OPERATING EXPERIENCE SUMMARY

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U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2002-18

September 9, 2002

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.

The OE Summary can be used as a DOE-wide information source as described in Section 5.1.2, DOE-STD-7501-99, *The DOE Corporate Lessons Learned Program*. Readers are cautioned that review of the Summary should not be a substitute for a thorough review of the interim and final occurrence reports.

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EVENTS

1. IMPROPERLY DESIGNED PIPING AND WORKER INATTENTION CAUSE INJURY

On May 2, 2002, at the Idaho National Environmental and Engineering Laboratory, a pipefitter struck his head on an overhead pipe and was knocked unconscious for a short period. The worker was transported to a hospital, where he was admitted and diagnosed with a herniated cranial disk. (ORPS Report ID--BNFL-AMWTF-2002-0003)

The worker, who wore a hard hat, was working at a construction site. The work area was congested, and rather than walk around a boiler, the 6'5" worker chose to take a shortcut under a liquid petroleum gas supply line that was 5 feet from the ground and extended 18 inches into the passageway. Being distracted and in a hurry, the worker saw the pipe and attempted to duck under it, but misjudged the distance and the top of his hard hat came in contact with the pipe.

The resulting investigation revealed that the root cause of this accident was improper design of the gas supply line. The typical design for the supply line as it exits the boiler is for the pipe to immediately make a 90-degree vertical turn; however, in this case, the pipe extended 18 inches from the boiler before turning 90 degrees. An independent design review before this piping system was constructed could have prevented this accident.

A contributing cause is the worker's inattention. The worker was not focused on what he was doing and elected to take this shortcut under the pipe to get to the other side of the boiler. At the time of the accident, there were other passageways to maneuver around the boiler that would have precluded the need for ducking under the pipe.

Corrective actions include redesigning and modifying the existing supply line systems feeding boilers within the facility, evaluating similar systems within the facility to ensure that any other design problems are detected and corrected, conducting a safety meeting with all workers emphasizing the need for awareness of hazards on the work site, and assessing the design review process for deficiencies.

On March 23, 2000 at the Hanford Site, while the 60-day fire riser flow test was being performed, the discharge water stream at the test point exit (outside the facility wall) struck two employees. No injuries were incurred. The testing was terminated until the other exit points were provided 100% monitoring. A critique determined that the direct cause was that the design of the nozzle was inadequate. It was located in an overhead position and not adequately marked as a discharge point. The root cause of this event was the workers' failure to verify that the discharge point was clear. The workers stated that the discharge point was verified at the beginning of the evolution; however, the procedure requires verification prior to performance of each test. (ORPS Report RL--PHMC-324FAC-2000-0003)

These events illustrate the importance of evaluating a work site for potential hazards and deficiencies in design before work begins. Workers should be alert to the potential for unexpected situations. As shown in the Idaho event, workers need to remember that personal protective equipment, such as the hard hat in this event, can reduce clearances around obstacles, and should factor this into their judgment of distance when maneuvering around the job site.

KEYWORDS: *Design problem, injury*

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

2. SPARKS FROM TORCH CUTTING CAUSE FIRE

On May 17, 2002, at the Lawrence Berkeley Laboratory, sparks from torch-cutting operations fell into a 1-inch opening in a steel plate covering a sub-grade trench and started a fire. The fire department responded and extinguished the fire. Although no one was injured, the fire caused more than $10,000 damage in addition to research reve-

nues lost during the two weeks the cyclotron was shut down. (ORPS Report OAK--LBL-OPERATIONS-2002-0002)

Two welders were working in a power substation west of the cyclotron. One welder was using an oxyacetylene torch to cut a steel roof beam. The other welder was about 8-10 feet away inserting leveling bolts on prefabricated steel supports, and served as a fire watch.

