OPERATING EXPERIENCE SUMMARY

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U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2002-22

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The Office of Environment, Safety and Health (EH), Office of Performance Assessment and Analysis 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.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and, time permitting, 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, 301-903-1845, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction.

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NEAR MISS WHEN 150-POUND STAINLESS STEEL PART WAS THROWN FROM A LATHE

On October 16, 2002, at the Oak Ridge Y-12 Site, a stainless steel part was thrown from the rotating table of a vertical turret lathe when unexpected stored energy beneath the part caused it to become loose. The 150-pound part was thrown approximately 15 feet. A contractor investigation similar to a Type B investigation is underway because of the potential for serious injury to workers nearby. Relevant lessons learned and corrective actions arising from this event will be published in a future edition of the OE Summary. (ORPS Report ORO--BWXT-Y12NUCLEAR-2002-0070)

EVENTS

1. FREEZE PROTECTION REMINDER

With the onset of the cold weather season, personnel at DOE facilities are reminded to review and implement their freeze protection plans. The DOE complex has already experienced one serious property damage event this season as a result of cold weather. On November 1, 2002, at the Idaho Nuclear Technology and Engineering Center, water in a firewater sprinkler system froze when the facility steam system was shutdown for repairs and a power outage de-energized portable electric heaters. The resulting damage included a broken firewater line and at least one broken sprinkler head. Interior office spaces were also flooded, resulting in considerable water damage. (ORPS Report ID--BBWI-FUELRCSTR-2002-0012)

Burst pipes, frozen water lines, and cracked sprinkler heads in fire protection systems are frequently reported problems during cold weather. Fifteen freeze protection-related events have been reported in the Occurrence Reporting and Processing System since January 2000. More than half of these occurrences resulted in water leaks from freeze/thaw events. Other problems associated with cold weather include collapsed roofs from the weight of snow and ice, flooding from melted snow, and electrical malfunctions resulting from water pipe leakage in buildings. Cold weather damage can be costly to clean up or repair and can adversely affect facility operations. Comprehensive freeze protection programs help avoid or reduce the consequences of events related to cold weather vulnerabilities.

A number of actions can be taken to establish effective freeze protection for facility systems and equipment. These actions, together with contingency plans for especially severe weather, should be incorporated into written procedures and should be re-examined periodically for effectiveness. The following list identifies some typical measures that could be included in freeze protection plans.

- Establish a task team to develop, implement, and verify severe weather protection plans. These plans should ensure that facility operations and safety personnel review requirements related to seasonal weather protection, especially those that could affect safety system functions, before implementing them.

- Clean, service, and functionally test facility heating systems, and ensure that power and temperature controls are protected against inadvertent deactivation.

- Check antifreeze used in cooling systems, and replace it as necessary.

- Secure all air intakes, windows, doors, and other access areas that could provide inflows of cold air.

- Develop plans for alerting personnel and providing increased surveillance of vulnerable systems during periods of extreme or extended cold weather. Operations and maintenance personnel should be on call to respond to weather-related events.

- Install temperature alarms or automatic backup heat sources on vulnerable systems that require special protection because of hazards or costs associated with freeze damage.

- Inspect outside storage pads and unheated storage areas to ensure that stored materials are not susceptible to freeze damage.
- Ensure that cold weather gear is readily available for emergency, maintenance, and operations personnel.
- Examine wet-pipe sprinkler systems for areas susceptible to freezing and develop provisions for preventive or compensatory actions (e.g., activating auxiliary heat, draining the pipes, and posting fire watches).
- Inspect for heat-tracing tape degradation.
- Inspect dry-pipe fire suppression systems to verify that all water is drained.
- Review prioritization of outstanding work packages to ensure that inoperable freeze protection equipment is returned to service as soon as practicable.
- Review procedures to ensure compensatory measures are available if power is lost to heat-tracing tape or other freeze protection equipment.
- Review controls on temporary equipment to ensure availability of freeze protection actions when needed.
- Review administrative controls governing design changes to ensure that freeze protection considerations are addressed (e.g., adding drains when converting a wet-pipe fire protection system to a dry-pipe system).
- Review the current status and configuration of shutdown facilities to determine if freeze protection is required.
- Develop a program to evaluate long-range weather projections and determine necessary actions to prevent systems from freezing in facilities where cold weather is typically not expected, but may occur infrequently.

Managers should evaluate the maintenance histories of systems and equipment, as well as policies, procedures, and work planning processes, and should walk down potentially vulnerable systems to identify possible cold weather problems.

