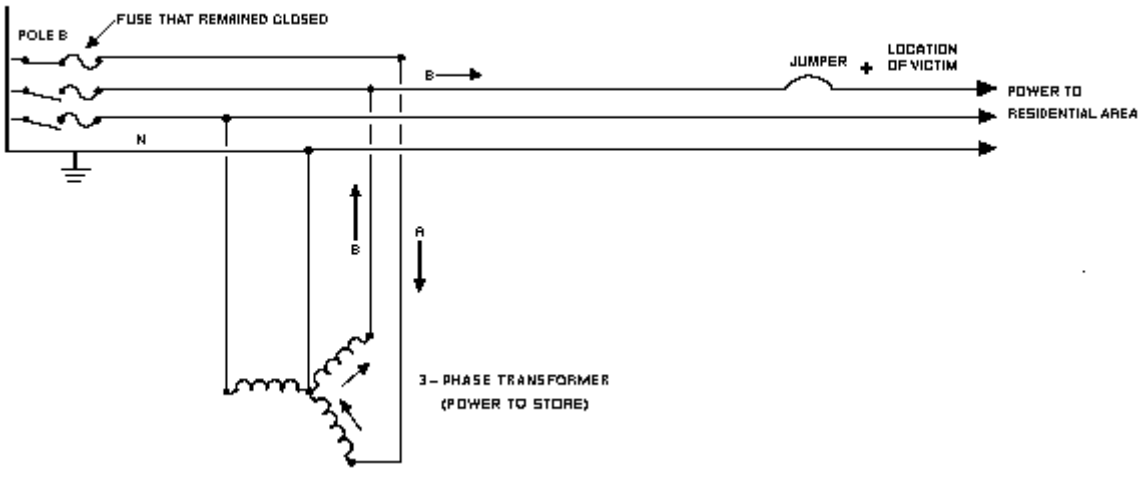


Figure 1. Electrical diagram for Case No. 1.

Case No. 2—ONE FATALITY

On November 6, 1985, a 33-year-old electrician contacted electrical energy while cleaning a substation switch and subsequently fell 30 feet from the aerial bucket from which he was working. He died on November 8, 1985, from injuries sustained as a result of the fall. The victim was one member of a crew of five electricians that was to clean five circuits on the day of the accident. Each circuit consisted of three switches that were located 30 feet aboveground on a steel frame structure. Standard operating procedures called for each circuit to be deenergized, for grounds to be placed on the supply and load sides of the switches while cleaning operations were being performed, and for the worker to be secured to the work platform. None of these procedures were being followed when the accident occurred. When the victim had completed cleaning the fourth circuit, it was reenergized to provide power to the area serviced by that line. The supply side to the fifth circuit was deenergized, grounded and “fuzzed” by the victim to test for voltage. However, the load side of the switch was not grounded. At some point in the cleaning process, the victim contacted both the load and supply sides of the switch. This action permitted energy (feedback from the fourth circuit) to flow through the victim to the grounded side of the supply line. The victim than fell 30 feet from the aerial bucket to the ground.

Note: A fatality in Texas involving circumstances almost identical to Case No. 1 has been documented by the Occupational Safety and Health Administration [OSHA 1984]. A similar electrocution of a lineman has also been documented by the California OSHA [State of California 1986]. However, in this case, procedures had been followed by placing grounds between the lineman’s work area and the power source on the supply side of the line. Feedback energy was present in the load side of the line, causing the lineman’s electrocution. The feedback energy possibly originated from a portable generator being used in a private residence during the power outage.

Regulatory Status

No existing OSHA regulations outline procedures to be followed while performing maintenance on electric distribution lines, but OSHA Standard 29 CFR* 1910.132 defines personal protective equipment requirements for electrical procedures. If workers had followed these standards and their companies’ standard operating procedures and safety precautions regarding personal protective equipment and grounding, the fatalities described here might have been prevented. Persons working on or in the vicinity of power lines should adhere strictly to OSHA Standard 1910.132 and to Section 42 of the National Electrical Safety Code [ANSI 1984]. Both standards discuss the use of proper personal protective equipment and general safety rules to be followed while working on power lines.

