OPERATING EXPERIENCE SUMMARY

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U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2003-18

September 8, 2003

The Office of Environment, Safety and Health (EH), Office of Analytical Studies, publishes the Operating Experience Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging the exchange of lessons-learned information among DOE facilities.

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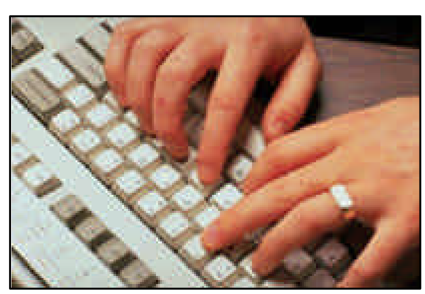

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EVENTS

1. TECHNICAL SAFETY REQUIREMENTS VIOLATION – COMBUSTIBLES CONTROL

On June 9, 2003, at the Nevada Test Site, construction workers left two gasoline-powered tamping devices overnight in a "No Combustibles Allowed Zone" at the Waste Examination Facility (WEF). This action violated a facility Technical Safety Requirement (TSR) in the form of an administrative control that prohibits unattended combustible materials within the zone. The 30-foot prohibited zone around a building was well marked with ropes, concrete stanchions, and signs, but neither the construction workers nor their escort realized they were violating the TSR when they left the devices near the building. (ORPS Report NVOO--BN-NTS-2003-0009; final report issued August 14, 2003)

A waste handler noticed the tamping devices inside the "No Combustibles Allowed Zone" during an inspection the following morning and notified the WEF supervisor. The supervisor and facility manager confirmed that the devices had been left within the exclusion zone overnight in violation of the TSR. Management personnel removed the devices and briefed waste handlers, radiological control technicians, and other escort personnel on the TSR violation.

The Management and Operating contractor provided escorts for subcontractor construction personnel because they had decided not to provide conduct of operations training to personnel performing short-term assignments. Although the escort received training on combustible material exclusion zone requirements, he apparently forgot that the unattended tamping devices violated these requirements. The escort also stated that he forgot about the gas-powered devices because he was focused on ensuring that the ropes marking off the area were secured when the construction workers completed the work for the day.

Investigators determined that inattention to detail was the direct cause of the occurrence because the construction workers' escort, who was an employee of the facility, trained in the TSR requirements and escort responsibilities, left the work area with the gas-powered tampers inside the prohibited zone. Investigators identified deficiencies in the pre-job briefing as a contributing cause for the incident. The pre-job briefing was generic in nature and did not discuss or list any limitations associated with the restricted locations for combustibles.

Investigators determined that the root cause of the incident was a lack of procedure because none was in place to define escort responsibilities or ensure that constraints imposed by TSR requirements and other elements of the authorization basis were met.

Corrective and compensatory actions resulting from this incident included the following.

- Reassign the escort involved in the incident until he has successfully completed additional training on escort responsibilities.
- Provide additional training on the reasons for, and implementation of, the 30-foot "No Combustibles Allowed Zone" for all project construction and operations personnel.
- Implement daily use of the "Radioactive Waste Management Complex Surveillance Checklist," which includes end-of-shift walkdowns of work areas to identify potential problems.

A search of the ORPS database for other incidents involving control of combustibles revealed several recent occurrences. On May 6, 2003, at the Rocky Flats Environmental Technology Site, a fire occurred in a glovebox when a piece of hot metal fell onto uncontrolled legacy combustibles that should not have been left in the bottom of the glovebox. Personnel were temporarily evacuated from the facility, and the site fire department used more than 600 gallons of water to extinguish the smoldering fire. (ORPS Report RFO--KHLL-371OPS-2003-0011)

On December 19, 2002, at the Pantex Plant, procedural and TSR violations related to the control of combustibles were identified. Transient combustibles were present and uncontrolled in a facility, and a combustibles storage

