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OPERATING EXPERIENCE SUMMARY

Office of Environment, Safety and Health

Summary 2002-01
January 14, 2002

The 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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Operating Experience Summary 2002-01

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EVENTS

1. DRILLER INJURED IN PINCH POINT INCIDENT

On November 16, 2001, at the Portsmouth Gaseous Diffusion Plant, a well driller incurred a severe hand injury in a pinch point accident, resulting in amputation of the right-hand ring finger, severed tendon in the index finger, laceration of the back of the hand, and middle and index fingers broken at the knuckle. (ORPS Report ORO--BJC-PORTENVRES-2001-0020)

Figure 1 shows the drilling equipment that was being used. At the time of the event, the driller was aligning an extension rod to the threaded rod cap that is nested inside the auger assembly (See Figure 2). The driller used his left hand to actuate the feed valve lever to lower the auger head. The assembly dropped faster than he expected, trapping his right hand in the drive assembly and auger.

Figure 1. The drilling equipment

Manually aligning the extension rod to the threaded rod cap, which introduces a driller's hand into the pinch point, has been an accepted practice among many drillers and considered in the purview of skill-of-the-craft. The driller was employed by an experienced subcontractor, and oversight by the site contractor, Bechtel Jacobs Company, LLC (BJC), had not included the involvement of a subject matter expert in drilling safety.

The activity hazards analysis (AHA) for the work activity addressed pinch points in a general manner; i.e., it identified a pinch point as a hazard and directed, "Do not place parts of the body between objects," without giving any detail regarding the drilling train assembly or disassembly. Operations were performed without written procedures, and the drill rig operating manual was not kept with the equipment. A slip wrench that is designed for extension rod handling, and which, if employed, would have prevented the injury.

The standards to which drill rigs are manufactured today incorporate additional safety measures that were not present when this drill rig was manufactured in 1973. Neither BJC nor the subcontractor require specialty contractors to characterize their equipment relative to current standards or to present compensatory measures, and as such, even obsolete equipment could be utilized on site. Heavy reliance is placed on the technical expertise of the specialty subcontractor to encompass safe work practices.

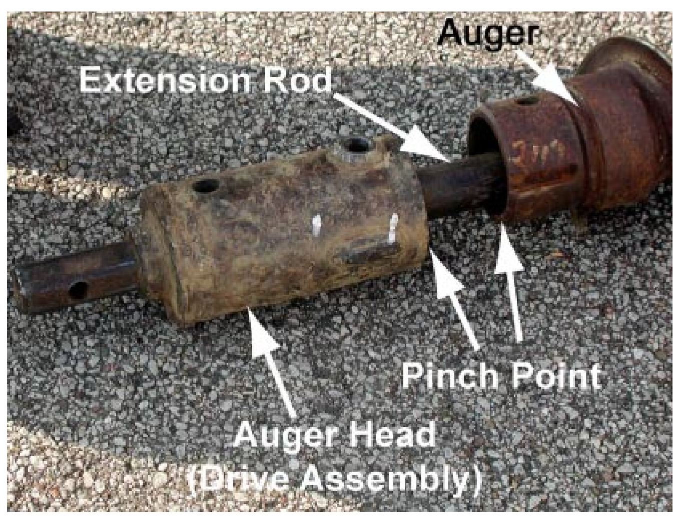

Figure 2. The auger assembly and pinch point

Corrective actions recommended by the on-site investigative team are good examples of the items all sites involved in drilling activities should consider. These include:

- BJC will assess all ongoing drilling activities to determine what exposures operators/crew have to pinch points and rotating hazards and verify that adequate mitigation and barriers are in place.

- BJC will revise its subcontracting process to require that contractors submit a comparison of equipment proposed for use against current manufacturer and industry standards to identify non-conformances and compensatory measures. All heavy equipment should contain operating manuals, and daily equipment checks should meet or exceed the requirements in the operating manual. The site should adopt the use of the drill receipt inspection checklist found in the BJC document, *Safety Guidance for Lifting Operations Associated with Drilling, Subsurface Sampling, and Monitoring Well Installation*, December 1994.

This event underscores the importance of recognizing possible pinch points. Many workplace injuries occur when a body part gets caught in a pinch point, such as between moving machine parts. The time to look for pinch points is before starting any work assignment. Workers should carefully check equipment to see where any body parts could get caught and plan the task to prevent pinch-point injuries. The short amount of time it takes to perform a safety evaluation of possible pinch points could prevent a serious or debilitating injury.

