OPERATING EXPERIENCE SUMMARY

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OE Summary 2002-21

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EVENTS

1. TWO PINCH-POINT ACCIDENTS CAUSE FRACTURED FINGERS

In two separate occurrences on September 24, 2002, one at the Pantex Plant and one at Los Alamos National Laboratory (LANL), workers fractured their fingers in accidents involving pinch points. The worker at Pantex crushed the ring finger on his right hand between a wrench handle and a fixed steel roller. At LANL, a 700-pound sliding door to a steel cabinet moved unexpectedly, crushing the worker's finger against a stop. Both workers received prompt medical attention and sustained no other injuries. (ORPS Reports ALO-AO-BWXP-PANTEX-2002-0053 and ALO-LA-LANL-WASTEMGT-2002-0005)

In the Pantex occurrence, workers were on the drilling platform of a truck-mounted drilling rig (Figure 1-1) attempting to disconnect two sec-

Figure 1-1. Truck-mounted drill rig

tions of the drill stem. They used a 60-inch pipe wrench as backup for a hydraulic wrench, with the rig applying the torque needed to break the connection between the sections. Figure 1-2 shows the 1.5-inch, metal pin they attempted to use as a stop for the pipe-wrench handle. The pin failed as they applied torque, and the wrench handle moved. The wrench lurched forward, pinching the worker's right hand between the wrench handle and a fixed steel roller (Figure 1-3). The worker sustained a compound fracture of his ring finger.

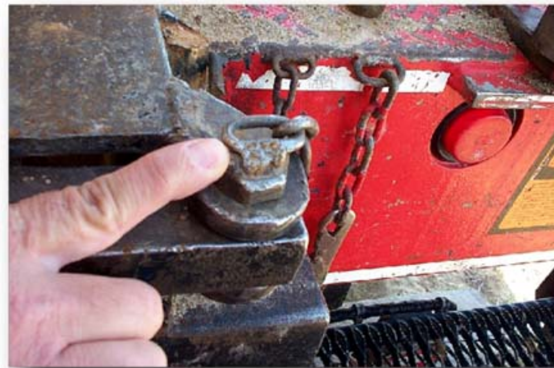

Figure 1-2. Failed 1.5-inch pin

Investigators determined that the direct cause of the accident was failure of the 1.5-inch pin stop. The pin, a modification to the drill rig, was not designed for use as a stop (i.e., to prevent movement of the pipe-wrench handle). Corrective actions included requiring disclosure of any modifications to heavy equipment used on site. These modifications must be approved before the equipment is used. Inspections will also be performed to identify any defects on the equipment and allow repairs to be made before work begins.

In the LANL occurrence, workers were installing a custom-made 11,000-pound steel cabinet (shown in Figure 1-4) when an unfastened 700-pound sliding door located at the top of the cabinet moved unexpectedly. The door crushed the worker's fingers against the stop (Figure 1-5).

Although a pre-work Activity Hazards Analysis identified potential pinch points at the base of the cabinet, movement of the sliding door was not anticipated. The door did not have a latch or locking device to hold it in a closed position, but two struts had been installed to prevent movement of the door during transport. The struts were removed before the cabinet was in its final location, and the workers who installed the cabinet were not informed.

Figure 1-3. Pipe wrench pinch point

Two causal factors in this event were (1) the premature removal of the struts installed to restrain door movement during transport; and (2) the inattention to detail when the obvious pinch points at the base of the cabinet were identified in the work package, but the rolling door pinch points were not. The struts preventing door movement could have been reinstalled before final installation of the cabinet, but the workers doing the lifting did not know about the struts.

A search of the ORPS database revealed several pinch-point injuries across the complex in the last 15 months. On June 8, 2001, at the Hanford Site, two workers were assisting with lay-down of a casing section that had just been pulled from a groundwater well. The casing rotated unexpectedly as they positioned it on the forks of a forklift transporter, pinching one worker's finger between the casing and a shackle. The worker sustained a bursting contusion injury to the tip of the little finger of his left hand. (ORPS Report RL--BHI-CENTPLAT 2002-0023)

Figure 1-4. Steel cabinet with sliding top

On July 23, 2001, at the East Tennessee Technology Park, a worker cutting a heavy tube-bundle frame with a plasma torch pinched his foot against an I-beam disassembly stand when the frame unexpectedly rolled. Two of his toes were fractured. (ORPS Report ORO--BNFL-K33-2001-0010; Operating Experience Summary 2001-03)