GOOD PRACTICES FOR ENHANCING FIRE SAFETY

- Ensure that facility personnel are familiar with the standards and guidance on fire safety published by the National Fire Protection Association.
- Ensure that facility personnel are familiar with the DOE fire protection programmatic and design requirements provided in Section 4.2, *Fire Protection,* of DOE Order 420.1A, *Facility Safety.*
- Practice good housekeeping in the facility by actively monitoring and controlling the locations and amounts of combustible materials.
- Ensure that all workers in a facility (full-time, part-time, and infrequent) are familiar with the facility requirements for fire safety.
- Ensure that permanent workers in the facility, and those who escort temporary workers, are familiar with the assumptions and results of the fire accident scenarios included in the facility documented safety analysis.
- Ensure that permanent workers in the facility, and those who escort temporary workers, are familiar with the technical safety requirement controls in the areas of fire prevention, fire detection, and fire suppression.
- Pay attention to detail when using and storing gasoline-powered equipment.
- Ensure that pre-job briefings and plan-of-the-day meetings address any fire safety considerations related to the work to be conducted that day.

cabinet was left open and unattended for an extended period of time. (ORPS Report ALO-AO-BWXP-PANTEX-2002-0065)

On October 3, 2002, at the Hanford Solid Waste Facility, a vehicle entered a fuel-restricted zone of the central waste complex with more fuel than is allowed by a procedural element of the combustible/flammable control program. The vehicle contained approximately 35 gallons of fuel while the administrative control procedure restricts vehicles to 26 gallons. (ORPS Report RL--PHMC-SOLIDWASTE-2002-0011)

The National Fire Protection Association (NFPA) publishes valuable standards and guidance documents on industrial fire hazards, fire prevention, and fire suppression functions. NFPA publications are available for purchase at http://www.nfpa.org. Section 4.2, *Fire Protection,* of DOE Order 420.1A, *Facility Safety,* describes general programmatic requirements and design requirements for fire protection.

These events reinforce the importance of ensuring that facility safety requirements, detailed work plans, and job-specific work controls are passed on to lower-tier subcontractors through mechanisms such as active escort oversight, pre-job briefings, and plan-of-the-day meetings. Even minor actions performed by subcontractors such as leaving a gas-powered tamper device on the wrong side of a concrete stanchion can result in a violation of the facility technical safety requirements. TSR controls on combustibles ensure that the magnitude of the fire scenario analyzed in the documented safety analysis for the facility is not exceeded by having more combustibles present than were assumed in the analysis.

KEYWORDS: *Technical Safety Requirements, TSR violation, combustible loading requirements, prohibition zones for combustibles*

ISM CORE FUNCTIONS: *Develop and Implement Hazard Controls, Perform Work within Controls*

2. REVIEW OF FORKLIFT EVENTS REPORTED IN 2003

There has been continuing improvement in the safe operation of powered industrial trucks over the past several years; however, recent events involving forklifts demonstrate that problems still persist. Nine forklift events were reported in ORPS in the past 3 months, and nearly half of the 15 events so far in 2003 resulted in a near miss. The purpose of this article is to notify the DOE complex of the characteristics of forklift events.

The Office of Environment, Safety and Health reviewed 33 forklift events reported from January 2002 through August 2003. Seventy-three percent of these events occurred during normal facility operations, including transportation activities. The following chart (Figure 2-1) shows the distribution of causes for these events. Hitting obstructions and dropping loads accounted for 79 percent of the forklift incidents. Fortunately, none of these were tip-over accidents, which are a major cause of injury or fatality.

