OPERATING EXPERIENCE SUMMARY

Inside This Issue

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EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health publishes a series of Just-In-Time reports on its Lessons Learned and Best Practices web site. These reports are targeted to work planners and workers and discuss safety topics relevant to the work they do. Each report presents examples of problems and mistakes encountered in actual reported cases and offers points to consider to avoid similar mistakes in the future.

EH plans to issue more Just-in-Times soon on other safety issues. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy 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 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, 301-903-8008, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction. If you have difficulty accessing the Summary on the Web (URL http://www.eh.doe.gov/paa), please contact the ES&H Information Center, (800) 473-4375, for assistance. We would like to hear from you regarding how we can make our products better and more useful. Please forward any comments to Frank.Russo@eh.doe.gov.

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EVENTS

1. COATED HAND TOOLS ARE NOT NECESSARILY ELECTRICALLY INSULATED

On February 10, 2005, at the Savannah River Site, a worker inadvertently cut an energized power cord with a pair of lineman's pliers (Figure 1-1), causing a ground fault. The worker was using pliers with Plastisol®-coated handles. The worker did not receive an electrical shock and was not injured. (ORPS Report SR--WSRC-FDP-2005-0002)

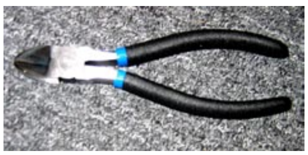

Figure 1-1. Pliers that cut the power cord

Plastisol® is a plastic coating used for ergonomic comfort. The coating did not provide the worker with a complete or adequate safety barrier because it is not designed to insulate against electrical current. Fortunately, the power cord was plugged into a circuit equipped with a ground fault circuit interrupter that tripped as designed when the worker cut the cord.

Figure 1-2. Insulated screwdriver

Tools rated for electricians are made and sold by many manufacturers. The screwdriver shown in Figure 1-2, for example, is insulated to the head to prevent workers from inadvertently contacting energized components with the metal shaft. Electrically rated lineman's pliers (see Figure 1-3) have handles coated with insulation and are designed to withstand certain levels of voltage (e.g., 1000 volts). The Plastisol-coated pliers the worker was using at the time of the incident were not electrically rated.

Subpart S, *Electrical*, of the OSHA Standard (29 CFR 1910) governs the use of electrical personal protective equipment and insulated tools. Section 335(a)(2), General protective equipment and tools, states:

When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.

Figure 1-3. Insulated lineman's pliers

The national and international standards for selecting and using insulated tools when working near energized sources and equipment are listed below. These references can be ordered from their respective web sites.

- The American Society for Testing and Materials, ASTM F 1505-01, *Standard Specification for Insulated and Insulating Hand Tools*, is the current national standard.
- The American National Standards Institute recently published the 2004 version of its International Electrotechnical Commission (IEC) Standard 60900, *Live working - Hand tools for use up to 1000 V a.c. and 1500 V d.c.*

Never assume that a tool is insulated and acceptable for working on energized equipment or systems simply because it appears to have a nonconductive or plastic coating on its handles. Workers should understand that insulated tools must meet specific standards, but using them provides only a partial barrier in protecting workers from electrical hazards. Insulated gloves and other protective equipment should always be used with insulated tools.

Working on energized equipment or systems should always be the least preferred alternative; de-energized equipment or systems are always safest.

KEYWORDS: *Insulated tools, pliers, near miss, electrically rated, energized*

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

2. AVOID OVERHEAD CRANE ACCIDENTS— CHECK FOR TRAVEL PATH OBSTRUCTIONS

On December 27, 2004, at the Y-12 National Security Complex, the trolley of a moving overhead crane struck a light fixture causing the lens to detach and fall 35 feet to the floor (the broken fixture is shown in Figure 2-1). The fixture was one of 16 that had recently been replaced, and the ballasts were approximately 4 inches longer than those in the original fixtures. The 4-inch change affected the vertical length of the fixture, and consequently, the clearance requirement for the crane traveling beneath it. No injuries resulted, and the only damage was to the fixture. (ORPS Report ORYS-YSO-BWXT-Y12SITE-2004-0023)

After installation, the new fixtures hung down into the travel path of the crane, but installers did not consider the change in length either during or after the installation. Following the incident, investigators found additional fixtures, which were not replacements, also were hanging down into the crane's travel path. Following an inspection, the fixture hit by the crane, as well as 10 other fixtures, were raised to the proper height, and inspectors verified that the necessary clearance had been taken into account.