A construction inspector saw sparks and hot metal falling to the steel deck area, then scattering and falling through a hole in the plates covering the cable trench. As the inspector asked the welders to show their hot work permit, he noticed smoke at the roof level and informed the welders. The welder performing the torch cutting discharged his water extinguisher into the roof cavity.

Figure 2-1. Burned cables

In the cyclotron control room, the operator suddenly lost the beam from the target, heard an alarm, and smelled burning wires. More alarms signaled loss of the radiofrequency signal, main magnet field, and electric power. Minutes later, white smoke was observed behind the main control panel, and cyclotron operations were shut down.

After reviewing the hot work permit, the inspector saw black smoke coming from the power supplies and called the laboratory fire department. The welder serving as the fire watch also called the fire department. When the fire department arrived, they discharged a halon and a CO_2 extinguisher into the power supply enclosures, but the fire continued to burn. When the firefighters removed the cable trench plates, they found burning electrical cables (Figure 2-1), dry leaves, and a wooden ladder (Figure 2-2). The firefighters were successful in extinguishing the fire with a dry chemical extinguisher.

The direct cause of this event was the welders allowing sparks and hot metal to fall into an area containing combustibles. The root cause was the welders' failure to follow the precautions listed in the hot work permit, such as using fire blankets to cover floor openings, protect combustibles, or contain sparks, although they had checked these on the hot work permit.

Corrective actions include inspecting the trench areas and removing any combustibles, discussing procedures for fire prevention (the use of fire blankets, protecting openings in walls and floors, and protecting combustibles), and conducting mandatory training for welders on complying with all requirements of a hot work permit.

The Occupational Safety and Health Administration standard, 29 CFR 1910, Subpart Q, *Welding, Cutting, and Brazing,* requires welders to protect combustible materials, guard against heat and sparks, and protect openings in walls and floors. In addition, the fire watch needs to have immediately available fire extinguishers appropriate to the type of combustible material present.

A search of the Occurrence Reporting and Processing System found a similar occurrence at Idaho, where, on February 12, 2002, a construction worker burned a hole through two sets of anti-contamination clothing (one of which was fire-retardant) and modesty clothing while using an oxyacetylene torch to cut a metal frame. The metal frame's rectangular channels directed hot metal toward the worker's clothing, where the continuous heat burned through the protective clothing. The worker failed to consider the hazard of the hot metal coming in contact with his protective clothing, and did not shield himself

Figure 2-2. The charred ladder

from it. The worker was not injured or contaminated. (ORPS Report ID--BBWI-SMC-2002-0002)

These events illustrate the importance of evaluating a work site for potential fire hazards before welding work begins. Welders should protect themselves from hot metal sparks, protect or remove combustibles wherever possible, use fire blankets to contain sparks, and protect openings in walls and floors.

KEYWORDS: *Sparks, torch cutting, welder, fire*

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

3. LOCKOUT/TAGOUT ERROR LEADS TO NEAR MISS

On July 23, 2002, at the Idaho National Engineering and Environmental Laboratory, an experienced electrician mistakenly placed a lockout device on the wrong circuit breaker and proceeded to work on an electrical transformer without lockout/tagout protection. Although the electrician had de-energized the transformer, the only physical barrier between him and a potentially serious injury was an uncontrolled open circuit breaker. On July 25, other workers assigned to assist in the electrical work noticed the incorrect location of the locking device and corrected the error. There were no injuries as a result of this near-miss occurrence. (ORPS Report ID--BBWI-TOWN-2002-0004; final report filed August 27, 2002)

The 28-year veteran electrician was working to an expedited work order to install electrical service to a laboratory for a new battery tester. In order to perform this work, he de-energized the 480-volt, 150-kilovolt-ampere (kVA) transformer in the laboratory by switching a circuit breaker to the OFF (open) position. He then went to obtain the proper locking device for this application and returned to the panel. At that time, he inadvertently placed the locking device on a different circuit breaker, which was in the ON (closed) position, instead of on the circuit breaker he had intended to lock out. No independent verification of the lockout/tagout was procedurally required in this case because a single point of energy was involved, and a personal lock and tag process was considered acceptable.