Figure 1-5. Cabinet pinch point

On November 16, 2002, at the Portsmouth Gaseous Diffusion Plant, a well driller incurred a severe hand injury in a pinch-point accident. The accident resulted in amputation of the ring finger of his right hand, a severed tendon in his index finger, lacerations on the back of his hand, and broken knuckles on his middle and index fingers. (ORPS Report ORO--BJC-PORTENVRES-2001-0020; Operating Experience Summary 2002-01)

Several lessons learned resulted from these events.

- Do not use equipment (such as the 1.5-inch pin stop on the Pantex drilling rig) for purposes for which it was not designed.

- Identify all potential pinch-point hazards (such as the sliding door on top of the LANL cabinet) in the Activity Hazards Analysis performed as part of the work planning process.
- Communicate information on pinch-point hazards to workers performing the work.
- Implement controls on pinch-point hazards to prevent worker injuries.

KEYWORDS: *Pinch points, hand injuries, fractures*

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

2. INADEQUATE HAZARD ANALYSIS RESULTS IN NITROGEN DIOXIDE EXPOSURES

Between February and August 2002, at the Fernald Environmental Management Project, five incidents occurred that involved personnel exposures to nitrogen dioxide (NO_2). Three workers suffered adverse health effects as a result of acute NO_2 exposures.

Nitrogen dioxide is a toxic, brownish gas that is formed when nitric acid reacts with metal. NO_2 causes coughing, throat and eye irritation, and lung damage. The Occupational Safety and Health Administration (OSHA) specifies a ceiling limit for personal NO_2 exposures of 5 parts per million (ppm).

Figure 2-1. Torch cutting at Fernald

On February 7, three subcontractor workers were cutting the outer metal shells of denitration pots when hot slag fell to the floor and reacted with an unknown material thought to be uranyl nitrate. All three workers wore flame-resistant coveralls and full-face powered air-purifying respirators (PAPRs) with high-efficiency particulate air (HEPA) filter cartridges (which provide protection against particulate matter, not gases). The workers exhibited symptoms of NO_2 exposure: two of them began coughing and felt irritation in their eyes and throats. The contractor emergency duty officer categorized this event as loggable but non-reportable in the Occurrence Reporting and Processing System.

Corrective actions for the February event specified using fire blankets on the brick. Combination acid gas-organic vapor-HEPA cartridges were specified for PAPRs to provide some degree of protection against NO_2.

On March 12, another three-member work crew performed a similar torch-cutting operation like the one in Figure 2-1. This crew wore rear belt-mounted PAPRs and personal single-gas monitors calibrated for NO_2. While he was cutting metal shells, the torch cutter's personal single-gas monitor alarmed, and the entire work crew backed away. The alarm cleared almost immediately, and the workers resumed torch cutting. Later, the torch cutter had to re-route a secondary exhaust hose from one ventilation unit to another. While the worker was reaching into the exhaust hose to retrieve an alarming, in-line single-gas monitor that had fallen in, he did not hear his personal single-gas monitor begin to alarm. Industrial hygiene personnel later discovered that the worker received an exposure with an average concentration of 11.6 ppm per 1-minute interval, more than twice the OSHA limit of 5 ppm. None of the workers, however, reported symptoms of overexposure. (ORPS Report OH-FN-FFI-FEMP-2002-0012; final report issued April 19, 2002)

The following day, as a welder torch-cut the shaft of a pump motor, hot slag fell onto the base plate of the motor, splattering onto the concrete pump base. Both the welder and a helper had eye, nose, and throat irritation from the resulting fumes. They reported the event to management and went to Medical Services for evaluation. Later in the day, both stated that they had chest tightness and headaches. Management suspended all hot work on the project until further notice. (ORPS Report OH-FN-FFI-FEMP-2002-0013; final report issued June 26, 2002)

Three of the workers involved in the February 7 and March 13 events suffered longer-term effects from NO_2 exposure. One suffered acute bronchiolitis. His lung condition continues to improve. Another worker complained of headaches. The third worker initially complained of irritation of the eyes, nose, and throat, accompanied by a significant cough.