KEYWORDS: *Pinch point, drill rig*

ISM CORE FUNCTIONS: *Develop And Implement Hazard Controls, Perform Work Within Controls*

2. LARGE SHIPPING CONTAINER LID FALLS, RESULTING IN A NEAR MISS

On December 5, 2001, at the Princeton Plasma Physics Laboratory, while placing a vacuum vessel segment from the Tokamak Fusion Test Reactor (TFTR) into a Type A shipping container, the lid of the container, which was leaning against the container, was knocked over. The lid, which weighs approximately 1,500 pounds, then fell in the vicinity of a person working in the area on another job. No one was injured, and there was no damage to equipment. However, because of the potential for personnel injury, the facility manager reported this occurrence as a near miss. (ORPS Report CH-PA-PPPL-PPPL-2001-0006)

In the process of disassembling the TFTR, large shipping containers are brought into the facility test cell and loaded with vacuum vessel segments for shipment off site. In preparing for one of these shipments, disassembly workers had removed the lid from the large shipping container on the day previous to the lift and leaned it against the container. They did not place the lid on the floor because there wasn't enough room between the container and a radiologically controlled area (RCA) where toroidal field coils were being temporarily stored. The disassembly workers secured the lid near its bottom after leaning it against the shipping container because they recognized the hazard if the lid slid away. However, they did not account for the potential for the lid to fall over, and therefore did not secure it at the top.

While the lift team was lowering a concrete-filled vacuum vessel segment weighing approximately 25,000 pounds into the shipping container, they realized that the load needed to be repositioned to fit. In the process of rotating the partially loaded segment to a new orientation in the container, a pipe protruding from the segment contacted the top of the lid and pushed it over.

Concurrently, a health physics technician was watching the lift and when the load was partially lowered into the container, assumed it was safe to enter the RCA on the side away from the shipping container and lid to perform unrelated work near the toroidal field coils. The technician immediately vacated the RCA when the lift team started yelling as the lid started to tip over. The shipping container lid fell over into the RCA and struck a holding/disassembly fixture on the side away from where the technician was working. The lift team terminated the lift and placed the vacuum vessel segment on the floor. They lifted the lid and leaned it against the shipping container, but this time they secured the lid around both the top and bottom.

The root cause of the incident was the failure to recognize the hazard presented by the unstable configuration of the container lid and the possibility that it could fall over; consequently, adequate precautions were not taken. Additionally, neither the lift procedure nor the Job Hazard Analysis Survey mentioned unstable loads or equipment configurations as a potential concern when performing lifts or other tasks. Certainly, had this hazard been recognized, appropriate steps would have been taken to ensure all personnel (such as the health physics technician) were kept clear of an exclusion zone for the lift.

This event illustrates the importance of recognizing all potential hazards associated with a task during task hazard analysis. Site job planning personnel should consider the potential for this type of hazard when performing job hazard analyses for tasks involving lifting operations. Personnel performing work involving unstable loads or equipment configurations should also evaluate the job and take appropriate steps to ensure the safety workers nearby.

KEYWORDS: *Unstable load, job hazard analysis, shipping container, container lid, tipping*

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

3. RESEARCHER RECEIVES X-RAY EXPOSURE

On November 15, 2001, at the Oak Ridge National Laboratory Central Facility, a researcher received an estimated dose of 12 millirem to the eyes as a result of accidental exposure to x-rays from an x-ray machine. The researcher was preparing a sample for use in the machine and was unaware that the beam shutter was not fully closed. (ORPS Report ORO--ORNL-X10CENTRAL-2001-0009)

The shutter stuck because of a combination of design and material factors. The researcher was relying on an indirect indication of shutter position that indicated that the shutter was closed prior to initiating work. This occurrence highlights the deficiency associated with shutter construction and interlock design philosophies of some x-ray machines.

The basic components of an x-ray diffractometer include a high-voltage power supply, a tube housing, which contains an x-ray tube and a shutter, and a goniometer, or device to precisely measure the angle of scattered x-rays, which are monitored with a radiation detector. The tube housing and goniometer are in an enclosure with interlocked doors designed to prevent inadvertent personnel exposure during operation.

This shutter consists of a brass slide with a lead insert to stop x-rays when the shutter covers the hole in the tube housing where x-rays escape from (Figure 1). The shutter is held closed by a spring and can only be retracted when a solenoid withdraws the shutter by overcoming spring tension. The spring returns the shutter to the closed position when the solenoid is de-energized by the control panel or when a door interlock is activated.