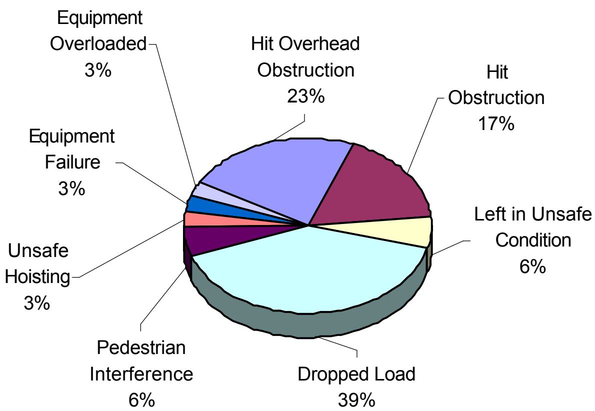

Figure 2-1. Distribution of event causes

The following recent events are representative of the types of events reported at DOE facilities.

- On August 21, 2003, at Pantex, the mast of a forklift caught on cathodic protection lines (less than 30 volts) and pulled them away from a building. The forklift operator was backing up at the time of the incident. (ORPS Report ALO-AO-BWXP-PANTEX-2003-0040)
- On August 12, 2003, at Brookhaven National Laboratory, the mast of a forklift contacted a telephone cable and pulled a power pole over 15 degrees such that 208-volt power cables sagged to within 4 feet of the road surface. (ORPS Report CH-BH-BNL-BNL-2003-0013)
- On July 28, 2003, at Fernald, an unattended forklift rolled 25 feet, breached a fence, and came to rest against a 30-gallon fuel cell. The operator had left the forklift with the load elevated, engine running, and parking brake on. (ORPS Report OH-FN-FFI-FEMP-2003-0016)
- On June 25, 2003, at the Y-12 Waste Management Facility, a waste container dropped from a forklift. As the operator was lowering the load, the container became unstable and flipped off the front of the forks. (ORPS Report ORO--BJC-Y12WASTE-2003-0008)

Forklift operators need to ensure that the load is balanced, their view is unobstructed, and the weight of the load is within the stated load capacity of the truck (Figure 2-2).

Figure 2-2. Large unbalanced load

Operating forklifts on loading docks can be dangerous, as shown in Figure 2-3. The impact of moving in and out of a trailer can cause the trailer to move. Operators need to know floor capacities (Figure 2-4) to prevent accidents resulting from collapsed floors. They also should be aware of overhead clearances to avoid hitting obstructions.

The U.S. Bureau of Statistics reports that every year in this country there are about 95,000 powered industrial truck accidents that result in injury and more than 100 deaths from forklift mishaps occur annually. Vehicle tip-over is the single largest cause of forklift-related deaths, followed by being crushed by the vehicle. The same applies to non-fatal accidents, where tip-over and being struck by the vehicle, followed by being struck by falling loads, account for the majority of industrial truck accidents. The following recent fatalities resulted from crushing injuries.

- On August 1, 2003, the operator of a stand-behind forklift at a plant in Berwick, Maine, was killed when he backed into a storage rack, pinning himself between a shelving unit and the forklift.

Figure 2-3. Loading dock mishap

Figure 2-4. Floor collapse

- On June 3, 2003, the operator of a forklift in Klamath Falls, Oregon, was killed when he was accidentally pinned between the forks and the body of the forklift when his tool belt got caught on a lever that caused the front forks to lower.

Personnel using a forklift to lift, suspend, or move material must understand the basic safe work practices for these maneuvers and must have training, experience, and proficiency in forklift operation.

A review of selected summaries from OSHA investigations of forklift fatalities identified the following commonly made errors.

COMMONLY MADE ERRORS DURING FORKLIFT OPERATION

- Driving while load obstructs view
- Taking turns with excessive speed, resulting in tip-over
- Leaving forklift unattended and in unsafe condition (e.g., engine running, load raised, parking brake not set)
- Attempting to jump clear of the forklift during a tip-over accident
- Failing to wear seatbelt when provided
- Standing on load while it is lifted
- Allowing others to ride on the forklift
- Failing to check for adequate clearance
- Not securing the load
- Failing to keep loads low and balanced
- Failing to determine the weight of load
- Failing to maintain the forklift center of gravity within the vehicle stability triangle
- Failing to maintain a safe distance from dock and ramp edges
- Failing to keep the load "uphill" when traveling on ramps or grades

All personnel involved in the use of forklifts should understand the information provided in the following references.

