TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (FACE) Program

SUBJECT: Plumber is electrocuted when he contacts the frayed wires of his work light in California

SUMMARY
California FACE Report #96CA014

A 40-year old male plumber (victim) died after laying on his work light while installing plumbing under a house being remodeled. The victim was crawling under the house carrying the work light with him. The electrical wire inside the work light's conduit became bare and energized the light's housing. The victim owned his own company and he was the only employee. Training records were not available. The CA/FACE investigator concluded that, in order to prevent future occurrences, employers should:

- Use a ground fault circuit interrupter (GFCI) when using cord and plug tools or equipment.
- Use battery or low voltage operated work lights whenever possible.
- Relocate ground wires when they must be disconnected from plumbing or assure grounds are properly connected.
- Institute a cord and plug assured grounding conductor program.

INTRODUCTION

On October 1, 1996, at 1:00 p.m., a 40-year old male plumber was electrocuted while installing plumbing at a home remodeling site when he contacted his 120-volt work light which had become energized. The decedent was using his work light while installing plumbing under the home. He was carrying the work light as he was crawling. The work light became energized when the electrical wire inside its conduit became bare. When the decedent contacted the work light, the power went through him to ground.

The CA/FACE investigator learned of this fatality on October 2, 1996 from the California Division of Occupational Safety and Health's Bureau of Investigations. The CA/FACE investigator traveled to the site of the incident on October 4, 1996, but found the project shut down. The CA/FACE investigator contacted, by telephone, the owner of the residence, the general contractor, the family attorney, and the emergency services investigators. He also photographed the work light involved in this incident at the police property room on

October 7, 1996. The remodeling project had been underway for three weeks. The decedent had been on the job for two days. The decedent was the owner and only employee of the company. The decedent had worked as a plumber for 20 years. Safety documents and training records are not available.

INVESTIGATION

The site of the incident is a large, two-story home. The project was a remodeling job which included extending the family and dining rooms and the kitchen. In order to gain access under the home, two holes were cut in the plywood flooring. The decedent used one of these holes to crawl under the home. The area underneath the home was approximately two feet high from the ground to the subflooring. The decedent spoke to the general contractor who was at the site from 10:30 a.m. to 12:30 p.m. The decedent was in the process of relocating the kitchen sink. His job was to reroute a copper water line for the sink. In order to do this, he had to crawl under the house with a small tool box and a 120 volt halogen work light (see exhibit 1) which was connected to a long extension cord. He needed to access the far southeast portion of the home.

The decedent proceeded to crawl under the home through one of the holes cut in the floor. He was under the home for a short period when the owner and some visiting friends heard a muffled scream and thought they heard the word "help." They indicated the scream lasted about five seconds. The owner and his friends attempted to communicate with the decedent, but received no response. One of the visitors obtained a flashlight and tried to locate the decedent by shinning it into one of the holes in the floor. He finally noted the decedent laying on the ground in the southeast portion of the home.

Since the decedent was unresponsive, the owner immediately called 911. The municipal fire department was dispatched at 1:02 p.m. and arrived at 1:06 p.m. They noted the location of the victim and thought it would be very difficult to attempt a rescue using the hole in the floor. Thinking the decedent may have been electrocuted, they asked the owner to turn off all power to the home. One paramedic accessed the victim from the hole in the floor. He found him lying on top of an electrical extension cord with his face and shoulder resting on the portable halogen work light. He determined the decedent had no pulse or spontaneous respirations. Rescuers located a screened-off crawl hole in the east side of the home. This access hole had not been used by the decedent. They moved some bushes aside, removed the screen and finally extricated the decedent at approximately 1:16 p.m. It was noted that the victim had burns on his left cheek, lip, tongue and abrasions on his forehead.

Once the decedent had been extricated, and they had room to work, rescuers immediately began CPR. Using defibrillation paddles, they attempted to achieve a heart beat. They administered epinephrine (EPI) twice and atropine once. All attempts at revival were unsuccessful. The decedent was transported to a local hospital where he was pronounced dead at 2:16 p.m**.** An investigation after the incident revealed that the ground for the home's electric system was a wire connected to a hose bib on the north side of the home. This wire terminated at the home's electric service panel. The electrode for this ground was a cold water pipe located on the south side of the home. However, the hose bib (an outside garden faucet) had been removed by the decedent due to the remodeling project, effectively disconnecting this ground.

A supplemental electrode located near the electric service panel, was found disconnected.

