The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research NIOSH

Two Maintenance Workers Die After Inhaling Hydrogen Sulfide in Manhole

FACE 8928

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 31, 1989, a 29-year-old male maintenance worker (the victim) entered a sewer manhole to repair a pipe, and collapsed at the bottom. In a rescue attempt, a 43-year-old male maintenance worker (co-worker victim) entered the manhole and also collapsed. Both workers (hereinafter referred to as initial victim and co-worker victim) were pronounced dead at the scene.

CONTACTS/ACTIVITIES

An industry association notified DSR of this multiple fatality and requested technical assistance. On April 5 and 6, 1989, a DSR research industrial hygienist met with the state OSHA compliance director and the company vice president to gather information, and traveled to the site of the incident to conduct an investigation.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer is an animal hide tanning company with 24 employees. The company operates a plant which has been in existence for 27 years (4 years under its present ownership). Most of the employees are tanning laborers (12 employees), drum operators (3 employees), and maintenance workers (2 employees). The victim had been with the company for nearly 4 years. Two months before the incident he had been promoted to the position of maintenance worker. The co-worker had been with the company for 6 years. He had been a maintenance worker for the last 4 years.

The company has a safety committee consisting of the two department heads, a union steward, and a foreman. The committee meets each week to discuss and follow up on needed safety improvements at the plant. Material safety data sheets (MSDS) on the various chemicals used in the plant are available throughout the plant. The company has a written

safety policy consisting of plant safety rules and procedures for machine safety, chemical safety, and manhole entry. However, none of these rules and procedures were implemented. In addition, regular safety meetings for plant workers were not held.

SYNOPSIS OF EVENTS

The plant uses up to 120,000 gallons of water per day to process animal hides. After primary treatment, the wastewater is discharged into a series of lagoons approximately 400 yards from the plant. A gate valve located in a concrete manhole between a retention lagoon and a discharge lagoon regulates the flow of wastewater discharged. The manhole is 10 feet deep with an inside diameter of 4 feet. The top of the manhole has a 2-foot-square opening with a locked steel cover. Steel rungs on the inside of the manhole provide access to the bottom.

The manhole normally operates with about 3 feet of wastewater at the bottom. Rising vertically from a horizontal pipe at the bottom of the manhole is a 12-inch-diameter plastic overflow pipe. This pipe extends to 18 inches below ground level. The wastewater discharge volume was periodically adjusted by a worker who would partially enter the manhole (to about shoulder height and without entering the water), reach over and turn the gate valve. This adjustment was made on a routine basis without testing or ventilating the manhole atmosphere. (Since the incident, the company has extended the valve stem to a level above the ground, thereby eliminating the need for workers to routinely enter the manhole to adjust the valve.)

On the day of the incident the maintenance foreman assigned the two maintenance workers (initial victim and co-worker victim) the task of repairing a crack in the top of the overflow pipe. Although there were no eyewitnesses, evidence suggests that at about 11:00 a.m. the initial victim entered the manhole without first testing and ventilating the inside. Presumably, the initial victim, while standing on the steel rungs inside the manhole, began to repair the broken pipe with the co-worker victim observing the work from the top, handing down tools and supplies as needed. Hard hats and steel toe boots were the only personal protective equipment worn by the workers. While repairing the broken pipe, the initial victim was apparently overcome by hydrogen sulfide gas. He fell into approximately 3 feet of wastewater and sludge at the bottom of the manhole. Presumably in a rescue attempt, the co-worker victim entered the manhole, also lost consciousness, and fell to the bottom.

At about 11:45 a.m. , the maintenance foreman came to the manhole to tell the two workers it was lunchtime. When he looked into the manhole, he saw the co-worker victim at the bottom facedown in the water. The foreman did not see the initial victim, who was totally submerged in the wastewater. The foreman entered the manhole in an attempt to pull the co-worker victim out, but could not move him. The foreman became dizzy and felt like he was losing consciousness, so he climbed out. He then fell unconscious on the ground next to the manhole. When he regained consciousness approximately 15 minutes later, he ran to the plant office and notified plant personnel of the emergency. A call was placed to the emergency medical service (EMS) and the local fire department while four plant workers ran to the site. Another plant worker, who had been a local volunteer fire fighter, grabbed a self-contained breathing apparatus (SCBA) from the plant office and drove to the manhole site. The four plant workers who had arrived on foot each briefly entered the manhole in unsuccessful rescue attempts. None of these workers wore respiratory protection. They were all able to exit the manhole without any noticeable ill effects. The worker who arrived with the SCBA entered the manhole wearing the SCBA, but was also unsuccessful in his rescue attempt.