- OSHA regulation 29 CFR 1910.178, *Powered Industrial Trucks*, contains safety requirements related to the maintenance and use of platform lift trucks and fork trucks (forklifts), including operator training requirements.

- DOE-STD-1090-01, *Hoisting and Rigging*, Chapter 10, "Forklift Trucks," provides direction concerning forklift inspections, testing and operations. Section 10.5, "Operations," provides important guidance on general operator conduct when operating forklift trucks, including loading and traveling.

These events demonstrate the importance for safe operation of powered industrial trucks such as forklifts. Pre-job briefings and training should emphasize the dangers associated with equipment operation. Many events have occurred while drivers were backing up equipment, indicating a need for increased awareness of hazards in all directions, including overhead. Equipment operators should walk down areas to identify and evaluate potential hazards, and spotters should be used if equipment will be operated in the vicinity of overhead hazards. Equipment operator training should be continuing and should include "hands on" demonstration of operator proficiency. Operator qualifications should be current and training/qualification records should be maintained.

KEYWORDS: *Forklift, industrial operations, hoisting, rigging, dropped load, injury*

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

3. NEAR MISS: UNDERGROUND ELECTRICAL CABLE SNAGGED AND CUT

On June 30, 2003, at the Sandia National Laboratory, construction workers using a grader with a ripper blade inadvertently snagged an electrical cable while preparing to install a fence. There was no immediate indication that the conductor was energized, so the workers cut the cable and continued installing the fence. Several days later, Sandia managers were notified that a nearby site had lost 120-volt electrical power. Although site policy requires all cables to be buried at least 1 foot underground, the cut cable was only about 8 inches below the surface, probably because of soil erosion over time. (ORPS Report ALO-KO-SNL-6000-2003-0004; final report filed August 27, 2003)

Established site guidance does not require a search for underground utilities when excavating to a depth of less than 12 inches. The construction crew initially used a commercial trenching machine to prepare the area for the fence. They did not consider the generic Site Excavation Permit applicable because the trencher does not disturb the soil deeper than 12 inches. When the trenching equipment was unable to penetrate the soil, the workers decided to use a grader with a ripper blade with adjustable 1-foot-long tines. They set the tines to 8 inches before excavating.

Figure 3-1 shows the site and the approximate location of the cable run, which was about 100 feet long. When the ripper blade snagged the cable, an equipment operator checked the breaker for the conductor and determined it had tripped. Workers used a multimeter to check the line for energy and concluded it was not energized, so they cut the line and continued with the installation. At the end of the shift, they told contractor management that they had encountered an electrical cable, determined it was de-energized, and cut and re-buried it. When Sandia managers learned that power had been lost to a nearby facility, they concluded that the line was probably energized when it was snagged.

Investigators determined that the direct cause of the occurrence was a lack of procedure because there was no relevant procedural requirement in the excavation section of the site Environment, Safety, and Health (ES&H) Manual that provided guidance to help the workers determine how to proceed when they snagged the line. The workers should have stopped work and notified a supervisor instead of cutting the electrical cable and continuing with the fence installation.

Investigators identified a communications problem as a contributing cause for the occurrence. Although the generic Site Excavation Permit was not considered applicable to the fence installation task, work planners assumed that an activity-specific excavation permit might be needed. They requested this permit from the facilities organization, but did not clearly define the area for which the permit was requested. Facilities personnel thought that the work area