Section 4.18 of DOE G 433.1-1, *Seasonal/Severe Weather and Adverse Environmental Conditions Maintenance,* provides guidance to assist facility maintenance organizations in reviewing existing methods (and developing new methods) for establishing a seasonal maintenance program. This guide can be found at http://www.directives.doe.gov/serieslist.html under the title *Series 400 Work Process*. Section 4.18.3.2 of the guide includes cold weather preparation information; section 4.18.3.7 provides an example of a cold weather checklist. In addition to information on cold weather protection, the guidance addresses hurricanes, tornadoes, flash floods, and other natural disasters.

DOE Safety and Health Bulletin 91-4, also identified as DOE/EH-0213, *Cold Weather Protection,* October 1991, provides insights, corrective actions, and recommendations appropriate for sites susceptible to cold weather. This bulletin can be found at URL http://tis.eh.doe.gov/docs/bull/bull0070.html.

KEYWORDS: *Freeze protection, maintenance*

ISM CORE FUNCTION: *Develop and Implement Hazard Controls*

2. MACHINIST INJURED BY ROTATING CUTTING BIT

On July 1, 2002, at a Lawrence Livermore National Laboratory machine shop, a machinist was injured when his shoulder came in contact with the cutting bit on an operating horizontal boring mill. A co-worker immediately called the fire department. Fire department personnel transported the machinist to a hospital where he was treated for a 1-inch-deep gash to his shoulder. The machinist received 12 sutures to close the wound and was released from the hospital that day. (ORPS Report OAK--LLNL-LLNL-2002-0016)

The machinist was setting up an aluminum part on the horizontal boring mill. The mill was fitted with a four-bladed, carbide cutting bit (Figure 2-1) and was rotating at 2,000 rpm. When he completed the setup, the machinist pivoted to his left to exit the machine tool working area, and the carbide cutting bit cut the back of his left shoulder. The machinist felt a brief pull on his shirt and thought that only his shirt was cut. After realizing that a laceration had occurred he applied pressure to his shoulder with a towel and waited for help.

Figure 2-1. Carbide cutting bit

The machinist was fortunate that his clothing did not get caught up in the rotating bit or that his head did not contact the bit, as he could have been badly injured. Figure 2-2 is a reenactment showing a machinist facing the aluminum part with the cutting bit near his shoulder.

The contractor investigated the incident and determined that personnel error was both the direct and root cause of this occurrence because the machinist did not follow established procedures requiring the spindle to be stopped before adjusting machine setup. The contractor also identified the following contributing causes.

1. Personnel error (did not pay attention to detail) – The machinist had worked overtime for a long duration, which could have resulted in a level of fatigue that impacted his alertness and judgment.

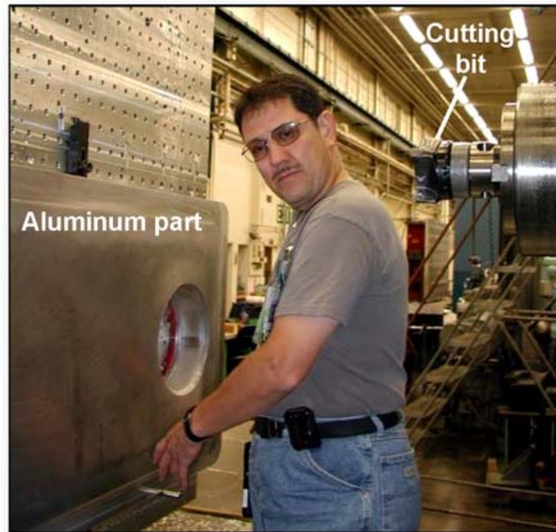

Figure 2-2. Position of machinist and cutting bit

2. Training deficiency (inadequate refresher training) – Specific training on how to operate the horizontal boring mill had not been formally conducted in the past 8 years.

3. Management problem (inadequate administrative control) – Engineering and administrative controls were not adequate to prevent personnel entry into the machine- work zone while the spindle was running.

Corrective actions included (1) performing a feasibility study on installing engineering controls to prohibit access to the machine-work zone during operation and (2) posting warning signs (consistent with industry standards) on machine tools in the complex. In addition, a review of the Machine Tool Operation Safety Training Program was performed to verify that all machine tools were identified and properly referenced in safety documentation.

There have been other events reported in ORPS where injuries or near misses occurred during work with rotating machinery. The following, while not recent, are representative of these events.