The electrician performed a zero-energy check at the transformer before starting work and verified that it was de-energized. He then completed the assigned work on the transformer. Two days later, when additional craftsmen were assigned to perform electrical work in the area, they discovered that the locking device, along with the lock and tag, had been placed on the wrong circuit breaker. Because of this error, electrical work had been performed on the transformer without lockout/tagout protection.

The direct cause of this occurrence was determined to be personnel error (inattention to detail) because the electrician mistakenly locked out a breaker located immediately below the breaker that was designated to be locked and tagged. In addition to failing to verify the correct breaker, the electrician also failed to notice that the breaker he mistakenly locked out was in the ON (closed) position, rather than the OFF (open) position.

The occurrence investigation examined several issues that might have contributed to the lockout of the incorrect breaker. The electrician stated during the critique that approximately one hour elapsed between the time he opened the correct breaker and the time he returned to the panel with the appropriate lockout device, which he applied to the incorrect breaker. In response to a statement by the electrician that the lighting levels near the breaker panel were very low, a lighting survey was performed that demonstrated adequate lighting levels in the

area. Additional issues investigated and determined not to be contributors to the event were the clarity of the work order and the adequacy of supervision.

Corrective actions taken by the contractor have included developing a lessons learned document and discussing it with all appropriate maintenance and operations personnel, and providing mentoring and additional training to the electrician that will emphasize operational safety and working according to procedures.

Lockout/tagout (LO/TO) deficiencies are a recurring problem at many DOE sites and facilities. Recent LO/TO events reported in the Operating Experience Summary include a February 20, 2002 event at the Savannah River Site where an inadequate single-point LO/TO created an electrical hazard for workers because of multiple sources of energy (ORPS Report SR--WSRC-LTA-2002-0004, Operating Experience Summary 2002-09), and a March 26, 2002 occurrence, also at Savannah River, where an inadequate LO/TO was discovered by a pre-work voltage check that found energized components. (ORPS Report SR--WSRC-WVIT-2002-0002; Operating Experience Summary 2002-08)

The events surrounding this near-miss occurrence could have caused serious injury to the electrician who incorrectly installed the locking device or to his co-workers, had they not taken the initiative to personally inspect the lockout/tagout before beginning work. Recognizing that examples of inattention to detail will occasionally occur, workers and managers need to minimize the frequency of such lapses and demonstrate consistent discipline during work planning and performance to ensure that they do not become complacent or distracted. Job supervisors and foremen should consistently address the potential hazards of inattention to detail in pre-job briefings. Workers should incorporate self-checking, a risk management tool designed to reduce human error by focusing attention on the details of the task at hand, into their work practices to help them positively identify correct components.

KEYWORDS: *Lockout/tagout, near miss, electrical safety, inattention to detail*

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

4. CONSTRUCTION CREW WORKS OUTSIDE ISOLATION BOUNDARIES

On August 15, 2002, at the Idaho National Engineering and Environmental Laboratory, a crew of construction pipefitters unknowingly cut into a pressurized (20 pounds per square inch, gauge (psig)) air line with an electric bandsaw on two separate sections of pipe. In each incident, they closed an isolation valve to stop the leak and continued cutting pipe. The crew did not stop work and report the unexpected conditions, nor did they realize they were working outside isolation boundaries. There were no injuries as a result of this event. (ORPS Report ID--BBWI-WASTEMNGT-2002-0009)

The pipefitters were removing two sections of piping and valves as part of a modification to install remotely controlled valves in the process equipment waste system. When they made the first cut, low-pressure air started leaking from the breached line. Instead of stopping work, a pipefitter closed an upstream valve to isolate the air leak. Before cutting the adjacent air line having an identical configuration, the pipefitter shut a second isolation valve and continued demolition work. Figure 4-1 shows the two upstream isolation valves where the cuts were made (yellow plastic) and from which the resultant air leaks occurred.