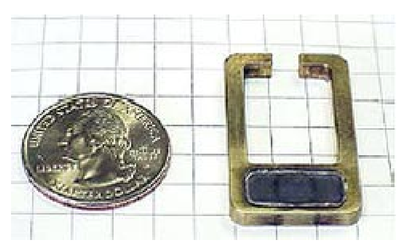

Figure 1. The shutter

The interlock system was designed to function via switches in the enclosure frame that will close the shutter if the enclosure doors are opened. An electric solenoid, when energized, holds the shutter open against pressure from a spring, and when the interlocks are activated, the solenoid is de-energized and

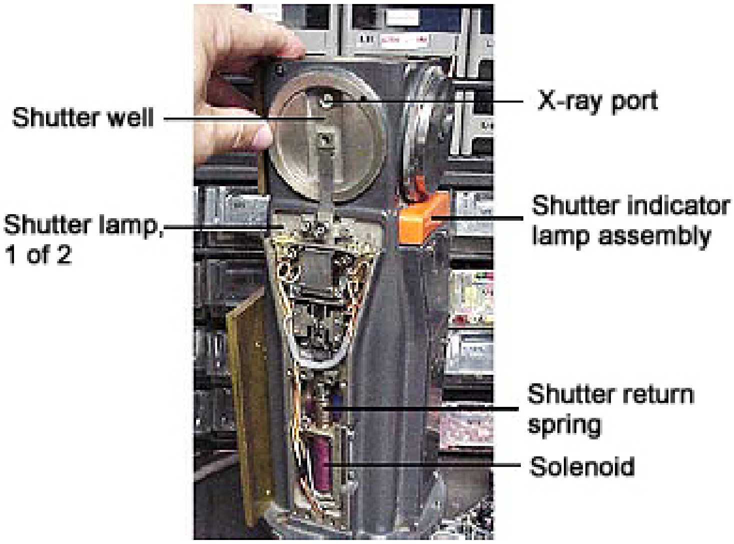

Figure 2. The x-ray tube housing

the spring returns the shutter to the closed position, blocking x-rays escaping from the port in the tube housing (Figure 2).

An x-ray machine custodian was checking a problem with the experimental setup while the interlock enclosure doors were open and the “shutter open” indicator illuminated. The researcher did not notice the indicator, as the view of the indicator was partially obscured and instead relied on the console indicator, which was readily observable. The console indicator is actuated by the console switch, not the shutter mechanism itself, and is an indirect indication of the actual shutter position; however, the researcher did not understand that the console indicator (indirect indication) and the tube housing lamps (direct indication) could be in different states.

The lead shutter insert protruded above the sliding surface of the shutter. It is believed to have deformed and loosened, causing uneven wear and binding. Another deficiency associated with lead is the formation of lead oxide, and this oxidation is believed to have caused a stuck shutter in a similar device in April and July of 1993 at Oak Ridge (OE Weekly Summary 93-28, *Personnel Radiation Exposure Caused By X-ray Diffraction Machine Component Failures* (ORPS Report ORO--MMES-X10METCER-1993-0008). Corrosion, however, is not believed to have been a significant factor in the 2001 event.

In the 1993 event, the shutter failed to close when commanded by the computer control to do so. The most visible "x-rays on" indicating light was off, (indicating no x-rays present) because it operated from the computer command to close the shutter, rather than from a signal from the shutter position-indicating switch.

Another similar event occurred on April 19, 2000, at the Ames Laboratory, when a shutter that was stuck open on an x-ray machine resulted in an accidental x-ray exposure to a researcher who was retrieving irradiated samples from the machine. The shutter that covers the x-ray port had jammed open, though indicator lights showed a closed-shutter condition. The researcher received a radiation dose of 30 millirem to the left hand based on the reading of the researcher's thermoluminescent dosimeter finger rings for the elapsed portion of the quarter. Investigators determined that a mechanical shutter slug had become stuck in the shutter slug guide, causing the shutter to remain partially open. Also, one set of shutter LED indication lights was not operating because of a broken wire. (ORPS Report CH--AMES-AMES-2000-0002)

The Oak Ridge National Laboratory (ORNL) review board investigating the 2001 occurrence recommends the use of additional methods besides the tube housing lamps to alert users to the presence of x-rays or the use of power-interrupting interlocks (as opposed to generating a signal to close the shutter). The board concluded that continued reliance on a large number of users with varying backgrounds to notice shutter position indicators would, because of the normal variability of human performance, allow periodic recurrence of this type of event if reliance on a single automatic shutter to control x-ray emissions is an allowed configuration. Additionally, the elimination of lead in shutters was recommended, especially if alternatives supplied by the original equipment manufacturer, such as tantalum or tungsten, can be obtained.