The fire blankets specified in the February corrective actions were used in the later events, but they failed to keep the hot slag from getting under the blankets to the motor base plate to react with residual material beneath the base plate.

Following the March 13 event, managers stopped all hot work. Hot work resumed after the following corrective actions were taken.

- The subcontractor revised the equipment dismantlement plan to specify that all workers performing process-piping hot work and torch cutting must use full-face, supplied-air respiratory protection.
- The subcontractor required safety personnel to evaluate chemical process systems and areas where nitric acid, uranyl nitrate, or raffinates were processed to determine if cold cutting methods could be used instead of torch cutting.
- The project manager directed the safety and industrial hygiene team to perform a monthly survey of work plans and practices. He also ordered monthly quality control assessments to ensure that the surveys continued as directed.

Two subsequent events at Fernald in August 2002 also involved potential NO_2 exposures. In the first event on August 7, uranyl nitrate leaked from a pump housing and reacted with the metal rim of a pump support, releasing NO_2 fumes. (ORPS Report OH-FN-FFI-FEMP-2002-0029; final report issued September 20, 2002)

In this event, two workers wore personal protective equipment and full-face PAPRs with combination acid gas-organic vapor-HEPA cartridges, but the RCT, who accompanied them, did not. The work permit did not require the RCT to wear protective equipment or a respirator. An evaluation for NO_2 exposure indicated that 1-minute exposure concentrations for the two workers were 8.8 ppm and 26.8 ppm. The workers and the RCT reported no physical complaints, and were released without restriction.

On August 12, approximately one cup of greenish liquid being drained from a nick-cut stainless steel pipe dripped onto the tie wire of a bucket handle and reacted with the metal, producing a brownish gas. The workers' single-gas monitors alarmed, and they left the room. Later, the workers re-entered the room, accompanied by their supervisor and chemist, and one worker held a bucket to catch any remaining holdup, a violation of the procedures in the equipment dismantlement plan. Using an incompatible material (the metal bucket handle) resulted in a reaction that generated NO_2. (ORPS Report OH-FN-FFI-FEMP-2002-0030; final report filed September 25, 2002) Data collected from the workers' single-gas monitors indicated NO_2 exposures of 6.5 and 9.1 ppm average over a 30-second interval. Two minutes later, the readings were 3.7 and 10.8 ppm.

Site management stopped work on all activities that could generate NO_2, and formed an assessment team to evaluate these activities. The team identified the following areas where improvement is needed.

- Safe work plans need to be more user-friendly so that they can be used for briefings or as an information resource.
- Safety personnel need to better identify and evaluate potential hazards.
- The work planning process must include subcontractor foremen and superintendents.
- Workers should, wherever possible, avoid activities that could result in the release of NO_2 (e.g., use cold-cutting methods).
- Local and general-area ventilation should be used for any activities that could release NO_2.
- Supplied-air respirators should be used rather than HEPA filters or PAPRs with combination cartridges.

- Management needs to increase oversight of planning and execution for activities involving extreme hazards.

These five events illustrate inadequacies in hazard analysis, ineffective management oversight and enforcement, and failure to follow procedural requirements. These factors, in addition to the failure to fully implement corrective actions (e.g., appropriate respiratory protection), resulted in exposures of toxic NO_2 gas to workers.

KEYWORDS: *Nitrogen dioxide, torch cutting, metal reaction, respirator*

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

3. LID TO SANDBLASTING POT BLOWS OFF, CAUSING NEAR MISS

On August 20, 2002, at the Fernald Environmental Management Project, a hinged access cover (lid) on a bulk sandblasting pot blew off and landed approximately 500 feet away. A painter was pressurizing the pot (tank) with compressed air when the studs holding down the 50-pound lid failed. No one was injured; however, the contractor reported this event as a near miss because of the potential for injury from the flying lid, hold-down studs, and sandblasting grit. (ORPS Report OH-FN-FFI-FEMP-2002-0034, final report issued October 16, 2002)

At the time of the incident, the painter had started the compressor and was opening the air supply valve to the blasting pot. About 1 minute later the cover blew off of the top of the pot with a loud explosion-like sound. When the 18-inch diameter lid (Figure 3-1) blew off, a large amount of grit from the tank blew approximately 50 feet into the air. The painter, who was wearing a hard hat, safety glasses, and ear protection, immediately secured the air compressor as grit rained down on him.

