OPERATING EXPERIENCE SUMMARY

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The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy complex by encouraging the exchange of lessons-learned information among DOE facilities.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Frank Russo, 301-903-8008, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction. If you have difficulty accessing the Summary on the Web (URL http://www.eh.doe.gov/paa), please contact the ES&H Information Center, (800) 473-4375, for assistance. We would like to hear from you regarding how we can make our products better and more useful. Please forward any comments to Frank.Russo@eh.doe.gov.

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EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health recently began publishing a series of "Just-In-Time" reports. These two-page reports inform work planners and workers about specific safety issues related to work they are about to perform. The format of the Just-In-Time reports was adapted from the highly successful format used by the Institute of Nuclear Power Operations (INPO). Each report presents brief examples of problems and mistakes actually encountered in reported cases, then presents points to consider to help avoid such pitfalls.

1. Deficiencies in identification and control of electrical hazards during excavation have resulted in hazardous working conditions.
2. Deficiencies in work planning and hazards identification have resulted in electrical near misses when performing blind penetrations and core drilling.
3. Working near energized circuits has resulted in electrical near misses.
4. Deficiencies in control and identification of electrical hazards during facility demolition have resulted in hazardous working conditions.
5. Electrical wiring mistakes have resulted in electrical shocks and near misses.
6. Deficiencies in planning and use of spotters contributed to vehicles striking overhead power lines.

The first six Just-in-Time reports were prepared as part of the 2004 Electrical Safety Campaign. In April, the Office of Environment, Safety and Health published a Special Report on Electrical Safety. The purpose of this report is to describe commonly made electrical safety errors and to identify lessons learned and specific actions that should be taken to prevent similar occurrences. This report can be accessed at http://www.eh.doe.gov/paa/reports/Electrical_Safety_Report-Final.pdf.

EH plans to issue more Just-in-Times soon on other safety issues, such as lockout and tagout, fall protection, and freeze protection. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

EVENTS

1. REBAR CURTAIN COLLAPSE RESULTS IN NEAR-MISS EVENT

On June 17, 2004, at the Bechtel National, Inc. (BNI) Waste Treatment Plant (WTP) construction project at the Hanford Site, a near-miss event occurred when an 850-pound section of a rebar curtain fell to the ground. Three ironworkers were slightly injured, but the potential for much more serious injury was very high. The event occurred when ironworkers were installing a rebar splice curtain (shown in Figure 1-1) on the wall of the pre-treatment building. (ORPS Report RP--BNRP-RPPWTP-2004-0009; final report filed August 2, 2004)

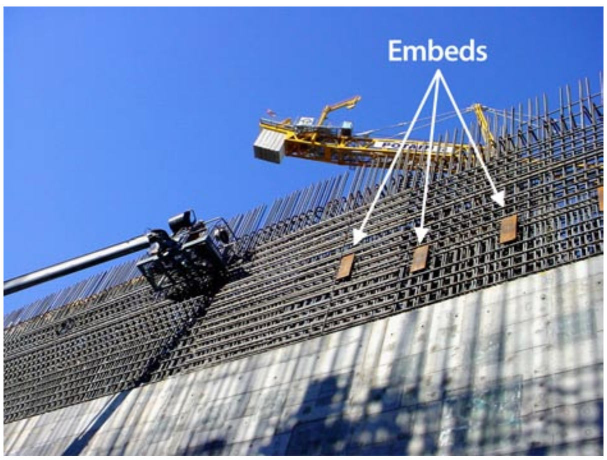

Figure 1-1. Splice curtain

The splice curtain consisted of 2 vertical bars of #5 size (0.625-inch diameter) and 18 rows of #11 size (1.41-inch diameter) horizontal bar pairs. Before the incident, ironworkers had positioned the splice curtain into place, secured enough horizontal bars to release the tower crane, and started work on a second curtain. The workers set the second curtain and took a short rest break. When they returned to work, they began repositioning the upper bars to correct a misalignment in the curtain by removing the tie wires to the #5 vertical bars. After the workers removed several of the ties, the weight from the #11 bars caused the lower portion of the splice curtain to fall to the ground.

Work stopped, and workers secured the area and notified BNI managers, who initiated an investigation. BNI management also ordered a stand-down for the second-shift ironworkers and discussed the need for safe work practices, the use of stop-work authority, and the correct method for installing rebar before allowing them to return to work.