A similar incident occurred at Rocky Flats, in June 2002. In that incident, an overhead crane contacted an electrical conduit, causing a short circuit. (ORPS Report RFO--KHLL-NONPUOPS2-2002-0002) The incident occurred when the crane was being moved from one end of the building to the other. The operator was walking behind the crane as it was moving, and did not check for overhead obstructions in the crane's travel path.

Analysis revealed that the affected conduit was not adequately supported. Apparently, a stanchion that supported the conduit had been removed. As clearance between the crane and the overhead building equipment was already minimal, the removal of the stanchion caused just enough sagging for the conduit to be in the path of the crane.

Figure 2-1. Broken light fixture

The previous events underscore the need to be aware of changes in the configuration of any area in which an overhead crane is installed. Failure to do so can result in a near miss or a serious accident.

On April 29, 2003, at the Thomas Jefferson National Accelerator, an overhead crane was being used to replace lighting in the Test Lab high bay (ORO--SURA-TJNAF-2003-0001). The crane hook contacted an equipment cabinet and damaged two conduits, one of which contained a 120-volt power circuit, creating a near miss situation. The crane and crane hook are shown in Figure 2-2.

Figure 2-2. Overhead crane and crane hook

Causal analysis revealed that workers had not evaluated the location of the crane hook before the operation began. They had been using the same crane for a period of weeks without incident, and they had consistently found the crane in the same configuration in which they had left it. Because of complacency, they did not check the position of the crane hook.

Being aware of one's surroundings can prevent accidents that damage property and equipment, as well as those that result in serious injuries or a near miss. For example, on September 20, 2001, a near-miss event occurred at Lawrence Livermore National Laboratory. A worker on a roof observed an overhead bridge crane coming toward him (ORPS Report OAK--LLNL-LLNL-2001-0038). He attempted to signal the operator, who could not see him. He then lay down in a prone position, and the crane passed over him. The operator stopped the crane only after it struck a ladder that the worker had used to reach the roof.

Investigators determined that the root cause of this event was a management failure to ensure complete, detailed coordination and planning for the work activities of multiple crews who were working in the area simultaneously.

Investigators also determined that no one had verified a clear path of travel for the crane. They identified the direct cause as a failure to conduct the crane operation in accordance with all requirements.

In all of these events important facts related to the work space had not been ascertained before operating the cranes. Environments in which overhead cranes are operated are not static, and one should never presume that the workspace remains in the same condition in which it was left. A complete check of a crane's planned travel path is warranted before work begins. Additionally, any changes to the workspace in which an overhead crane is installed must be accomplished with a full awareness that these changes may have an impact on the crane's field of motion. Any resulting encumbrance to the field of motion must be corrected.

KEYWORDS: *Conduct of operations, near miss, industrial operations, overhead crane, travel path*

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

3. CHEMICAL REACTION CAUSES WASTE COLLECTION BOTTLE TO RUPTURE

On February 2, 2005, at the Pacific Northwest National Laboratory, a chemical reaction inside a 4-liter, glass waste collection bottle caused the bottle to rupture. Incompatible chemicals (methanol and nitric acid) mixed and generated gas inside the waste collection bottle, which was labeled for the collection of acid waste. The rupture also broke an adjacent 4-liter bottle. The contents of both bottles spilled into a secondary container. No one was in the laboratory area when the bottle ruptured. (ORPS Report RL--PNNL-PNNLBOPER-2005-0004)

The waste collection bottles were in a satellite accumulation area located underneath a fume hood. Each bottle was sealed with a plastic screw-top cap and sat in a large plastic container (secondary containment) sized to contain the full contents of the bottles. A post-doctoral researcher entered the area and discovered a few shards of glass on the floor in front of the satellite accumulation area. The spill was cleaned up, and the waste transferred to a 90-day storage area.

