The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research NIOSH

Two Men Die in Well Cleaning Operation–Maryland

FACE 9317

SUMMARY

Two self-employed well cleaners (the victims) drowned while cleaning a residential well. Victim #1 was a 40-year-old male and victim #2 was a 43-year-old male. The well was 36 inches in diameter and 40-feet deep. Concrete casings supported the sides of the well, while the well floor was left as exposed soil to allow flow of ground water. At the time of the incident, victim #1 was at the well bottom brushing down the concrete casings and shoveling muck from the well floor; he apparently became disoriented and was unable to exit the well. Victim #2 then entered the well in a rescue attempt. However, the two were unable to exit the well due to inadequate rescue equipment. The homeowner called 911 and emergency rescue units arrived within approximately 10 minutes. Victim #2 was removed from the well approximately 20 minutes after the first rescue unit arrived. He was transported to the local hospital and pronounced dead shortly after arrival. Victim #1 was pulled from the well approximately 4 hours after the 911 call. He was pronounced dead at the scene. NIOSH investigators determined that, to prevent similar occurrences, employers, including the self-employed involved in well cleaning operations, should:

- **develop and implement a comprehensive confined space entry program.**

NIOSH investigators also determined, for the protection of rescue personnel, volunteer fire departments should:

- **identify the types of confined spaces within their jurisdictions and develop and implement confined space entry and rescue programs**
- **develop and implement a respiratory protection program to protect firefighters from respiratory hazards**
- **develop and implement a general safety program to help firefighters recognize, understand, and control hazards.**

INTRODUCTION

On May 1, 1993, two self-employed well cleaners (the victims) drowned while conducting well cleaning operations at a residential well site. On June 23, 1993, the Maryland Occupational Safety and Health Administration (MOSH), notified the Division of Safety Research (DSR) of these deaths and requested technical assistance. On July 12, 1993, an environmental health and safety specialist and an engineering intern from DSR conducted a field investigation of this incident. Interviews were conducted with the MOSH investigator, the county confined space rescue team, the county volunteer fire department, and the son of victim #2. Photographs were obtained of the incident site. Medical examiner's reports for both victims were also obtained. No atmospheric testing was conducted as the well site had been filled in and sealed.

The investigation was complicated in part by certain factors: the time lapse between the incident and the investigation, the number of emergency responders, the particular sequence of events, and the time frames of these events, and differing perceptions of the series of events occurring in a crisis situation. Therefore, a scenario of this incident was developed after carefully evaluating a diverse mixture of information. The victims in this incident worked part-time as self-employed well cleaners and grave diggers. This was the only source of employment for victim #1. Victim #2 was employed full-time as a truck driver for the county in which the incident occurred. Neither victim had any safety or confined space training. However, both victims were aware that well cleaning was a dangerous job, according to the son of victim #2.

INVESTIGATION

On May 1, 1993 three self-employed well cleaners—a 43-year-old male (victim #1), a 40-year-old male (victim #2), and his 17-year-old son—arrived at the residential well site to clean a shallow (36-inch-diameter by 40-foot-deep) well. They arrived at the work site at 9 a.m. and used a portable gasoline pump to remove water from the well, which was filled to approximately the 20 foot level. The gasoline pump was not adequate to remove all of the water, so the workmen went to a local equipment rental store and rented an electric sump pump to complete the job. They placed the pump at the bottom of the well and pumped out the remaining water to a depth of 6 to 8 inches. The victims did not use any type of respiratory protection, atmospheric test equipment, or ventilation equipment during the well cleaning operation.

Victim #1 was lowered into the well at approximately 10:30 a.m. to begin cleaning. A steel bucket, steel cable, and a homemade windlass were used to raise and lower workers, supplies, and muck from the well. The windlass was made of 2-inch by 6-inch wooden boards, crudely designed in an “X” configuration, with a steel bar across the top intersection of the “X” which included a handle at each end (Figure). Victim #1 began shoveling muck out of the well and brushing down the sides. Water was the only solvent used to clean the sides of the well. Approximately 1 hour and 15 minutes later, victim #2, at the top of the well, asked victim #1 how much longer before the cleaning job would be completed. Not hearing a response, victim #2 inquired as to the condition of victim #1. There was still no response. The second victim’s son asked the homeowner to call 911 (at approximately 11:50 a.m.), stating there was trouble in the well, then requested the homeowner’s assistance in lowering his father (victim #2) into the well to rescue victim #1. In a rescue attempt, the son and the homeowner lowered victim #2 into the well on a small wooden (2 inch by 12 inch by 16 inch) board which served as a seat.