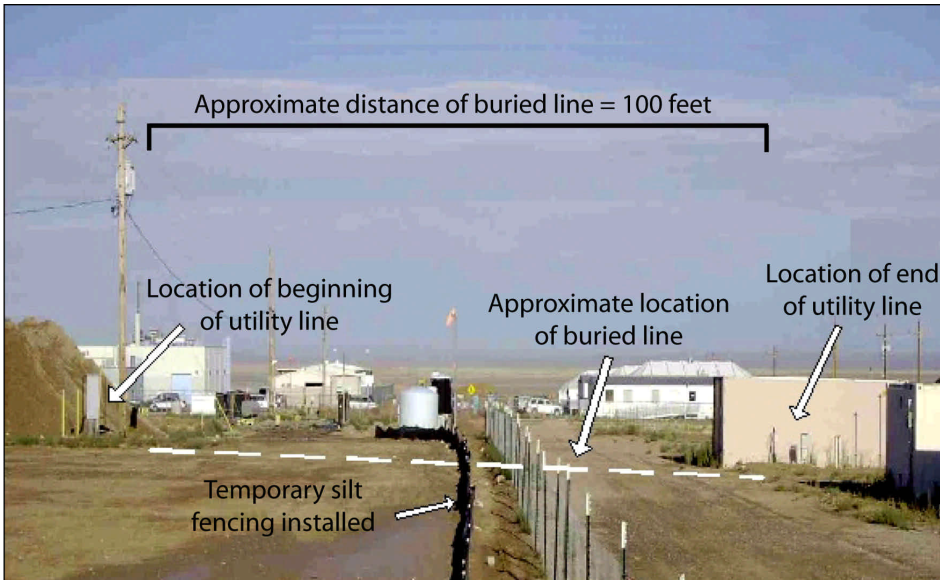

Figure 3-1. Location of cut cable

was entirely inside the facility fence line where there were no underground utility lines, and responded that there were no underground obstructions.

Investigators identified the root cause of the occurrence as a defective or inadequate procedure. For years, site environmental restoration personnel had used established guidance called the "1-foot rule" when planning earth-moving activities (i.e., if the soil will be disturbed to a depth of 1 foot or less, consulting the generic Site Excavation Permit for locating underground utilities is not necessary). Installing the fence required workers to dig only 6 to 8 inches, so they assumed that the 1-foot rule applied. Work planners did not consider that past activity or erosion at the site could have reduced the distance from the soil surface to the cable, even if it had initially been buried more than 1 foot deep.

Corrective actions resulting from this incident included the following.

- Conduct refresher training for all environmental restoration field workers to reinforce proper excavation procedures and to stress the need to stop work if unexpected underground utilities are encountered.
- Prepare and implement a new process for task planners to follow before conducting any soil disturbance activities and revise affected field checklists and Health and Safety Plans to reflect the new process.
- Prepare and implement a training program for all environmental restoration personnel on the new process for excavation planning.
- Prepare and implement procedural changes that make it clear that the former "1-foot rule" is no longer valid for environmental restoration work at this site.
- Review the sections of the site ES&H Manual that address excavations, trenches, and

COMMONLY MADE ELECTRICAL SAFETY ERRORS DURING EXCAVATION

- Failing to perform a subsurface investigation for potentially hazardous buried utility lines
- Working outside the boundaries of the approved excavation/penetration permit
- Failing to identify all sources of electrical energy during work planning
- Relying on inaccurate or out-of-date drawings to locate underground utilities
- Not obtaining or not following excavation/penetration permits
- Assuming subcontractors understand the site permitting process for excavations or penetrations
- Taking shortcuts because of schedule pressures (e.g., using heavy equipment instead of hand-digging near buried utilities)

floor/wall penetrations and make recommendations for additional or improved guidance in these areas.

Information on electrical safety practices within DOE can be found in an EH publication, *Electrical Safety Report,* dated May 21, 1999. Information on preventing damage to underground utilities can be found in *Common Ground, Study of One-Call Systems and Damage Prevention Best Practices,* dated August 1999. The report is published by and available from the Common Ground Alliance. Chapter 4 of the report addresses best practices for locating and marking underground structures.