Investigators conducted a critique of the event. A key finding was that the event did not result from separate additions to the waste container (i.e., an inadvertent addition of methanol to the acid waste bottle), but rather from the addition of a mixture that contained the methanol. In August 2004, a student researcher had mixed the methanol (organic) with hydrochloric acid and ferric chloride (inorganic acids) as part of the work-up for an experiment. At the time of disposal, the researcher considered the mixture to be an "acid waste" and disposed of it in the half-full waste bottle that already contained nitric acid. Methanol is compatible with the hydrochloric acid but not nitric acid. As a result of the critique finding, the following corrective actions are planned.

- The satellite accumulation area will be posted for "Aqueous Waste Only," and the posting will indicate that no organic waste is to be added to these waste containers.
- The secondary containment, waste containers, and inventory sheets will be labeled as "Acid Waste Only," and containers for oxidizing acids and non-oxidizing acids will be used to segregate these wastes streams.
- The Chemical Process Permit for the lab will address the mixing of organic waste with acid waste from both an experimental design and waste management perspective.

Investigators determined the following causal factors.

Direct Cause — An incompatible chemical waste was added to the waste collection bottle. The student researcher deviated from the experiment work-up procedure, which was designed such that the acid component would be disposed of before performing the methanol wash step. This would have allowed the two process streams to be disposed of separately. However, this step was ignored and the waste streams were combined.

Root Cause —Experiment planning did not properly identify steps to keep the acid and organic solvent waste streams separate during the experiment.

Contributing Cause — The organic component was not adequately considered in the decision-making process regarding waste disposal.

Contributing factors (but probably not causes) and issues included the following.

Four students worked in this particular laboratory over the summer of 2004. Working conditions in the lab were sometimes crowded. Housekeeping was not always as it should have been and the level of oversight and mentoring may not have been adequate.

- The reporting of the incident by the post-doctoral researcher was less than adequate. Following discovery of the spill, the researcher began cleanup before notifying the Cognizant Space Manager (30 minutes later), and prompt notification of this off-normal event to the Laboratory's Single Point of Contact was not performed for hours.
- Laboratory workers, researchers, and experimenters need to consider the resultant mixtures that they produce and then consider safe methods for how that mixture should ultimately be disposed. For example, it may be prudent to neutralize some constituents before disposing of them as waste.

Information about chemicals, chemical hazards, and chemical safety programs can be found on the DOE Chemical Safety Homepage (www.eh.doe.gov/chem_safety). The homepage provides a forum for the exchange of best practices, lessons learned, reference documents, and guidance in the area of Chemical Management. National Research Council Publication, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, 1995, section 7.B.3, "Collection and Storage of Waste," provides information and guidance for the accumulation and temporary storage of chemical wastes. The section also states that it is imperative to know the identity of all chemicals and to understand their compatibility before mixing them.

Chemical Storage and Disposal Recommendations

- Adhere to manufacturer precautions and recommendations for storage and disposal.
- Thoroughly clean containers used for chemicals before adding new chemicals to prevent unexpected reactions.
- Check for compatibility before mixing chemicals and use appropriate containers.
- Neutralize chemicals before disposal and only dispose of them in correctly labeled containers.
- Keep liquid chemicals in appropriate containment trays.
- Store chemicals by compatibility groups.
- Procure only the quantities of chemicals needed. Small packages reduce the risk of breakage and storage costs and to minimize the spread of chemicals during accidents.
- Conduct assessments for chemical storage and compatibility in the laboratory.

This event highlights the need for chemical and laboratory workers to properly identify and understand the risks involved with handling, mixing, and storing chemicals and those involved with their disposal as chemical waste. Facility procedures should provide instructions concerning safe limits for mixing and chemical compatibility. Laboratory managers should ensure that experiment plans address how the constituents within chemical mixtures will ultimately be neutralized and disposed following their use. Laboratory workers need to adhere to experiment procedures and follow proper reporting requirements in the event of off-normal conditions.