The crew did not realize that they were outside isolation boundaries until they discovered locked and tagged air valves between the two cuts of each removed section of piping. The crew continued activities until the piping was removed from the overhead spaces, then notified the operations supervisor, who placed a hold on the work.

The contractor has not yet completed a causal analysis of this event or determined corrective actions. However, the following information learned at a formal critique suggests that compliance with work control requirements was less

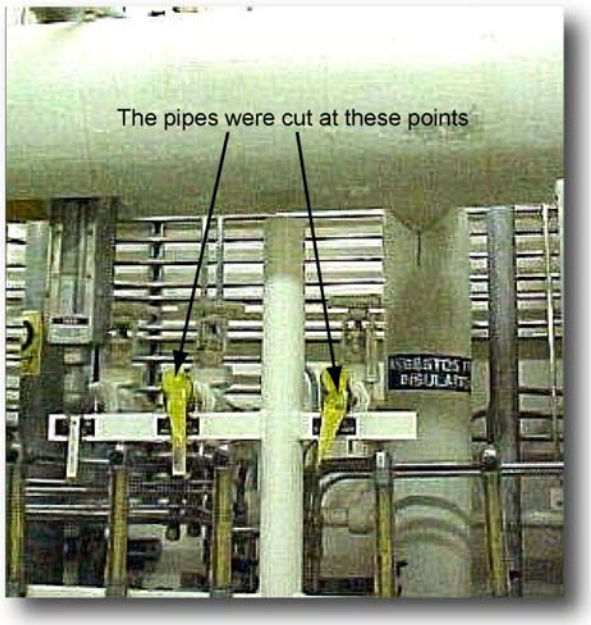

Figure 4-1. Isolation valves where cuts were made

than adequate at all levels of planning and execution.

- Piping drawings used to establish the isolation boundaries were accurate but difficult to read, contributing to the selection of the wrong isolation valves.
- Lockout/tagout preparers relied solely on drawings and did not walk down the system.
- A pipefitter foreman walked down the lockout/tagout, but overlooked the fact that the demolition boundaries were outside the isolation boundaries.
- The demolition boundaries were not marked or tagged on the piping system.
- The zero-energy check for the presence of elevated pressure was poorly chosen. It required checking a flow indicator that was isolated by downstream valves. Flow indicated zero even though piping was pressurized.
- Project drawings instructed the crew to disconnect the pipe at unions (not with a bandsaw), but, because the unions were not shown in dark lines (designated for demolition), the crew didn't believe they were authorized to disassemble the unions.
- The pipefitters operated equipment (valves) that they were not authorized to operate.
- The pipefitters failed to stop work when unexpected conditions were encountered.

Another event involving work on a pressurized system occurred at Rocky Flats on July 17, 2002. While performing work to add valves to an instrument air line, personnel uncapped a line that was pressurized to 90 psig. The pressure from the air line dislodged the cap and vented air and residual condensate, resulting in the spread of contamination in the work area. The line had not been isolated and placed under a lockout/tagout as required. Investigators determined that two separate work packages were being used; however, the one that contained the isolation and lockout steps was not covered in the pre-job briefing and was not available at the work area. (ORPS Report RFO--KHLL-371OPS-2002-0042)

These events illustrate the importance of comprehensive work planning and clear communication among all personnel involved in work planning and execution. Work planners and job supervisors need to have a clear understanding of the equipment, the work to be performed, and the isolation boundaries necessary to protect workers from potential hazards. Above all, individual workers must exercise their authority to stop work when unexpected conditions are encountered. Failure to recognize changing conditions and to stop work in order to address new hazards can result in injury, equipment damage, or the spread of contamination.