Using his arms, victim #2 was able to secure his co-worker and was being hoisted up by his son and the homeowner when at approximately the halfway point (20 feet), the board that was supporting the victims started to crack. Victim #2 yelled to his son to lower them back to the bottom of the well. Victim #1 was still semiconscious but unable to assist victim #2 in attempting to exit the well. The two workers made no other attempt to leave the well until rescue units arrived. The first rescue squad to arrive on the scene was the county emergency medical squad (EMS) at approximately 12 noon. The paramedics from the EMS positioned their truck 5 to 7 feet from the well opening in order to use a light to see into the well. A rope was thrown down to the victims but victim #2 was unable to secure the rope around victim #1. By this time, the well was starting to fill with water (approximately 10 feet deep), and the victims were treading water.

Within 2 to 4 minutes after the first EMS unit arrived, the local volunteer fire unit arrived on the scene. The first rescue unit was promptly ordered by the deputy chief of the local volunteer fire unit to move their vehicle away from the well. At this point, victim #2 was coherent enough to communicate with the rescuers, but was not able to use a rope to exit the well. Victim #1 was not coherent, and was believed to be unconscious. The second rescue unit was equipped for fire rescue. Therefore, they only had 60 minute air tanks on the self-contained breathing apparatus (SCBA); they did not feel there was room in the well for a rescuer with full turn-out gear and an SCBA. The deputy chief of the volunteer fire unit requested a 15-minute (smaller in size) unit be brought to the scene from the fire house, which was approximately 5 miles from the incident scene.

Because victim #2 was going under the water, the volunteer fireman (rescuer #1) preparing to make the descent into the well in a rescue attempt told the deputy chief they did not have time to wait for the 15-minute unit. A decision was made to lower the fireman into the well without any respiratory protection, wearing the bottom half of the turn-out gear, a harness, and a lifeline. The fireman was lowered into the well, which now had approximately 20 feet of water, and was able to reach victim #2 within a few minutes and place a rescue line around him. (The temperature of the water was between 35 and 40 degrees F, as reported by the volunteer fireman.) The rescuing fireman was then hoisted from the well without any ill

effects from the atmosphere or the cold water. (Note: the atmosphere was being tested before and after the fireman's entry —the oxygen level was measured at 17% by volume). Victim #2 was then pulled from the well, in an unresponsive condition. Paramedics administered CPR and transported him to the local hospital where he was pronounced dead, after further life-saving efforts were unsuccessful.

The elapsed time for the rescue of victim #2 was approximately 20 minutes after the first EMS arrived on the scene. By the time Victim #2 was removed from the well, victim #1 had been underwater for approximately 30 minutes. The volunteer fire unit was not prepared for an underwater recovery; the decision was made to avoid the risk of losing a firefighter in what was believed to be at this point, a body recovery. They chose instead to wait for the arrival of better equipped units, whose assistance had been requested to retrieve victim #1.

Divers from an adjacent county arrived approximately 40 minutes after the second 911 call. Two divers made separate dives (each equipped with self contained underwater breathing apparatus [SCUBA], full rubberized diving suits, underwater lights, and life lines). The first diver (rescuer #2) found victim #1 at the bottom of the well and managed to get a rope around him; however, when they attempted to raise him from the well, the victim slipped out of the rope and sank back to the bottom. The second diver (rescuer #3) was unsuccessful in his attempt to secure a line to the victim. A volunteer fireman from the local fire department (rescuer #4) entered the well wearing SCUBA; however, he was also unsuccessful in his recovery attempt, and complained of the cold water inhibiting his ability to recover the victim. A specialized confined space rescue team had now arrived from a different county and requested the area be cleared of all those working on the rescue effort. The specialized rescue team sent one of their divers (rescuer #5) wearing SCUBA, a full rubberized suit, life line, underwater lights, and communication equipment into the well. It took approximately 20 minutes for this diver to secure a line to victim #1. Victim #1 was then recovered from the well, approximately 4 hours after the initial 911 call. Victim #1 was pronounced dead at the scene by a forensic examiner.

In summarizing this confined space investigation, there were three major hazards identified: (1) oxygen deficient atmosphere (NIOSH, 1979), (2) toxic (carbon monoxide) atmosphere (NIOSH, 1972), and (3) cold water exposure (Golden, 1976). The medical examiner listed the blood carboxyhemoglobin saturation levels as 37% in victim #1 and 13% in victim #2.