The pot cover was discovered approximately 500 feet away to the northeast of the sandblasting unit. The assistant emergency duty officer found five of the six hold-down studs and nuts, some of them over 500 feet away. He determined that the cover had flown over three office trailers before it impacted a small gravel parking lot, bounced, hit the top rung of a cattle gate, then landed in a weeded area. A severed hinge bolt head was later discovered on the ground near the pot. Part of the O-ring for the cover was found in an excavation area about 100 feet away.

Figure 3-1. Lid to bulk sandblasting pot

A painting subcontractor brought the sandblasting unit to the site in April 2002. As shown in Figure 3-2, the entire unit (a Key Houston, Ind., Model T8-L) is mounted on a flatbed trailer. The unit includes a chiller, moisture separator, 8-ton weight-capacity bulk blasting pot, and associated valves, pipes, and hoses. A 150 psig-rated air compressor provides the motive force for the blast grit. The contractor investigated

Figure 3-2. Sandblast unit next to air compressor

the incident and determined that the direct cause was that the cover hold-down fasteners failed. The fasteners consisted of six sets of 5/8-inch diameter by 6-inch long threaded studs, 5/8-inch nuts, washers, and drilled and tapped steel blocks made from round stock. In all cases the failure was by pullout of the studs from the steel blocks.

Figure 3-3. Hold-down stud with damaged threads on the right

The threads between the hex nuts and the upper end of each stud showed no visible damage. However, the external threads on the lower end of each stud and the internal threads of each steel block showed significant damage and wear. Figure 3-3 shows one of the recovered studs with a deformed washer and damaged threads that pulled free from one of the steel blocks attached to the pot opening.

Because threaded fasteners are designed so the fastener will break before the engaged threads can shear, engineers concluded that the lid failed because of thread wear, especially in the steel blocks (Figures 3-4 and 3-5). The fasteners failed before the safety relief valve installed on the pot was challenged.

Figure 3-4. Pot opening and six threaded steel hold-down blocks

Before the contractor allowed the sandblasting unit to be used at Fernald, project safety personnel performed a safety inspection. However, they did not consider checking for thread wear on the hold-down fasteners. To prevent recurrence of this type of event, the contractor will modify their pressure vessel safety program to ensure that vendor-owned pressure vessels are also properly inspected before and during use at Fernald.

The contractor's lesson learned from this event states that contractors need to ensure that subcontractor and vendor equipment is safe to operate on their site. A vendor may or may not have the same commitment to quality and safety as the contractor, and the contractor must realize that a serious problem with vendor-owned equipment could result in serious health and safety consequences for their employees. Therefore, all vendor-owned and operated equipment, especially pressure vessels, must be inspected for indications of wear, abuse, or unintended operations before the vendor is permitted to use the equipment on site.

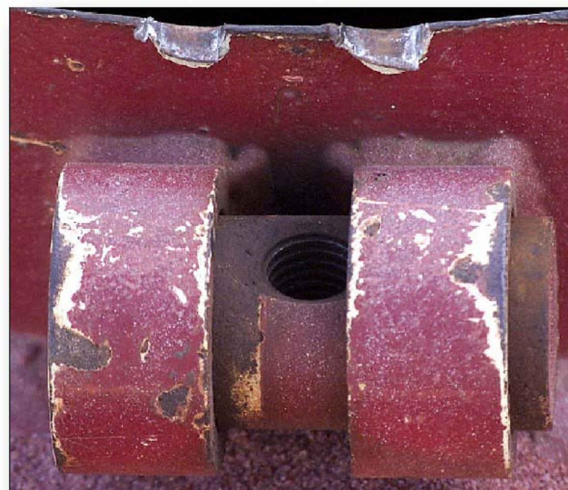

Figure 3-5. Steel block with damaged threads

A similar near-miss event involving a mobile sandblasting unit occurred March 13, 1998, at the West Hackberry Site. Hold-down bolts failed when the pot was over-pressurized, propelling the lid a distance of 205 feet. Investigators determined that a subcontractor had not performed preventive maintenance (cleaning) of the pressure regulating system for the compressor resulting in a defective pressure switch, pressure regulator, and relief valve, which caused the pot to over-pressurize. The manufacturer stated that the pot does not have a pressure relief valve and that the pressure must be regulated at the compressor. (ORPS Report HQ--SPR-WH-1998-0001)