Investigators determined that the crew foreman deviated from standard work practices. He directed the crew to tie off every fourth bar to expedite the work and had them change the tying direction from bottom-up to top-down. Both of these deviations led to the rebar curtain's collapsing.

A similar near-miss event occurred at the WTP construction site 5 days later. On June 22, 2004, a 100-pound embed (Figure 1-2) fell approximately 45 feet as carpenters removed a concrete wall-form panel. The carpenters had removed the bolts securing an embed that was located just above the concrete placement level of a wall. As they pulled the form away from the wall, the embed slid down between the form and the wall and fell onto a scissor lift. No one was injured, but the embed landed about 8 feet from a carpenter who was standing on the opposite side of the scissor lift. (ORPS Report RP--BNRP-RPPWTP-2004-0010; final report filed August 5, 2004)

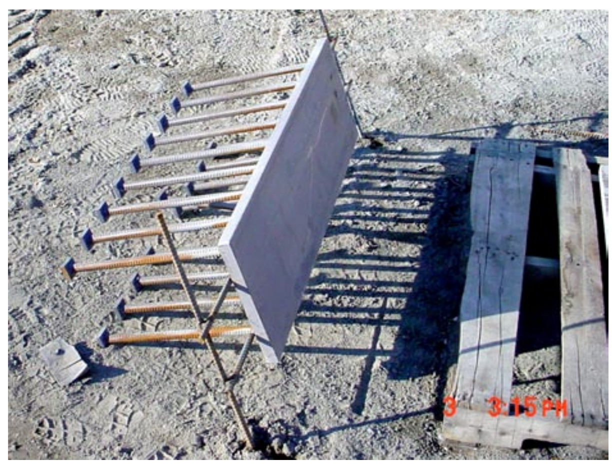

Figure 1-2. Embed

Workers secured the area and notified BNI management. The ensuing investigation revealed that the placement height of the concrete wall had changed from 56 feet to 50 feet; as a result, some embeds were positioned above the pour level and were not attached. No one checked to see that these embeds were secure. When the carpenters removed the bolts holding the embeds to the concrete form, they did not realize that some embeds were unattached.

In addition to taking place within days of each other and 100 feet apart, these events bear similarity to each other in that the standard process changed. Normally, process changes undergo an Integrated Safety Management System (ISMS) evaluation. The changed process is reanalyzed to identify new hazards, and controls are developed to mitigate the hazards. However, in these two cases, work proceeded under changed conditions without an ISMS evaluation. Following the second event, BNI made the following recommendations:

- Superintendents should discuss significant changes in work scope with crews, safety representatives, and field engineering to identify and analyze new hazards and to develop controls.
- Construction personnel should develop a multidisciplinary checklist of items that must be verified prior to stripping formwork, such as inspecting for loose items between the forms above the pour line.
- All personnel should be actively involved in identifying hazards that could arise from changed work environments or task conditions.
- Management should review and establish acceptable superintendent-to-craft ratios.

These events illustrate the importance of recognizing and analyzing hazards when process deviations occur before continuing work.

KEYWORDS: *Near miss, rebar, rebar curtain, embed*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls*

2. TYPE A ACCIDENT INVESTIGATION OF SUBCONTRACTOR FATALITY

On July 26, 2004, at the Savannah River Site Pond B Dam, a truck driver who was helping a teamster load an excavator onto a lowboy trailer suffered fatal injuries when he was crushed by the excavator. A Type A Accident Investigation Board evaluated the accident and developed causal factors and Judgments of Need. (ORPS Report SR--WSRC-CMD-2004-0003)

A subcontractor excavating company was finishing upgrade work on the dam and rented a long-boom excavator from an outside vendor to complete some punchlist items. The excavating company completed the work, and on July 26, a teamster employee of the excavating company met a vendor truck driver at the security gate to escort him to the Pond B Dam to retrieve the excavator and deliver it to the rental company.

Upon arrival at the Pond B Dam, the truck driver parked the lowboy trailer (Figure 2-1) near the excavator, and the teamster drove the excavator onto the lowboy. Although the teamster was not qualified to operate the excavator and had not been assigned to move it, he stated in a post-accident interview that he drove the excavator onto the lowboy as a courtesy to the truck driver.