- On April 16, 1996, at Sandia National Laboratory/California, a machinist sustained four superficial cuts and damage to a nerve bundle on his left hand when he was struck by the rotating chuck of a lathe. He had reached under the guard to remove tailings while the lathe was still running. (ORPS Report ALO-KO-SNL-CASITE-1996-0002)

- On August 10, 1995, at Los Alamos National Laboratory, a research assistant caught his hair on the lead screw of a lathe when he leaned over to closely observe the part he was machining. (ORPS Report ALO-LA-LANL-LANL-1995-0011)

- On April 13, 1995, a machinist was hit on the left hand and left chest/shoulder area by a stainless steel rod that was in the collet on a lathe. The machinist had turned the machine on at 1,800 rpm and centrifugal force bent the rod at a right angle. (ORPS Report ALO-KO-SNL-CASITE-1996-0002)

These events underscore the importance of following equipment and safety procedures when working with rotating machinery. Workers need to recognize safety hazards and not place themselves at risk for injury by ignoring safety practices or taking short cuts. If tools have safety guards, workers should keep them in place, ensure they are in working order and are properly adjusted, and never remove them when the tool is being used. Also, co-workers need to communicate with each other if they observe unsafe work practices or potentially hazardous situations.

The principal hazards when working with horizontal boring machines and equipment like this are entanglement with revolving tools with most injuries occurring during setting changes and adjustments. During machining operations, access to the work zone should be prevented by fixed (e.g., perimeter fencing) and/or interlocked guards that remove power. Where powered movement of the machine elements is necessary for setting purposes, hold-to-run controls can be installed that work with braking systems.

The U.S. Department of Labor/Bureau of Labor Standards Bulletin, *The Principles and Techniques of Mechanical Guarding*, states "Any rotating object is dangerous. Even smooth, slowly rotating shafts can grip clothing or hair. Accidents due to contact with rotating objects are not frequent, but the severity of injury is always high." Worker exposure to unguarded or inadequately guarded machines results in approximately 18,000 amputations, lacerations, crushing injuries, abrasions, and more than 800 deaths per year. Amputation is one of the most severe and crippling types of injuries in the occupational workplace, and often results in permanent disability. For this reason, all motion hazards should be guarded by physical barriers and "skill" of the operators should not be the principal means of risk reduction. Information on machine safety and guarding can be found in 29 CFR 1910, Subpart O, *Machinery and Machine Guarding*. OSHA regulations can be accessed at http://www.osha.gov.

KEYWORDS: *Injury, cutting, machine shop*

ISM CORE FUNCTION: *Perform Work within Controls*

3. TWO DUMP TRUCKS OVERTURN IN SEPARATE ACCIDENTS

In two separate accidents in August 2002, contractor-operated dump trucks overturned during construction activities. On August 14, at the Lawrence Berkeley National Laboratory (LBNL), a dump truck overturned while dumping a load of construction material. On August 22, at the Oak Ridge Y-12 Site, a dump truck overturned while dumping a load of topsoil at a landfill. No serious injuries resulted from either accident. (ORPS Reports OAK--LBL-OPERATIONS-2002-0004 and ORO--BJC-Y12WASTE-2002-0006)

In the LBNL occurrence, the truck driver suffered only minor bruises. Approximately 2 gallons of diesel fuel and a small amount of antifreeze spilled onto the ground.

Investigators identified inattention to detail as the direct cause of the LBNL incident. The driver failed to ensure that the truck was in a stable configuration before raising the bed to dump the load. A contributing cause was inadequate supervision. A supervisor was not present at the time of the incident, and there was no spotter to help the driver as he positioned the truck to dump the load. A root cause analysis identified a deficiency in work organization and planning. The hazards analysis fo-

Figure 3-1. Damaged truck, front view

cused on excavating and laying new pipe, and did not address hauling dirt from the excavation site and dumping it.

In the Y-12 incident, workers were installing an earthen cap on a landfill in accordance with the site Landfill Closure Plan. The truck driver sustained a small scrape to his skin, but did not require medical attention. No spills occurred as a result of this incident. The contractor secured the work site and suspended work activities.

The truck driver drove his truck to the designated dumping area and backed up to an area where he had previously dumped loads. The slopes and angles appeared to be about the same as for the earlier loads, so he began to raise the bed of the truck. As the truck bed started to rise, the truck began to lean. The driver pushed the lever to bring the bed back down, but it would not come down and the truck overturned, landing on the passenger side. Following the accident, the truck was returned to an upright position to prevent oil, hydraulic fluid, antifreeze, or fuel leaks, and a recovery plan was developed.