This was a concrete-encased electrode, commonly called a UFER, and consists of a 20-foot piece of metal in the home's footing connected to the electric service. The portable work light used in this incident appeared to have previous damage. The damage was to the connector which connected the lamp housing to its tripod base. The boss (raised portion) of the connector which slipped over the wiring conduit leading to the base was cracked and had pulled away from the connector. The set screw, which appeared not to be an original, would not tighten. This would cause the connector to work up and down (or wobble) on the conduit eventually resulting in damage to the wiring. Although it is not certain that some damage to the connector's boss existed before this incident, it is likely given to the condition of the lamp and its wiring noted upon inspection (see exhibit 2). Specifically, the wiring appeared twisted as if the top portion of the work light had been turned around on its base a number of times. In addition, it was discovered that the decedent had a portable GFCI. It was found among his tools, rolled up and unused.

CAUSE OF DEATH

The death certificate stated the cause of death to be ventricular arrhythmia due to electrocution.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should use a ground fault circuit interrupter (GFCI) when using cord and plug tools or equipment.

Discussion: Although the decedent had a portable GFCI as part of his tools and equipment, he did not use it in this incident. A GFCI is a fast-acting circuit breaker which senses small imbalances in the circuit caused by leakage to ground and, in as little as 1/40 of a second, shuts off the electricity. It does this by continually matching the amount of current going to an electric device (the "hot" wire) against that returning (the neutral wire). When it detects approximately a 5 milliamp (5/1000) difference it trips the circuit. Since it normally takes in excess of 50 milliamps to harm the human body, use of a properly operating GFCI in this incident would have prevented the electrocution.

Recommendation #2: Employers should use battery or low voltage operated work lights whenever possible.

Discussion: Work lights connected to 120 volts have an inherent danger, especially when used in very cramped spaces. Electrocution is a possible outcome if the light becomes faulty. Battery-operated lighting is a much safer choice. It can be used in shorter term situations where the batteries will maintain power for the duration of the project. Alternatively, low voltage connected lighting is a safer choice than 120-volt electricity. Such lighting, when connected through a low voltage transformer, is much less of an electrocution hazard. If battery-operated lighting or low-voltage lighting had been used in this incident, the electrocution may not have happened.

Recommendation #3: Employers should relocate ground wires when they must be disconnected from plumbing or assure grounds are properly connected.

Discussion: Electric service must have a ground connection so circuits can be completed. When the decedent removed the hose bib to which the ground wire was connected, he effectively disconnected the ground for the home's electric service. The concrete-encased electrode, or UFER, would have provided the necessary ground for the home's electric service if it had been connected at the electric service panel. Although post-incident inspection revealed that the work light's neutral wire had parted, the ground wire was intact although a few strands were broken. The "hot" wire was touching the lamp's base. If there was a proper ground for the electric service, the power would have traveled from the hot wire, into the base, along the light's ground wire back into the extension cord and back to ground (either the cold water pipe via the hose bib or the UFER). This was the path of least resistance. Since there was no proper ground, the current traveled from the hot wire, through the light's base and/or housing, and through the decedent to ground causing his electrocution. A proper electric service ground would have most likely prevented this fatality.

Recommendation #4: Employers should institute a cord and plug assured grounding conductor program.

Discussion: The work light involved in this incident appeared well used and to have pre-incident damage. Particularly, it appeared that the set screw on the connector's boss had been replaced. Most likely, the lamp housing was not tightly connected to its base which would, in time, cause wiring failure. A written and properly implemented cord and plug program may have revealed any potential for harm. Such a program requires that cord and plug equipped tools and equipment be inspected each day before use. If damage is discovered, the tool or equipment must be repaired before use. If this had been done, the work light in this incident probably would have been deemed unsafe. Also part of a cord and plug program is testing the wiring of each tool, equipment or extension cord. This is usually done with a tool/appliance test instrument available for this purpose. Since the wiring appeared to have damage prior to this incident, such testing may have revealed an unsafe situation and the work light would have been taken out of service until properly repaired. If a proper inspection and testing of the work light was performed before its use, this fatality may not have happened.

References:

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Health Services, in cooperation with the Public Health Institute and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations of work-related fatalities. The goal of this program, known as the California Fatality Assessment and Control Evaluation (CA/FACE), is to prevent fatal work injuries in the future. CA/FACE aims to achieve this goal by studying the work 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. NIOSH-funded, state-based FACE programs include: Alaska, California, Iowa, Kentucky, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Oklahoma, Oregon, Washington, West Virginia, and Wisconsin.

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Additional information regarding the CA/FACE program is available from:

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