Figure 2-1. Lowboy trailer after removing excavator

The teamster stated that the truck driver told him that the outrigger plank on the driver's side of the lowboy was cocked and needed to be repositioned. The driver asked the teamster to use the excavator boom to pick up the tracks on that side so he could reposition the outrigger plank. The teamster raised the excavator boom and swung it about 90 degrees to the right so that it was nearly perpendicular to the excavator tracks. He positioned the boom and the arm to place the bucket on the ground about 10 to 12 feet from the trailer.

The teamster then used the excavator controls to push down on the boom and out on the arm to raise the track off the trailer. This position of the boom and arm is contradictory to the manufacturer's recommended method of raising the tracks. He stated that the truck driver asked him at least twice to raise the track higher. While he was doing this, the driver was in the teamster's line of sight. The driver squatted down near the excavator and trailer, and he then disappeared from the teamster's line of sight.

The teamster stated that shortly afterward he felt the excavator budge, as if it had dropped. He then focused his attention on the excavator bucket and the ground, and a short time later saw the excavator drop. He stated that he thought he could feel the hydraulic pressure bleeding down, allowing the track to come back down. He then began calling to the driver to get out, that the excavator was coming down. The teamster stated that the truck driver told him to hold on a minute and not do anything. The teamster reported that he had the sensation that the bucket was sliding, not the excavator.

The teamster heard the truck driver scream out in pain and "boomed back up" by pushing down on the boom and out on the arm. The teamster asked the driver if he was okay and was told by the driver that he was not okay and he needed some help. The teamster stated that he locked down the hydraulic controls on the excavator, ran off the back of the trailer without looking at the injured driver, got into the company vehicle, and drove four-tenths of a mile across the dam to the construction office trailer to get help.

The teamster's foreman, upon arriving at the accident scene (Figure 2-2), determined that the truck driver needed an ambulance and called the excavating company's onsite office via cell phone. The onsite company office in turn contacted the Savannah River Site Emergency Duty Officer and informed him that an accident had occurred that required medical assistance.

Figure 2-2. The accident scene

The Emergency Duty Officer dispatched fire department personnel, emergency medical technicians, and a paramedic from Savannah River Fire Department Station 3 to the remote accident scene. The driver was conscious and responding to questions when emergency personnel arrived at the scene. They treated the victim and readied him for transport as quickly as possible. The victim was transferred by regular ambulance from the accident scene to the closest trauma center – the Medical College of Georgia in Augusta, Georgia.

Testimony from emergency responders indicates that consideration was given to using the site helicopter for MEDEVAC transport but that there was disagreement as to whether MEDEVAC would have been effective in securing, treating, and transporting the accident victim to the Medical College of Georgia. In addition, initial communication from the accident scene was sketchy, and the first responders did not fully appreciate the nature of the accident (i.e., the driver was pinned under the excavator tracks) until after the victim had been transported. The Board concluded that using the site helicopter could have reduced transport time by 30 minutes or more.

Hospital personnel determined that the driver could not move his lower extremities and had no sensation in either leg. X-rays showed fractures in the driver's right femur, pelvis, and lumbar vertebra. Several times during the course of treatment, the driver displayed respiratory distress and was placed on mechanical ventilation. The driver then experienced a cardiopulmonary arrest from which he could not be resuscitated. The next day, forensic pathologists ruled that the cause of death was hypovolemic shock caused by the fractures and blunt trauma.

The Savannah River Operations Office Manager appointed a Type A Accident Investigation Board on July 28. The Board began their investigation on August 2, 2004, and concluded it on September 1. They determined that this accident could have been prevented and identified the following root causes that need to be addressed to prevent a future event of this type.

- DOE and its managing and operating contractors were inattentive to programmatic deficiencies in communicating and implementing safety requirements for subcontracted construction work at the Pond B Dam Project.
- The subcontractors' unstructured approach to work did not ensure that safety and health requirements were translated into work controls, did not take those actions necessary to enforce compliance with fundamental safety requirements during the work, and did not define their safety and health expectations for the activity prior to work.
- Facility management failed to fully address causal factors from previous operational occurrences through the corrective action processes at the site. One example was reported in OE Summary 2004-12 in an article entitled *Field-Modified Equipment Overturn*, in which two subcontractor-modified vehicles hauling water tanks overturned. (ORPS Report SR--WSRC-CMD-2004-0002)

The Board further determined that the following were the direct causes of the accident that resulted in the excavator falling onto the driver.