ORNL corrective actions include replacing the lead-containing shutter with one made of tungsten, adding a set of enclosure door switches to interrupt x-ray generator power, and adding a more visible set of shutter-position indicator lamps.

KEYWORDS: *X-ray exposure, x-ray shutter failure*

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

4. END-OF-LIFE FAILURE OF BURIED WASTE PIPE RELEASES RADIONUCLIDES

On October 9, 2001 while excavating soil as part of a pipe replacement project at the Idaho Advanced Test Reactor, a construction crew encountered wet soil in the vicinity of an underground 4-inch radioactive warm wastewater transfer line. Tests revealed that the soil was radioactively contaminated. Further excavation revealed that the 4-inch pipe had broken subsequent to, and perhaps as a result of, an inspection excavation performed in 1997. The edges of the sheared pipe were corroded, indicating that the break had existed for some time. No personnel contamination or spread of contamination outside of the posted soil contamination boundaries occurred. The ORPS report states that the soil could be contaminated to a depth greater than 10 feet below the pipe break, and could remain so for an indefinite period of time. A final report was filed on December 10, 2001, which provides additional information and insight into underground pipe failures. (ORPS Report ID--BBWI-ATR-2001-0014)

Under carefully controlled conditions, the construction crew excavated approximately 6 feet below grade, until the 4-inch pipe was uncovered. The crew saw water seeping from around the pipe and, as they continued to remove soil, a 3-gallon puddle of radioactively contaminated water formed in the hole around the pipe. It was evident from a ½-inch offset shear that the 4-inch carbon steel pipe had broken. A survey of the excavated soil with a hand-held frisker confirmed the soil was contaminated to 300,000 disintegrations per minute. The seepage was stopped by turning off system pumps, and a fiberglass patch was installed over the pipe break.

The warm wastewater in the pipe is normally pre-treated to remove most radioactive constituents except tritium, which cannot be removed from water. It is not currently known how long the leak existed or how much leakage occurred from the pipe. The ORPS report states that a calculated worst-case scenario shows that no radioactive isotopes in the water would have exceeded 24-hour release limits.

The direct cause and root cause of this event was an equipment/material problem (end-of-life failure). The failed pipe was about 50 years old, having been installed in the early 1950s. Engineers had identified the vulnerability for pipe failure and the need for replacing this underground piping in long-range planning documents many years ago. In order to obtain direct evidence of the deteriorated condition of the pipe and strengthen justification for replacement, this pipe was uncovered and inspected in 1997. No pipe breaks were observed at that time. However, the condition of the pipe was of concern because the inspection revealed heavy internal and external general surface corrosion and areas of pitting of a depth that approached half-wall thickness. It is likely that a combination of the deteriorated condition of the pipe and soil settling following this inspection excavation led to the pipe break.

A possible contributing cause is a legacy management problem (improper resource allocation). Based upon engineering judgment and funding issues, replacement was recommended within five years. The piping is on track for replacement within that time frame. The spill could have been avoided if the pipe had been taken out of service and replaced at the time of 1997 inspection.

The following corrective actions will be implemented as a result of this event.

- The 4-inch pipe has been leak-checked, repaired, and placed back in service.

- The contaminated soil will be removed to an approximate depth of ten feet below grade and replaced with clean soil.
- The soil will be sampled to confirm that all contaminated soil resulting from the 4-inch line break has been removed to 10 feet below grade. The sampling results will be reported to the Environmental Restoration Group.
- The contractor will review with DOE the vulnerabilities and consequences of failure of other underground piping scheduled for replacement.

This event illustrates the need for timely replacement of underground carbon steel piping that could fail and result in a spill of radioactive or hazardous materials. There are inherent risks in delaying replacement of such piping. Furthermore, managers and engineers need to consider that when soil around aged underground pipes is uncovered for inspection, the risk of a future pipe break in the affected area increases.

KEYWORDS: *Radioactive waste pipe, radionuclide, soil contamination, underground, wastewater*

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

5. INADEQUATE WELDS ON DRUM DOLLY RETAINING HOOKS

On October 25, 2001, at the Rocky Flats Environmental Technology Site, workers were moving drums in Building 371 when a retaining hook on a drum dolly broke off, causing a 55-gallon waste drum to drop to the floor. The drum was not breached, and there were no personnel injuries. The use of drum dollies was curtailed pending a thorough inspection of the retaining hook weld points. The initial indication was that the welds on the hook were defective. (ORPS Report RFO--KHLL-371OPS-2001-0080)

Drum dollies are frequently used to move drums within the facility. Because of a defective weld on a drum retaining hook, the hook broke off the dolly frame, causing the drum to drop to the floor. The defective weld apparently caused the retaining hook to be over-stressed. One drum dolly was identified as having a retaining hook that had spread (bent open), preventing the hook from properly grasping the drum ring.

