The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research

Journeyman Electrician Electrocuted when Lockout Attempt Fails

FACE 89-18

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.

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.

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