- The driver was working under or near the excavator.
- The teamster was not qualified to operate the excavator.
- The subcontractor excavating company failed to exercise control over its employee and vendor.
- Stop-work authority was not effectively utilized.

The Board concluded that this accident was preventable. The Board also identified weaknesses in the site's implementation of Integrated Safety Management (ISM) policy through work practices as it relates to the subcontractor and vendors performing work at the Pond B Dam Upgrade Project. Facility management did not ensure that the subcontractor met the basic requirements imposed by the Department, the site, and the Occupational Safety and Health Administration. Although internal and external oversight activities and a series of operational occurrences identified construction safety-related issues and concerns with similar systemic causes, a lack of rigorous causal analysis prevented identification of lessons-learned and systemic weaknesses and implementation of effective corrective actions.

The Board concluded that DOE Savannah River and its managing and operating contractor need to intensify their efforts and commitment to ensure that all the elements associated with ISM are promptly and effectively addressed for all construction subcontractors and sub-tier contractors and vendors to prevent additional accidents.

This event illustrates the importance of learning from previous events. Performing an in-depth root cause analysis and taking corrective actions that fully address the underlying causes can help prevent future adverse events both at the site and across the Complex.

KEYWORDS: *Excavator, fatality, truck driver, teamster, trailer*

ISM CORE FUNCTIONS: *Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

3. DANGERS OF AIRBORNE (RESPIRABLE) SILICA

The Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health report that more than 250 American workers die annually from silicosis and more than 1 million are exposed to crystalline silica. There is no cure for silicosis, but it is 100 percent preventable if employers, workers, and health professionals work together to reduce exposures through good work planning and engineered controls.

On October 13, 2004, two events involving worker overexposures to respirable crystalline silica were reported to ORPS. One event occurred at Fernald Environmental Management Project; the other, at Lawrence Livermore National Laboratory (LLNL).

At Fernald, personal air samples taken at the Demolition, Soils, and Disposition Project indicated that a soil-screener operator working without respiratory protection had been exposed to respirable silica in excess of the threshold established by the American Conference of Governmental Industrial Hygienists (ACGIH). The screener operator, who works on foot or in a small, open-cab front-end loader, is the only worker involved in the operation who does not perform tasks in an enclosed heavy equipment cab. No respiratory protection was required for this task.

Industrial Hygiene staff conducted personal air sampling in September and sent the samples to an outside laboratory. Three of the five samples were above the time-weighted average for crystalline silica. Sampling had been conducted for another screener at the same location the previous year with results well below established limits, but no worker samples had been taken since. Corrective actions included providing an enclosed front-end loader for the operator and requiring operators to remain upwind when

Protect Yourself from Silica

- Maximize dry dust collection by using shrouds and proper equipment.
- Maintain dust collection equipment by changing filters according to manufacturer's directions or when they no longer clean properly and by maintaining deck shrouds/ skirts.
- Maximize wet suppression by using wet drilling and regulating water flow.
- Properly maintain wet suppression devices by using a filter to collect debris.
- Properly use and maintain enclosed cabs to ensure a sufficient air flow; wash cab frequently; replace worn or missing seals; keep door closed when drilling; and change air filters frequently.
- Do not stand in visible clouds of dust.
- Position drills with respect to prevailing winds in order to stay upwind of dust sources.
- When using a respirator, follow guidelines based on OSHA and MSHA regulations.

Source: Mine Safety and Health Administration Bulletin performing work activities on foot. (ORPS Report OH-FN-FFI-FEMP-2004-0030)

The LLNL event report resulted from air sample monitoring conducted in July 2004 on the breathing zones of two workers who were using a pneumatic jackhammer to remove concrete at the site. One of the workers received an exposure above the threshold limit value. The exposure occurred despite wet methods (e.g., spraying the concrete) being used during all activities. Both workers wore personal protective equipment (hearing and eye protection and leather gloves), but no respiratory protection. Respiratory protection has been required since the event occurred, and personal sampling will continue. (ORPS Report OAK--LLNL-LLNL-2004-0048)