These events illustrate the potential hazards associated with pressurized systems that have not been properly maintained or inspected in accordance with manufacturer's instructions. Pressure boundary closure devices that may require frequent operation, such as filling a sandblast pot, should be inspected for wear, corrosion, and indication of abuse (i.e., over torque). Inspections and testing of safety relief valves are required in 29 CFR 1910.169, *Air Receivers.*

KEYWORDS: *Near miss, sandblasting, pressurized, pressure vessel*

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

4. BERYLLIUM-CONTAMINATED REFRIGERATOR MOVED OFFSITE

On September 13, 2002, at the Pacific Northwest National Laboratory (PNNL), an industrial hygienist developing a decontamination recovery plan for a beryllium-contaminated facility discovered that an explosion-proof refrigerator, known to have a low level of beryllium contamination, was missing. The refrigerator was not labeled as contaminated when the area was posted for beryllium contamination. The following Monday, Laboratory personnel traced the refrigerator to a local community college, where it was on loan and being used for chemical storage. PNNL personnel retrieved the refrigerator from the college immediately. (ORPS Report RL--PNNL-PNNLBOPER-2002-0014)

In April 2000, as part of a 10 CFR 850 implementation, several facilities at PNNL suspected of being contaminated with beryllium were surveyed. At that time, a sample taken from the top of the refrigerator indicated beryllium contamination of 0.262 micrograms per 100 cm^2. This amount is in excess of the public release limit, but below the housekeeping limit (3 μg/100 cm^2). Facility personnel posted the area to warn of the existence of beryllium contamination, but no one labeled the refrigerator.

The refrigerator was replaced in late 2001 and transferred to excess equipment storage a few months later. In May 2002, PNNL staff arranged to loan the refrigerator to a local community college. Workers from the college picked up the refrigerator at the PNNL warehouse and transported it to an unoccupied chemical laboratory at the college.

When the industrial hygienist discovered the refrigerator was missing, PNNL contractor personnel investigated and found it had been excessed by personnel who were not aware that it was contaminated. PNNL personnel taped plastic around the area where the contamination was originally detected and returned the refrigerator to PNNL, where it will eventually undergo land disposal. The Laboratory gave the college a new refrigerator and provided beryllium sensitivity screening for the workers who moved the refrigerator.

The Laboratory will also label all movable equipment in contaminated areas to ensure that the presence of this hazardous substance is adequately communicated.

Beryllium is a brittle, silvery-gray metal used in a wide variety of applications in the aerospace, nuclear, and manufacturing industries. In addition, beryllium is amazingly versatile as a metal alloy, where it is used in dental appliances, golf clubs, non-sparking tools, wheelchairs, and electronic gadgets. Beryllium also causes lung and skin disease in 2 to 10 percent of workers exposed to it. For additional health risk information, see the National Jewish Medical and Research Center web site at http://www.njc.org/medfacts/beryllium_medfact.html.

The adverse health effects of beryllium exposure are caused by the body's immune system reacting with the metal, resulting in an allergic-type response. The public release limit for beryllium specified in 10 CFR 850, *Chronic Beryllium Disease Prevention Program*), section 850.31, "Release Criteria," is 0.2 µg/100 cm^2. (URL http://www.access.gpo.gov/nara/cfr/waisidx_01/10cfr850_01.html)

A similar event involving beryllium occurred at the Oak Ridge National Laboratory where a radiological control technician discovered an open bag inside a wooden box that contained beryllium-contaminated pieces of broken material and a ceramic ring. After surveying the box and material inside for radioactivity and detecting none, the technician removed a foam insert from the box and found a beryllium hazard label on the box. The technician immediately placed everything back into the bag, clipped it shut, and notified his supervisor.

These events illustrate the hazard posed by inadequate administrative controls. It is imperative to restrict access to potentially contaminated equipment, particularly when extremely hazardous materials, such as beryllium, are involved. Ensuring that all personnel are made aware of the existence of the contamination is also essential.

KEYWORDS: *Beryllium contamination, excessed equipment, decontamination*

ISM CORE FUNCTION: *Develop and Implement Hazard Controls*