KEYWORDS: *Chemical safety, mixing, spills, chemicals, incompatible, waste disposal*

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

4. DEFEATING SAFETY INTERLOCKS CAN BE HAZARDOUS

The U.S. Nuclear Regulatory Commission (NRC) issued Information Notice 2004-18 about two workers (an operator and a materials handler) who received significant radiological doses when they defeated a safety interlock. This event provides valuable lessons on the importance of safety interlocks that can be applied to activities at DOE sites.

The event occurred on April 21, 2004, at an NRC-licensed irradiator facility that sterilizes medical supplies. The irradiator is a storage pool that contains two source racks operating simultaneously, each containing approximately 2 million curies of cobalt-60.

The operator was having difficulty operating a source rack upper-limit switch that indicated when the source racks were in the raised (exposed) position, so he attempted to repair it. When he raised the sources to test the repair, faults occurred, causing the safety interlocks to prevent access to the irradiation room.

Defeating the safety interlocks to enter the irradiator had been a common practice at this facility for years. The alternate radiation safety officer authorized the operator to defeat the safety interlocks, telling him to enter the irradiator by the product exit barrier door, then walk through the irradiation room and open the locked personnel access door from inside the room.

While he worked to repair the switch, the operator placed a ladder over the source pool to reach the rack hoist mechanism. After 6 hours of effort, the operator (supervised by the alternate radiation safety officer) raised and lowered the source racks to test the repairs he had made. However, the operator forgot to remove the ladder, which jammed against one of the source racks and prevented it from lowering into the pool.

The operator and alternate radiation safety officer assumed that the control panel indicating the still-exposed source rack was spurious. Based on this incorrect assumption, the alternate radiation safety officer again authorized the operator to defeat the safety interlocks and enter the irradiator.

The operator asked a materials handler to help him, and together they entered the irradiator. With only one wall of concrete separating them from direct exposure to the exposed source rack, the operator noticed an unexpectedly high reading on the survey meter and told the material handler (who was not wearing dosimetry) to leave immediately. The operator then left the irradiator and told the alternate radiation safety officer about the unexpected radiation levels. In a matter of seconds, the operator and materials handler had received doses of 44 and 28 millisievert (4.4 and 2.8 rem).

NRC investigators found numerous deficiencies leading to this event.

- Although this was an emergency condition, the licensee did not implement emergency procedures.
- The operator did not perform adequate radiological surveys before entering the irradiator.
- Defeating safety interlocks and entering the irradiation room had become common practice at this facility.
- The licensee did not investigate recurring switch problems to determine their underlying causes or perform preventive maintenance.
- Personnel did not understand how to operate and use the irradiation room's radiation monitor.
- Operating procedures were unclear about when to invoke emergency procedures.
- Annual safety training did not provide practice on recognizing and handling emergency situations.

Two mid-2004 events reported in the ORPS database also involved personnel deliberately overriding or defeating safety interlocks.

On May 6, 2004, at the Los Alamos National Laboratory, facility managers discovered that a screwdriver was being used as a shim between a roll-up door and a microswitch at the bottom of the door to close the microswitch contacts. This discovery led to a positive Unreviewed Safety Question. (ORPS Report ALO-LA-LANL-HEMACHPRES-2004-0003)

The microswitch, which is part of the facility's radiation safety system, ensures that the roll-up door is all the way down before the high-energy x-ray machine can be operated. A plate on the door that is designed to close the contacts in the switch did not always work because of play in the door that had occurred over time. Instead of repairing the door, facility personnel used the screwdriver to take up the play and activate the switch.

As in the NRC event, personnel routinely defeated the safety interlocks rather than troubleshooting the cause of the mechanical fault. Fortunately, no one received a radiological dose at Los Alamos as a result of the defeated interlock.