The bacterial action and biomass in the well could have been a source for a small percentage of the carbon monoxide. However, an external source was probably responsible for the largest percentage of carbon monoxide. Testing conducted by the volunteer fire unit indicated that the oxygen level (only gas tested) at the 20-foot level was 17% by volume. When the well was pumped to the bottom, the oxygen level would have likely decreased to 12 to 15% by volume. Under conditions of reduced ambient oxygen concentration, such as the reduced oxygen level in the well, the exposure to carbon monoxide was even more critical.

The water temperature in the well was reported to be between 35 and 40 degrees F. Survival time in water at 32 degrees F is predicted to be less than 15 minutes (Golden, 1976).

CAUSE OF DEATH

The medical examiner listed the cause of death for victim #1 as "drowning complicating carbon monoxide poisoning," and the cause of death for victim #2 as drowning.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers involved in well cleaning operations, including the self-employed, should develop and implement a comprehensive confined space entry program.

Discussion: There was no confined space entry program in effect at the residential well site at the time of the incident. The atmosphere was not tested before entry, no mechanical ventilation or respiratory protection was provided, and no rescue plans were developed. Employers, even self-employed well cleaning operations, should develop and implement a written confined space entry program to address all provisions outlined in the following NIOSH Publications: Working in Confined

Spaces: Criteria for a Recommended Standard (Pub. No. 80-106); NIOSH Alert, Request for Assistance in Preventing Occupational Fatalities in Confined Spaces (Pub. No. 86-110); A Guide to Safety in Confined Spaces (Pub. No. 87-113); and NIOSH Guide to Industrial Respiratory Protection (Pub. No. 87-116).

A confined space entry program should include the following:

- written confined space entry procedures
- evaluation to determine whether entry is necessary
- issuance of a confined space entry permit
- evaluation of the confined space by a qualified person
- testing and monitoring the air quality in the confined space to ensure:
  - oxygen level is at least 19.5%
  - flammable range is less than 10% of the LFL (lower flammable limit)
  - absence of toxic air contaminants
- training of workers and supervisors in the selection and use of:
  - safe entry procedures
  - respiratory protection
  - lifelines and retrieval systems
  - protective clothing
- training of employees in safe work procedures in and around confined spaces
- training of employees in confined space rescue procedures
- conducting safety meetings to discuss confined space safety
- availability and use of proper ventilation equipment
- monitoring the air quality while workers are in the confined space.

Recommendation #2: Volunteer fire departments should identify the types of confined spaces within their jurisdiction and develop and implement confined space entry and rescue programs.

Discussion: Volunteer firefighters may be required to enter confined spaces to perform either non-emergency tasks or emergency rescue. Therefore, volunteer fire departments should identify the types of confined spaces within their jurisdiction and develop and implement confined space entry and rescue programs that include written emergency rescue guidelines and procedures for entering confined spaces. A confined space program, as outlined in NIOSH Publications 80-106 and 87-113, should be implemented. At a minimum the following should be addressed:

1. Is entry necessary? Can the task be accomplished from the outside? For example, many fire departments use an underwater search and rescue device which consists of several sections of metal tubing connected together with a hook or retrieval device on the end. Such a device can be used to retrieve objects out of a well without the need for entry. Also, some fire departments in rural areas use water jet pumps, water siphon booster pumps, or high pressure ejector pumps to pump water at depths greater that 15 feet. This type of pump can be lowered into a well to pump out the water without the need for anyone to enter the well. Measures that eliminate the need for firefighters to enter confined spaces should be carefully evaluated and implemented if at all possible before considering human entry into confined spaces to perform non-emergency tasks.

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

- oxygen s 19.5%upply at least
- flammable range for all explosive gases less than 10% of the lower flammable limit
- absence of toxic air contaminants?

3. Is ventilation equipment available and/or used?

4. Is appropriate rescue equipment available?

5. Are firefighters and firefighter supervisors being continuously trained in the selection and use of appropriate rescue equipment such as:

- SCBA's
- lifelines
- human hoist systems offering mechanical advantage
- protective clothing
- ventilation systems

6. Are firefighters being properly trained in confined space entry procedures?

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

8. Are firefighters trained in confined space rescue procedures?

9. Is the air quality monitored when the ventilation equipment is operating?

The American National Standards Institute (ANSI) Standard Z117.1-1989 (Safety Requirements for Confined Spaces), 3.2 and 3.2.1 state, "Hazards shall be identified for each confined space. The hazard identification process shall include, ... the past and current uses of the confined space which may adversely affect the atmosphere of the confined space; ... The hazard identification process should consider items such as ... the operation of gasoline engine powered equipment in or around the confined space."