A search of the ORPS database for similar recent events revealed several occurrences, including the following. On March 6, 2003, at the Fermi National Accelerator Laboratory, an excavation subcontractor cut the insulation on an energized 480-volt cable while digging a building foundation, causing a circuit breaker to trip open. The location of the cable was known by the subcontractor and it should have been de-energized and locked out before beginning the work. Facility personnel, who did not know that worker's were hand digging near the cable, re-energized the circuit in response to a loss of power. The workers in the excavation saw steam rising from water around the damaged and energized cable. Work was immediately stopped. (ORPS Report CH-BA-FNAL-FERMILAB-2003-0001)

On January 7, 2003, at the Lawrence Livermore National Laboratory, workers partially severed an electrical conduit containing a 208/120-volt power line while cutting asphalt with a power saw. The workers assumed that the conduit was buried at least 18 inches deep, when in fact it was only 4 inches below the surface. No injuries or significant property damage resulted from this event. (ORPS Report OAK--LLNL-LLNL-2003-0001; OE Summary 2003-06)

These events underscore the need to locate and characterize potentially hazardous underground utility lines before performing excavation tasks. General rules of thumb like the "1-foot rule" at Sandia National Laboratory (i.e., no excavation permit is needed if the excavation is shallower than 1 foot) are ill-advised. Work planners should not rely on unverified assumptions about the location or depth of a utility line that presents hazards to workers. When buried utility lines are encountered unexpectedly, a stop work order should be issued and observed until the situation is evaluated. In spite of the increased attention given to electrical safety events in this publication and others (such as the DOE Lessons Learned database), these incidents continue to occur frequently, as described in the lead article in Operating Experience Summary 2003-13 (June 30, 2003).

KEYWORDS: *Underground cable, excavation, trenching, excavation permit, cut conductor, electrical safety*

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

4. *HYDROCHLORIC ACID CAUSES CYLINDER RUPTURE*

On July 28, 2003, at the Nevada Test Site, technicians found the bottom head (Figure 4-1) from a 110-gallon testing cylinder that apparently burst the previous weekend. The cylinder contained 55 gallons of hydrochloric acid, which was sprayed over a 50-foot radius when the vessel ruptured. The acid spray damaged some equipment, and personnel would very likely have been injured had the cylinder burst during work hours. (ORPS Report NVOO--BN-NTS-2003-0011)

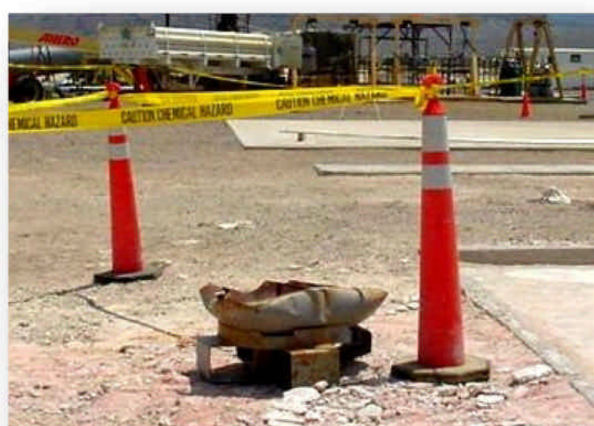

Figure 1. Facility personnel found the cylinder head lying on the ground some 50 feet away

Technicians had transferred the acid from a plastic 55-gallon barrel to the 110-gallon carbon-steel test cylinder on July 21, 2003. The cylinder was positioned on a concrete slab and chained to the horizontal bar of a 12-foot, A-frame overhead gantry stand with a roller-mounted chainfall. Wind direction issues resulted in the testing being postponed for several days, so the acid remained in the cylinder in direct sunlight. Test personnel examined the cylinder at noon on Thursday, July 24, and did not notice any signs that it was becoming degraded or over-pressurized.