On September 29, 2004, at the Hanford Office of River Protection Waste Treatment Plant, monitoring results indicated a possible worker overexposure to respirable silica during blasting operations and subsequent cleanup. Although most monitoring showed results well within protection factors provided by the full-face respirators worn by most workers, at least one sample showed dust or silica several times the time-weighted level. That sample was taken from a worker who wore a half-mask respirator. Corrective actions included requiring the use of supplied-air respirators and providing additional monitoring. (ORPS Report RP--BNRP-RPPWTP-2004-0020)

On April 22, 2004, at Oak Ridge Y-12, results of air samples taken in March indicated that construction workers had exceeded the acceptable levels for crystalline silica established by ACGIH. The workers were removing flooring (epoxy and concrete) using a wet saw and chipping hammer. Because the wet saw produced too much water, they began using a garden sprayer for dust suppression instead of stopping work altogether. However, the Job Hazard Analysis was not amended to reflect the change, and the garden hose did not adequately suppress the dust.

Early sampling showed elevated silica levels, but the protocol was inadequate, and the Industrial Hygiene technician did not believe his sampling results. As a result, work continued. Because the work had been completed by the time results were available, there were no corrective actions for that particular job. However, planning for future demolition work will address the fact that the grout/epoxy has a higher silica concentration than previously planned for and will also take into consideration the excess water produced by the saw. (ORPS Report ORO--BWXT-Y12CM-2004-0005)

On March 25, 2004, at Savannah River, a cement mason was exposed to respirable silica while removing concrete surface irregularities with an electric grinder, despite multiple controls. Controls included dust masks, safety glasses with side and face shields, polypropylene plastic draped over the work area, a pre-filter and Coppus blower on the local exhaust, a HEPA filter installed inline after the blower, and wet grinding to control dust. (ORPS Report SR--WSRC-CMD-2004-0001)

Investigators discovered that the filters reduced the effectiveness of the Coppus blower and concerns about electrical hazards resulted in the worker reducing the amount of water he used. They also believe that sample results may have been misrepresented because the exhaust was located near the employee's sampling device (i.e., the exhaust pulled more particulates past the sampler than might otherwise have been there). As is common in grinding operations, the grinder went past the wetted depth and released dry dust into the air. Corrective actions included purchasing tools with attached HEPA-filtered vacuum exhaust.

Where Do You Find Silica Dust?

Industries/activities posing potential risk of worker exposure to crystalline silica include:

- Construction — sandblasting, rock drilling, masonry, jack-hammering
- Tunneling
- Demolition
- Mining — cutting through sandstone and granite
- Shipyards
- Agriculture
- Manufacturing and using abrasives

Silicosis Develops over Years without Symptoms

Because chronic silicosis may go undetected for years, even a chest x-ray may not reveal an abnormality until after 15 or 20 years of exposure. Eventually, silica dust may overwhelm the body's ability to fight infections, leaving workers susceptible to diseases such as tuberculosis. Silicosis is not curable, but it is preventable.

Source: If It's Silica, It's Not Just Dust, *a guide published by the National Institute for Occupational Safety and Health (NIOSH), the Department of Labor, and the Mine Safety and Health Administration*

On February 3, 2004, at Savannah River, an elevated silica exposure was reported for October 2003 concrete sampling work. Although wetting techniques were used during cutting, the "breakaway" pieces had dry surfaces that may have exposed the worker who cleared them away. Less water than usual was used in this job because of radiological constraints. Recommendations for improvement included wetting the breakaway surfaces before removal and possible use of respiratory protection. (ORPS Report SR--WSRC-SGCP-2004-0001)

OSHA 29 CFR 1910, subpart G, 1910.94, *Ventilation*, and subpart I, 1910.134, *Respiratory Protection*, and Mine Safety and Health Administration (MSHA) 30 CFR 33.32, *Determination of Dust Concentration*, and 33.33, *Allowable Limits of Dust Concentration*, as well as other sections, provide requirements to ensure workplace safety. These actions include enforcing a permissible exposure limit, providing respiratory protection, posting warning signs, ensuring accurate recordkeeping and reporting, providing training, and performing air monitoring as needed.

There are three types of silicosis, depending on the airborne concentration of crystalline silica to which a worker has been exposed.

- Chronic silicosis, which usually occurs after 10 or more years of overexposure.
- Accelerated silicosis, which results from higher exposures and develops over 5 to 10 years.
- Acute silicosis, which occurs where exposures are the highest and can cause symptoms to develop within a few weeks or up to 5 years later.