Recommendation #3: Volunteer fire departments should develop and implement a respiratory protection program to protect firefighters from respiratory hazards.

Discussion: The National Fire Protection Association (NFPA) Standard 1404 3-1.2 and 3-1.3 (Standard for a Fire Department Self-Contained Breathing Apparatus Program) state, "Respiratory protection shall be used by all personnel who are exposed to respiratory hazards or who may be exposed to such hazards without warning .... Respiratory protection equipment shall be used by all personnel operating in confined spaces, below ground level, or where the possibility of a contaminated or oxygen deficient atmosphere exists until or unless it can be established by monitoring and continuous sampling that the atmosphere is not contaminated or oxygen deficient." Volunteer fire departments should develop and implement a respiratory protection program which includes training in the proper selection and use of respiratory protection equipment according to NIOSH Guide to Industrial Respiratory Protection (Publication No. 87-116).

Recommendation #4: Volunteer fire departments should develop and implement a general safety program to help firefighters recognize, understand, and control hazards.

Discussion: NFPA Standard 1500, 3-1.1 states that "The fire department shall establish and maintain a training and education program with the goal of preventing occupational accidents, deaths, injuries, and illnesses." NFPA Standard1500, 3-1.4 states that "The fire department shall provide training and education for all members to ensure that they are able to perform their assigned duties in a safe manner that does not present a hazard to themselves or to other members." As part of a safety program, fire departments should carefully evaluate each task to identify all potential hazards, (e.g., falls, electrocutions, burns, unsafe atmospheres, etc.) and implement appropriate control measures.

REFERENCES

National Institute for Occupational Safety and Health, Criteria for a Recommended Standard, Working in Confined Spaces. DHEW (NIOSH) Publication No. 80-106, December 1979.

National Institute for Occupational Safety and Health, Criteria for a Recommended Standard, Occupational Exposure to Carbon Monoxide, HSM Publication 73-11000, 1972.

Golden, F. Hypothermia: A Problem for North Sea Industries, J. Soc. Occup. Med. 1976; 26:85-88.

National Institute for Occupational Safety and Health, Alert—Request for Assistance in Preventing Occupational Fatalities in Confined Spaces. DHHS (NIOSH) Publication No. 86-110, January, 1986.

National Institute for Occupational Safety and Health, A Guide to Safety in Confined Spaces. DHHS (NIOSH) Publication No. 87-113, July, 1987.

National Institute for Occupational Safety and Health, Guide to Industrial Respiratory Protection. DHHS (NIOSH) Publication 87-116, September, 1987.

American National Standards Institute, Inc. (ANSI), Safety Requirements for Confined Spaces, ANSI Z117.1-1989.

National Fire Protection Association (NFPA), Fire Department Self-Contained Breathing Apparatus Program, NFPA 1404, 3-1, 1989.

National Fire Protection Association, (NFPA), Fire Department Occupational Safety and Health Program, NFPA 1500, 3-1, 1987.

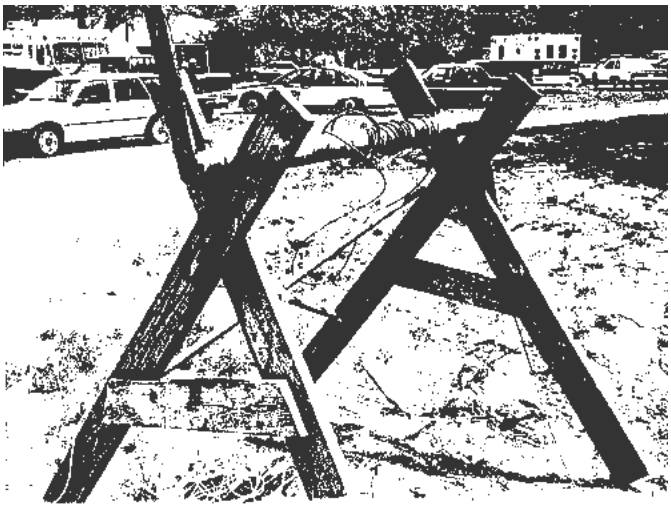

Figure. FACE 93-17.

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