Fire fighters from the local fire department arrived at the scene approximately 15 minutes after being notified. one of the fire fighters donned an SCBA, entered the manhole and tied a rope around the co-worker victim’s chest. Rescue personnel then hoisted him up out of the manhole. The initial victim’s body was located and removed from the manhole in the same manner. When local EMS personnel arrived, they noted that the initial victim and co-worker victim were obviously dead for some time. Therefore, cardiopulmonary resuscitation was not attempted and the county coroner pronounced both workers dead at the scene. The foreman was hospitalized, treated for hydrogen sulfide exposure, and released 2 days later. The other five plant workers and the fire fighter who entered the manhole were treated for hydrogen sulfide exposure and released the same day.

Six days after the incident, a compliance officer from the state OSHA office conducted an investigation. During the investigation the atmosphere of the manhole was tested for hydrogen sulfide (H2S). At first, a gas monitoring device capable of measuring concentrations up to 100 parts per million (ppm) was used. When measurements indicated that the concentration of H2S at the bottom of the manhole exceeded 100 ppm, a gas monitoring device capable of measuring H2S concentrations up to 500 ppm was used. A measurement of 200 ppm H2S was obtained just inside the manhole opening.

CAUSE OF DEATH

The medical examiner listed the cause of death for both workers as anoxia due to hydrogen sulfide inhalation.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All employers should develop and implement a safety program to protect their employees.

Discussion: The company did not have a formal safety program established. Although the company had written safety rules and procedures, they were not implemented. There was also no safety training or safety meetings conducted for plant workers. A logical first step in developing a safety program 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. The company should therefore develop and implement a safety program as outlined in NIOSH publications 77-101, “Health and Safety Guide for the Tanning Industry,” and 76-157, “Good Work Practices For Tannery Workers.”

Recommendation #2: The employer should develop and implement specific confined space entry procedures for each type of confined space.

Discussion: Although the company had confined space procedures for entering the sewer manhole, they were not implemented. Also, the company’s existing confined space procedures do not fully address every basic procedure; however, if the existing procedures had been closely followed, the two fatalities in this incident may have been prevented. The company has other types of confined spaces (i.e., drums, pits, tanks, etc.) with no written entry procedures. Although these types of confined spaces are not entered on a routine or even an occasional basis, they should still be covered by specific procedures for entry. The company should therefore develop and implement a confined space entry program as outlined in NIOSH publications 80-106, “Working in Confined Spaces,” and 87-113, “A Guide to Safety in Confined Spaces.” At a minimum, the following items should be addressed for each type of confined space:

1. Is entry necessary? Can the assigned task be completed from the outside?

2. Has a confined space safe entry permit been issued by the company?

3. Are confined spaces posted with warning signs and are confined space procedures posted where they will be noticed by employees?

4. If entry is to be made, has the air quality in the confined space been tested for safety based on the following criteria:

- 149 oxygen supply at least 19.5%
- 149 Flammable range less than 10% of the lower explosive limit
- Absence of toxic air contaminants

5. Have employees and supervisors been trained in the selection and use of:

protective clothing,

respiratory protection,

hard hats,

eye protection,

gloves,

lifelines,

and emergency rescue equipment?

6. Have employees been trained for confined space entry?

7. Are confined space safe work practices discussed in safety meetings?

8. Have employees been trained in confined space rescue procedures?

9. Is ventilation equipment available and/or used?

10. Is the air quality tested when the ventilation system is operating?

Recommendation #3: The employer should develop and implement a comprehensive respirator program as required by 29 CFR 1910.134, including either quantitative or qualitative fit testing and employee training in the use and limitations of SCBA and air-purifying respirators.

Discussion: Although the company had an SCBA in the office and provides escape only hydrogen sulfide gas masks (not for confined space entry) for plant workers and drum operators, employees are not trained in their use and limitations. Employees are not given physical examinations to determine if they are capable of wearing a respirator. It should be noted that 3 months prior to this incident, a state OSHA compliance officer had cited the company for failure to provide an employee respirator program. The absence of a respirator program contributed to the fatalities and the potential hazards associated with the unsuccessful worker rescue efforts in this incident. Respirators should be selected according to criteria in the “NIOSH Respirator Decision Logic” (DHHS (NIOSH) Publication No. 87-108). Additional information on the characteristics and use of respirators is available in the “NIOSH Guide to Industrial Respiratory Protection” (DHHS (NIOSH) Publication No. 87-116).

Return to In-house FACE reports

Last Reviewed: November 18, 2015