Figure 1. A Harper Model 9468 dolly

The dolly involved in this incident is as a Harper, Model 9468 (Figure 1), which is rated for 1,000 pounds. The 55-gallon drum being moved weighed approximately 385 pounds. During a quality insurance inspection, inspectors found 27 dollies with defective welds on the retaining hooks in addition to the one that had too large of an opening. A Safety Flash (site-wide notification of a safety-related event) was immediately issued to all Rocky Flats facilities. The deficient dollies were removed from service, and maintenance will re-weld them in accordance with the manufacturer's weld criteria.

The direct and root causes of this event were identified as inadequate welds that attach the retaining hook to the frame of the dolly. When this event was discovered, management directed the inspection of all Harper Model 9468 dollies that were used in the facility. Corrective actions included (1) verifying that welds on the dollies comply with the manufacturer's weld criteria, (2) repairing those that do not comply, and (3) issuing a site-wide notification of the drum dolly problems.

This event illustrates the need to periodically inspect equipment that is frequently used, and to thoroughly review equipment to the manufacturer's specifications. Equipment needs to be immediately taken out of service when it is identified as deficient. The actions taken by quality assurance personnel are a good example of prompt response in identifying suspect dollies and initiating corrective actions.

KEYWORDS: *Drum dolly, weld failure, 55-gallon drum*

ISM CORE FUNCTION: *Provide Feedback and Continuous Improvement*

6. FAILED HOSE CONNECTION CAUSES FLOODING OF LABORATORIES AND OFFICES

On May 29, 2001, at the Lawrence Livermore National Laboratory (LLNL), a hose connection in a low conductivity water distribution system failed, flooding the laboratories and offices on the second floor, interstitial floor, and first floor of Building 132 South with approximately 4,000 gallons of water. There were no personnel injuries, and the cleanup costs and damages were limited to $14,000. (ORPS Report OAK--LLNL-LLNL-2001-0019)

A custodian discovered the leak and reported it to the LLNL Emergency Management Dispatcher. The LLNL Fire Department, Hazards Control, and Security personnel responded to the emergency and secured the leak. Plant engineering and facility personnel secured electrical equipment and began to clean up the water. Major damage to the facility and research equipment was averted by the quick response. The cause of the leak was a failed hose connection between a de-ionizing filtration unit and the facility low conductivity water distribution system, which had been leaking for approximately six hours before discovery.

Investigation of the line failure found that the line had been in service for approximately five years at the time of the incident. The following factors contributed to the failure of this hose connection.

- During the original installation, the installer failed to place an insert into the end of the flexible tubing. The insert was designed to allow a compression ring to secure the tubing to the fitting and to prevent the tubing from pulling out.
- When not in use, the tubing was subjected to a static pressure of 78 pounds per square inch gauge (psig), slightly above its maximum working pressure of 75 psig. This caused the tubing to expand slightly.
- When in use, the pressure would drop to 47 psig, allowing the tubing to contract and, over time, to slip from the fitting.

The direct cause of the failed connection was "error in equipment or material selection," because a critical tubing insert was not inserted into the end of the tubing, which would have allowed the compression ring to grip the end of the tubing and prevent it from separating from the fitting. The contributing cause of the event was "procedure not used or used incorrectly," because the individual who assembled the hose and fitting did not follow proper procedures. The root cause was "work organization/planning deficiency" because a responsible individual or supervisor did not ensure that the individual performing the work had the necessary skills, knowledge, and ability, and did not periodically review the individual's work.

As the result of this occurrence, management will review this incident and the LLNL pressure safety policies with research personnel who work in the laboratories. Other corrective actions to be taken include (1) inspecting similar low conductivity water systems in other laboratories for proper installation, and (2) reviewing the design of these systems and the procedures used to safely operate them.

This event underscores the importance of assigning individuals who have the necessary skill, knowledge, and ability to properly perform the task and to require responsible individuals or supervisors to periodically inspect the work to ensure that it meets the appropriate requirements.

KEYWORDS: *Hose connection, low conductivity water, flooding*

ISM CORE FUNCTION: *Perform Work within Controls*