Investigators determined that the truck was not overloaded, and there was no reason to believe that the load was unbalanced in the bed of the truck. Approximately half of the load had been dumped when the truck suddenly overturned. Mechanical failures, tire pressure, and weather conditions were not considered to be factors in the accident. Figure 3-1 shows the damaged passenger-side mirror and the tilted truck bed.

Corrective actions for the Y-12 incident included contacting dump truck manufacturers for recommendations on maximum safe slope angles. Three manufacturers were contacted, and all agreed that there was no set, safe-slope-angle limit. The manufacturers also identified some factors that could result in overturning, including (1) the type of material being hauled, (2) the nature of the ground surface, and (3) the experience of the driver. Subsequent calls to construction company managers elicited information that maintaining a side-to-side slope of less than 10 percent was a safe rule of thumb for preventing overturning. Based on this information, the activity hazard analysis for the landfill earthen cap task was revised to address truck overturning hazards and establish maximum acceptable slope limits.

The Operating Experience Summary reported two other events involving overturned construction equipment that occurred in March of this year. On March 28, 2002, at the Fernald Environmental Management Project, a drum roller overturned because the operator was not experienced with rolling compound-sloped surfaces. (ORPS Report OH-FN-FFI-FEMP-2002-0015; Operating Experience Summary 2002-09) On March 4, 2002, at the Oak Ridge Y-12 site, a trenching machine operating on a slope overturned. The hazards analysis did not adequately address the hazards associated with working on slopes with loose soil. (ORPS Report ORO--BJC-Y12WASTE-2002-0003; Operating Experience Summary 2002-07)

These occurrences underscore the importance of using good judgment and paying attention to detail in hazards analysis, work planning, and conduct of operations involving heavy equipment. Operators should be experienced with and trained in topics such as soil conditions, acceptable maximum slope for operating a specific vehicle (e.g., trencher, drum roller, or dump truck), and changes in center-of-gravity as the vehicle configuration changes (e.g., raising the bed of a dump truck). Hazards analyses for heavy equipment operations should address all relevant parameters that could affect the probability of overturning the equipment in the context of the work to be performed, such as slope angle, soil conditions, type of load, weight of load, driver *experience, type of equipment, speed of motion, and weather.*

KEYWORDS: *Dump truck, heavy equipment, overturning hazard, accident*

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

4. WORKER RECEIVES HAND INJURY FROM FALLING CAGE ASSEMBLY CAP

On July 31, 2002, at the Los Alamos National Laboratory, a worker suffered fractured metacarpal bones (cylindrical bones extending from wrist to the fingers) in her right hand when a metal top cap for a cage assembly fell approximately 10 feet and struck the back of her hand. The worker was treated at a hospital and released that evening. (ORPS Report ALO-LA-LANL-CMPTRDIV-2002-0003; final report filed September 23, 2002)

Figure 4-1. A chain-link cage assembly

Three workers were installing chain-link metal storage cages like the one shown in Figure 4-1. Installing the cages required placing a chain-link panel upright, sliding floor shoes under the frame ends, and securing the C-shaped metal top cap (Figure 4-2), which measured 6 feet long by 1½ inches wide by 1/16 inch thick, across the panel joints, with 1½-inch threaded bolts and nuts.

Figure 4-2. The top cap piece

On the morning of the accident, the crew foreman briefed two workers who were new to the work evolution. The third worker had been on the job since it started. During the installation process, one of the workers was on a stepladder getting ready to install the top cap. He had placed the top cap and slid the bolt through both the cap and the top of the panel frame when another worker called to him that a floor shoe was missing. He climbed down the ladder, and he and a co-worker lifted the panels while the third worker slid the floor shoe onto the frame from beneath. One of the workers then returned to assembling panels while the other two used a ball-peen hammer to align the floor shoe with mounting holes. Because the top cap had not yet been secured, the hammering jarred it loose and it fell. The cap struck the right hand of one of the workers, causing the fracture to her metacarpal bones.

Investigators determined that the root cause of this event was failure to recognize a hazard. The worker who was securing the top cap failed to recognize the hazard posed by the unsecured cap when he was distracted by the missing floor shoe.

The subcontractor shop superintendent discussed the accident with the involved workers, and arranged for a safety meeting to present a detailed review of the incident and its causal factors.