Additional information about silica and silicosis is available at www.cdc.gov/niosh and at www.osha.gov/SLTC/silica. The text boxes also provide helpful information on this topic.

These events demonstrate the importance of being aware of potential silica dust, believing your indicators (the Y-12 industrial hygiene technician should have believed the elevated sample results and stopped the work), and stopping work when necessary. Respirable silica cannot be assumed to be an outdoor construction hazard only, as evidenced by the exposure during indoor demolition work at Y-12.

KEYWORDS: *Silica, silicosis, respiratory, air sampling, respirator*

ISM CORE FUNCTIONS: *Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

4. CONFINED SPACE CAN KILL

The National Institute for Occupational Safety and Health (NIOSH) defines confined space as a space that has limited openings for entry or exit, unfavorable natural ventilation that could contain or produce dangerous contaminants, and which is not intended for employee occupancy. Such spaces may include storage tanks, pits, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines. It is important to remember that confined space work may endanger employees not only because there may be dangerous breathing conditions but also because of excess heat, steam dangers, or proximity to moving machine parts.

On September 16, 2004, at Savannah River, a Safety Representative observed a subcontract employee working in a confined space (a tank) removing hardened grout without the proper protective measures in place. The tank had been placed on its side and workers had entered properly earlier in the day. Work was stopped

Inhalation Responses in Oxygen Deficient Atmospheres	
Oxygen Volume	**Symptoms or Results**
12-16%	Breathing and pulse rate increase, muscular coordination slightly disturbed
10-14%	Emotional upsets, abnormal fatigue upon exertion, disturbed respiration
6-10%	Nausea and vomiting, inability to move freely, may lose consciousness, may collapse, and although aware of circumstances may be unable to move or call out
Below 6%	Convulsive movements, gasping respiration, respiration stops, a few minutes later, heart action ceases

until the workers were retrained and the Job Hazard Analysis was revised. (ORPS Report SR—WSRC-CMD-2004-0004)

Although this event was without incident, the potential always exists for danger or even a fatality inside confined spaces. Examples of confined space fatalities are primarily found in non-DOE industries and agricultural situations, but the basic issues remain and apply to work at DOE sites: confined spaces endanger workers by placing them in proximity to heat, steam, moving parts, and most importantly, by enclosing/holding gases that can be almost immediately fatal.

On June 7, 2004, at Sandia National Laboratory, a group entering a steam pit did not have all required Entry Permit attachments. The maintenance activity's scope, use of retrieval gear in case of emergency, and personnel responsibilities had all been discussed at an employee safety meeting, but the attachments were not onsite during the actual activity. Although the team was prepared to use an air sampling device, the 6-foot tube was not long enough to monitor the air at the bottom of a 12-foot pit. The team believed they had to sample only the breathing zone — a belief that could have been fatal, as shown in the next example. (SELLS/NNSA Lesson Learned report 2004-SNL-10800-0003)

On May 28, 2003, a municipal engineer in New York State collapsed in a manhole while attempting to retrieve a flow meter for a regularly-scheduled battery replacement. He was pronounced dead after being transported to a hospital. The engineer had opened the manhole cover with a pickaxe and used a metal wire hook in an attempt to retrieve the flow meter, which was attached to a built-in ladder rung about 3 feet below the manhole opening. The meter slipped off the hook and fell more than 7 feet to the bottom of the hole. The engineer's response was automatic — and fatal. He quickly descended, picked up the fallen flow meter, placed it on the top rung, and began to ascend, but lost consciousness and collapsed. Figure 4-1 shows the manhole where the fatality occurred.

Figure 4-1. Landfill manhole where fatality occurred

A second engineer, who had the presence of mind not to attempt a rescue, called 911 on his cell phone. The fire department responded and used confined space rescue protocol to retrieve the victim. At the time of the attempted rescue, the oxygen concentration at the bottom of the manhole was only 2.1 percent (oxygen levels should be at least 19.5 percent because lack of oxygen can cause death in as little as 4 minutes). In addition to the asphyxiation danger, flammable gases that exceeded 60 percent of the Lower Explosive Limit were present (they should never exceed 10 percent). These gases could have exploded or ignited when the engineer used the pickaxe to open the manhole cover or if the metal hook he used to raise the flow meter had sparked. (New York Fatality Assessment and Control Evaluation Report 03NY027)

Two of the worst confined space asphyxiation events in recent history occurred in 2003 at a Canadian shipyard and in 1996 at a U.S Navy shipyard. On January 10, 2003, Canada was rocked by the news of four fatalities at a Fraser River shipyard, where a worker entered a confined-space flotation compartment and, when he did not return, four other workers entered to attempt rescue. The first worker and three of the would-be rescuers died, and one firefighter who attempted a rescue was injured.