The following Monday, July 28, 2003, at 7:45 a.m., the technicians were preparing the area for the test when they noticed the cylinder head lying on the ground and a 50-foot zone of discolored debris (Figure 4-2) and discolored equipment (Figure 4-3). The remains of the cylinder hung from the gantry stand above the concrete pad. Personnel closed and barricaded the main entrance to the facility. They collected the cylinder contents, put it in waste drums, and tested the ground, verifying it was neutralized.

Figure 4-2. Sprayed contents of the cylinder

Subject matter experts investigated the incident and found a number of factors that caused this event.

- The stainless steel pressure relief valve was corroded from the hydrochloric acid fumes and could not relieve the excess pressure that ultimately ruptured the cylinder.

Figure 4-3. Acid spray on nearby equipment

- The cylinder was improperly used to hold the hydrochloric acid while waiting for the wind direction to shift. As it sat in direct sunlight, heat and chemical reactions within the cylinder caused excess pressure to build up. The Material Safety Data Sheet for hydrochloric acid clearly states that it is corrosive, reactive with most metals, and must be kept away from heat, as it can decompose to form explosive hydrogen gas.

- Facility procedures for testing corrosives failed to address the appropriate holding time. The work package for using and storing chemicals states that strong acids, with the exception of hydrofluoric acid, shall be stored in glass containers. Work planning documents, however, did not mention at what point, following a delay in the work process, the acid was to be returned to storage. Figure 4-4 shows the degree of corrosion within the cylinder.

- Personnel did not recognize the potential hazard of using the carbon-steel cylinder to hold hydrochloric acid for an extended period of time. Chemical handling operations procedures specified that if any change occurs in the scope of work, personnel were to stop work. However, in this event, the technicians did not understand that the 4-day delay in testing constituted such a change.

Corrective actions, which are still under development, will include improving change control

Figure 4-4. Acid corrosion inside the cylinder

procedure. Because the experiments will not be conducted until next June, the equipment will be disassembled and inspected.

A number of other events involving explosive reactions in containers of acid have been reported in the ORPS database over the past few years. Summaries of these events are given below.

On August 1, 2003, at the Lawrence Livermore National Laboratory, a facility worker had placed computer/typewriter tapes into a 5-gallon carboy can containing nitric acid to dissolve them. About 30 minutes later, the worker was informed that the can had exploded. The can was split in half, and its contents scattered around the laboratory in a 6-foot radius. No workers were in the room when the explosion occurred. (ORPS Report OAK--LLNL-LLNL-2003-0027)

On January 25, 2001, at the Idaho National Engineering and Environmental Laboratory, a waste management worker discovered a 55-gallon drum which had pressurized, ruptured, and released its contents into a secondary containment. The waste material in the drum, consisting mostly of sulfuric acid with a pH of less than 2, had been transferred from carboys over a week earlier. Further investigations determined that the over-pressurization was due to a chemical incompatibility between the sulfuric acid and the carbon steel container. This incompatibility had not been thoroughly researched before the waste was transferred, and packaging and transportation personnel were not consulted for proper package selection, as the procedure requires. (ORPS Report ID--BBWI-TAN-2001-0003)

GOOD PRACTICES FOR HANDLING AND STORING CHEMICALS

- Know the materials that are being handled.
- Consult Material Safety Data Sheets before handling or storing chemicals.
- Store corrosive materials in suitable containers and in suitable environments.
- If the scope of work changes during a work evolution involving hazardous materials, stop work.
- When preparing to mix chemicals, be sure that they are compatible.

These events illustrate the importance of pre-job planning for activities involving acid storage in drums. Before a substance is stored in a drum for a period of time, personnel should know its constituents and how best to handle and store it. Prior to starting work, personnel need to know and understand all the hazards associated with a job and how to control those hazards. Work control documentation should adequately describe all job-related hazards and hazard controls as well.

KEYWORDS: *Cylinder, acid, chemical reaction, pressurized drum*

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