In a similar occurrence at Idaho National Engineering and Environmental Laboratory on July 11, 2000, a subcontractor electrician injured his left index finger and thumb while driving an electrical ground rod into soil. He was using a weighted two-handled device known as a steel fencepost driver, consisting of a pipe approximately 3 feet long by 3 inches in diameter with handles welded on opposing sides that fits over the rod. During the lifting stroke, the electrician lifted the driver too high, allowing the ground rod to become disengaged. The electrician was unable to stop the downward stroke in sufficient time to avoid the ground rod, which struck his left hand with such force that the tip of the index finger was severely abraded and the thumb was gashed. The electrician's thumb required surgery to repair arterial damage. (ORPS Report ID--BBWI-TAN-2000-0022)

These events illustrate the importance of workers remaining aware of potential hazards that can arise unexpectedly as they are working. In the case of the event at Los Alamos, the worker's failure to secure the top cap before attempting to place the floor shoe introduced an unanticipated hazard.

KEYWORDS: *Hand injury, chain link cage*

ISM CORE FUNCTIONS: *Analyze the Hazards, Perform Work within Controls*

5. *CRANE DAMAGED DUE TO OPERATOR INATTENTION AND INADEQUATE CONTROLS*

On September 9, 2002, at the Savannah River Site during an annual cell inspection, a crane operator was remotely maneuvering a crane into a cell area when the crane ran into the maintenance hoist, causing $32,000 damage to the crane braking system and main drive gearbox. No one was injured because the crane is remotely operated from another room, and the area of impact is inaccessible. (ORPS Report SR--WSRC-HCAN-2002-0013)

The crane operator had been assigned to remove a cell cover in one section, then to work in another section. As he was moving the crane back to the first section, he looked down from the video monitors to check the procedure for the upcoming cell inspection. When he looked back at the monitors, the crane had collided with the maintenance hoist. The crane's inertia had also moved a rail stop 3 feet from its position.

Engineered safety features to control the crane's movement included the use of travel limit switch actuator arms. One set slows the crane speed to micro-drive as it approaches specific sections of the building; the other stops the crane to prevent a collision with a previously used crane. A rail stop is also installed a few feet from the old crane. In April 2002, facility personnel moved the old crane into a maintenance area, and in the process both sets of actuators broke. Facility management did not place the highest level of priority on the repair of the actuator arms, and they were scheduled for repair on October 1, 2002.

Administrative controls in place at the time of the accident included labeling the crane control console and installing an operator aid to direct the crane operator to use micro-drive while maneuvering in the last section. The only engineering control was the crane rail stop, which is not designed to stop the crane at full speed.

A number of corrective actions have been taken to address this accident; for example, the crane operator has received remediation training. Until the travel limit switch actuator arms were repaired, the crane supervisor was required to be present while the crane was in operation. The maintenance hoist was moved out of the area, the crane limit switches were repaired and verified to be operable, and site condition tags were reviewed to verify crane status to ensure safe crane operations.

A similar event involving inadequate controls over heavy equipment occurred at the Los Alamos National Laboratory on October 5, 2001. Subcontractor maintenance personnel performed an annual crane inspection on a single-leg gantry crane (Figure 5-1) and found several discrepancies: (1) damage and misalignment of the bridge end trucks that support the gantry leg section, (2) damage to the bridge drive electric motor and controls, and (3) the bolts that attach the gantry leg to the end truck drive assembly were found to be hand-loose. (ORPS Report ALO-LA-LANL-MATSCCMPLX-2001-0005)

Inspectors could not determine when or how the crane sustained physical damage to its structure. However, they noticed black scuffmarks on both ends of the bridge end trucks, and be-

Figure 5-1. The gantry crane

lieved that a forklift or other piece of heavy equipment caused the damage. A qualified crane operator performed the monthly inspection on September 10, 2001, and reported that the crane was in good working order with no structural abnormalities. On October 5, 2001, certified crane inspectors performed an annual crane inspection. This inspection found that the gantry crane had several mechanical and structural defects. The investigators concluded that the damage to the crane occurred sometime between September 10 and October 5, 2001, and was never reported.

The investigators also found evidence that unauthorized repairs had been attempted on the crane. The crane was placed out of service and required extensive repairs costing approximately $16,000. Informal and inadequate controls on the use of heavy equipment contributed to this problem.

These occurrences illustrate that operating heavy equipment in areas with limited space has a high potential for problems. The use of a spotter should be considered for all heavy equipment operations, where possible. Workers should be encouraged to report all problems to their supervisor or facility contact. Problems that are not promptly reported can pose hazards to workers or result in damage to other equipment.

KEYWORDS: *Crane, operator, administrative control, damage, heavy equipment*

ISM CORE FUNCTION: *Perform Work within Controls*