KEYWORDS: *Modification, demolition, work planning, lockout/tagout, pressurized, piping, cutting*

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

5. ELECTRICAL INTRUSION EVENTS CONTINUE TO OCCUR ACROSS THE DOE COMPLEX

On August 15, 2002, at the Rocky Flats Environmental Technology Site, an electrician cut an energized 120-volt wire while removing wires

from an alarm panel as part of ongoing decontamination and decommissioning (D&D) work. The electrician was not wearing electrically-rated personal protective equipment (PPE), but he did use insulated wire cutters. The work was immediately stopped when the electrician heard a "pop," and the wire was locked out and tagged. There were no injuries from this near-miss event. (ORPS Report RFO--KHLL-PUFAB-2002-0052)

A fact-finding meeting was held and it was learned that: (1) the work package was not followed, (2) not understood, (3) did not have adequate system diagrams, and (4) was signed off that the wire was de-energized when it was not. Also, no electrical PPE was worn by the electrician as required. The wire was marked with a green sticker, indicating to the electrician that the wire had been air-gapped (physically separated from the power source) and verified de-energized with a voltmeter. However, the air gapping and zero-energy check had not been performed.

During the first half of August 2002, the following four additional electrical intrusion events were reported in the Occurrence Reporting and Processing System (ORPS).

- On August 9, at Sandia National Laboratory–Albuquerque, an electrical construction contractor penetrated energized 208-volt conductors located in a concrete duct bank with a jackhammer. The jackhammer operator wore electrically-rated gloves and believed the duct bank was abandoned. (ORPS Report ALO-KO-SNL-NMFAC-2002-0008)
- On August 7, at the Pantex Plant, while excavating oil-contaminated soil, a backhoe operator severed a 220-volt electrical line at a depth of 18 inches. Hand digging had located the line at 30 inches, and it was assumed that the line continued to run at that depth, although it did not. (ORPS Report ALO-AO-BWXP-PANTEX-2002-0048)
- On August 6, at Lawrence Berkeley Laboratory, a subcontractor using a jackhammer to remove concrete inadvertently punctured an electrical conduit and hit a 480-volt cable. The subcontractor believed the duct bank containing the conduit was encased in colored concrete, but it was not. (ORPS Report OAK--LBL-OPERATIONS-2002-0003)
- On August 6, at the Lawrence Livermore National Laboratory, a mechanical excavator struck and shorted a 13.8-kV cable during demolition work. The operator was not aware of the cable location. (ORPS Report OAK--LLNL-LLNL-2002-0024)

The contractors at these facilities have not completed their causal analyses of these events or determined corrective actions or lessons learned at this time. These five events involved excavation, penetration, or cutting operations, and in three of them, the worker was in close proximity to the energized conductor (jackhammers and wire cutters).

In June 2002, the Office of Environment, Safety and Health (EH) issued a special report on electrical intrusion events because of an increased frequency of this type of occurrence across the DOE complex. EH analyzed 63 events reported in ORPS from January 2000 through December 2001. These events included accidental contact with underground utilities during excavation or penetration of embedded or concealed utilities within structures. Problems included inaccurate as-built drawings, procedure non-compliance (e.g., not hand digging as required), blind penetrations, lack of zero-energy checks, and inadequate component marking during electrical conduit demolition. A lessons-learned report (HQ-EH-2002-01) on this topic can be accessed from the Society for Effective Lessons Learned Sharing (SELLS) website at http://tis.eh.doe.gov/ll/listdb.html.

These electrical intrusion events illustrate the importance of detailed pre-job planning and use of effective work controls during construction, modification, and demolition. Line management is responsible for ensuring adequate planning and control of work activities. The fact that these types of events continue to occur is all the more important that managers enforce facility safety requirements and ensure work control processes are followed. Supervisors, foremen, and job planners need to ensure that workers use appropriate PPE during excavation and penetration work when the potential exists for contact with energized electrical components, and most certainly if there is any doubt as to the

location of the hazard, its power source, or its energized status.

KEYWORDS: *Electrical safety, excavation, cutting, conduit, energized, construction, decommissioning*

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