In 1996, at a Navy Atlantic Division construction site, four workers died by asphyxiation in a sewer manhole after one was overcome and three others entered one-by-one to attempt rescue. The contractor had prepared a confined space entry permit for the sewer pumping station upgrade. The worker was disconnecting a bypass connection in a manhole when the manhole filled with sewage gasses. The worker was overcome by lack of oxygen and died, as did his would-be rescuers.

In March 1998, a worker at a Union Carbide plant was asphyxiated while inspecting the inside of a 48-inch-diameter pipe (Figure 4-2). The pipe, which contained nitrogen for moisture control, was not identified as a confined space.

Figure 4-2. Pipe in which worker was asphyxiated

Because poisonous gasses are often invisible, confined space atmospheres can only be determined by pre-entry testing, and rescuers should take nothing for granted (or rescues should be pre-planned). Statistics from the National Institute for Occupational Safety and Health indicate that more than 60 percent of confined space deaths occur among would-be rescuers. It is human nature to try to help someone who has collapsed without necessarily considering the reason for that collapse.

Some rescuers, aware of the hazard, mistakenly believe they can hold their breath or move quickly enough to avoid the same fate. The reality is that tension increases heart and respiration rates, and the body consumes oxygen more quickly. Confined spaces require additional exertion to enter and movement inside may be difficult. Rescue cannot be accomplished while holding one's breath for a limited time, especially when the atmosphere is composed of poisonous fumes. Therefore it is essential that rescue procedures and equipment be in place before workers enter a confined space and that rescuers be properly trained in the protocol.

Sample Confined Space Pre-entry Checklist

- ☑ Did you survey the surrounding area to show it to be free of hazards such as drifting vapors from tanks, pipes, sewers?
- ☑ Does your knowledge of industrial or other discharges indicate this area is likely to remain free of air contaminants while occupied?
- ☑ Are you certified in the use of the gas monitor to be used?
- ☑ Did you test the atmosphere of the confined space prior to entry?
- ☑ Was the oxygen content between 19.5 % and 23.5%?
- ☑ Was flammable vapor less than 10% of LEL/LFL?
- ☑ Were tests for toxic materials less than TLV/PEL?
- ☑ Have all sources of hazards been isolated from the confined space?
- ☑ Is all rescue equipment called out in the safe entry procedure available outside the confined space?
- ☑ Will the atmosphere be continually monitored while the space is occupied?
- ☑ Have the facility emergency and rescue services been notified that a confined space entry is about to be made?

If the answer to ANY of the questions is no, DO NOT ENTER the confined space until the conditions are corrected.

DOE OSH Technical Reference, Chapter 4, Appendix A

Additional information is available in the comprehensive guide, *Is it Safe to Enter a Confined Space?*, published by the California State Department of Industrial Relations. The publication is available at http:www.dir.ca.gov/dosh/dosh_publications/ConfSpa.pdf.

Previous OE Summary articles have addressed the hazards of nitrogen-enriched atmospheres (2003-14), carbon monoxide hazards encountered when using small gasoline-powered tools in enclosed or semi-enclosed spaces (2003-19), and the dangers of trenching and excavation work (2002-14).

These events demonstrate the life-saving importance of good planning and hazard analysis any time work is performed in a confined space.

KEYWORDS: *Confined space, enclosed space, asphyxiation, fatality*

ISM CORE FUNCTIONS: *Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

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Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
INPO	Institute for Nuclear Power Operations
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
SELLS	Society for Effective Lessons Learned

Units of Measure	
AC	alternating current
DC	direct current
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
NOV	Notice of Violation
SAR	Safety Analysis Report
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question

Regulations/Acts	
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
RCRA	Resource Conservation and Recovery Act
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement

Miscellaneous	
ALARA	As low as reasonably achievable
HVAC	Heating, Ventilation, and Air Conditioning
ISM	Integrated Safety Management
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control