Conclusions

The potential for electrocution due to feedback electrical energy should not be underestimated. NIOSH investigations indicate that workers may not be aware of the extreme hazard of electrocution and electrical injuries associated with feedback energy. These cases demonstrate that the problem of feedback electrical energy in electrical transmission and distribution systems is

always present and that diligent efforts should be applied to safeguard against it. “Fuzzing” a line is a standard practice to test for the presence of high voltage in power lines. “Fuzzing” is accomplished by bringing a metallic object, such as a pair of lineman’s pliers, close to a power line while watching for an arc and listening for a buzzing sound. This method does not reliably detect low voltages and should not be used as the only test for electrical energy in power lines. Once fuzzing has determined that high voltage is not present, low voltage testing equipment, such as a glowing neon light or a light-emitting diode, should be used to determine whether low voltage is present.

Recommendations

The following NIOSH recommendations should substantially reduce the number of electrocutions caused by undetected feedback electrical energy in power lines. Particular emphasis should be placed on the first two recommendations.

Universal Precautions

- Extreme caution must be exercised by persons working on or in the vicinity of unverified deenergized power lines. All persons performing this work should treat all power lines as “hot” unless they positively know these lines are properly deenergized and grounded.
- Persons should also be instructed that “fuzzing,” although an accepted practice to check for high voltage in power lines, is not a reliable test method. As reported in Case No. 1, lower voltage levels can be deadly, and may not be detected by the practice of “fuzzing.” “Fuzzing” must be done only after power lines have been deenergized and properly grounded. Because of the possibility of a feedback circuit, the person performing the work should personally ground all lines on both sides of the work area unless he/she is wearing the proper protective equipment.

Training Programs

- Training programs for linemen should emphasize proper procedures for working with electrical transmission and distribution systems and their associated hazards.
- Training programs for linemen should include basic electrical theory that addresses electrical distribution systems and the identification, evaluation, and control of the hazards associated with these systems. Because the danger of feedback energy is always present, an improved method of deenergizing these systems should be stressed.

Protective Equipment and Work Practices

- Power lines should not be repaired or otherwise accessed without adequate personal protective equipment unless the worker personally verifies that the line is deenergized and properly grounded.
- Workers must be specifically instructed to wear proper protective equipment, such as gloves and sleeves, required for the task to be performed.
- Linemen must be instructed to treat all power lines as energized unless they personally deenergize them by establishing a visible open point between the load and supply sides of the line to be repaired, by opening a fused disconnect, by opening a fused switch, or by removing a tap jumper if the load permits.
- Workers must verify that the power lines have been deenergized.
- Workers must provide proper grounding for the lines. 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 deenergized. Lines must be 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 multiphase system, grounds must be placed on all lines. Lines should be grounded in sight of the working area and work should be performed between the grounds whenever possible. If work is to be performed out of sight of the point where the line has been deenergized, an additional ground should be placed on all lines on the source side of the work area.

Detection of Low Voltage

- Persons working on or in the vicinity of power lines should be provided with appropriate safety and protective equipment and trained in procedures that address all magnitudes of voltages to which they may be exposed.

- Procedures should be established to perform a dual voltage check on the grounded load and supply sides of the open circuit. Once the “fuzzing” method has determined that high voltage is not present, low voltage testing equipment, such as a glowing neon light or a light-emitting diode, should be used to determine if lower voltage is present.

We urge employer and employee representatives and safety and trade associations to bring these recommendations to the attention of workers who may be exposed to these hazards.

Comments or questions concerning this announcement should be directed to Dr. Murray L. Cohen, Acting Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505-2888, telephone (304) 291-4595.

We greatly appreciate your assistance.

[signature]
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Centers for Disease Control

Note

* Code of Federal Regulations. See CFR in references. [Return to main text]

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Page last reviewed: June 6, 2014