On May 5, 2004, at the Thomas Jefferson National Accelerator Facility's Vertical Test Area, a worker preparing to run a test in a dewar (schematic shown in Figure 4-1) noticed that a metal plate had been attached to a safety interlock switch actuator in an effort to ensure the switch operated when the lid was closed. Two dewars in the facility were found to have been modified in this way. (ORPS Report ORTJ-TJNA-SURA-TJNAF-2004-0003)

The actuator contains a pair of switches and is attached to the inside of the shield lid. When the lid is closed, the switches send a signal that the safety interlock system must detect before allowing the high-power radiofrequency amplifier to operate.

The physicist who made the unauthorized interlock modification told investigators that he had made the modification to the two dewars about 6 months earlier to force the switches to function properly. He should have informed the Safety Systems Group of the intermittent

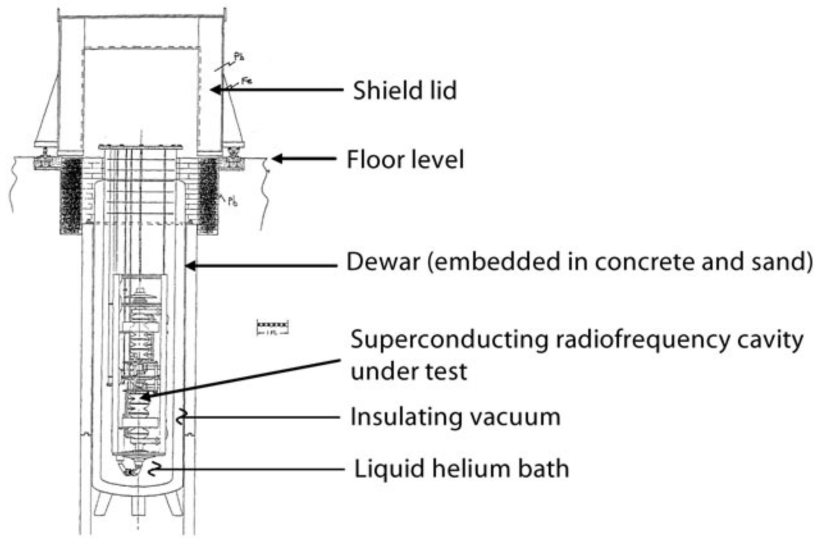

Figure 4-1. Dewar shield

malfunction of the switches instead of trying to fix them himself. All personnel were monitored for radiation exposures and none was detected.

Corrective actions taken include the following.

- The facility reported the event to the Noncompliance Tracking System, where the DOE Office of Enforcement could track it to closure.
- Facility management briefed personnel on the event and on the need to maintain configuration control of safety interlocks.
- The safety systems group replaced all switches and tested the interlocking functions.
- Maintenance plans and procedures were revised to ensure that lids and switches are operating as designed and that Safety Systems Group personnel inspect and recertify facility equipment after maintenance has been performed on it.
- Vertical Test Area personnel are required to notify the Safety Systems Group whenever safety-significant equipment is found damaged or nonfunctioning.
- Shield interlock switches were reconfigured to make them more reliable and less likely to become misaligned.

These events demonstrate that it is vital to keep safety interlocks in good working order. Any observed deficiencies or reduced function must be repaired and inspected before the equipment is returned to service. Under no circumstances is it acceptable to defeat or work around interlocks.

The Office of Environment, Safety and Health recently completed a study of laser safety at DOE facilities and observed that bypassing safety interlocks for lasers and radiation-generating devices was a fairly common practice.

KEYWORDS: *Safety interlock, switch, conduct of operations, near miss*

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

Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CPSC	Consumer Product Safety Commission
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
INPO	Institute for Nuclear Power Operations
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
SELLS	Society for Effective Lessons Learned

Units of Measure	
AC	alternating current
DC	direct current
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
NOV	Notice of Violation
SAR	Safety Analysis Report
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question

Regulations/Acts	
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
RCRA	Resource Conservation and Recovery Act
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement

Miscellaneous	
ALARA	As low as reasonably achievable
HVAC	Heating, Ventilation, and Air Conditioning
ISM	Integrated Safety Management
MSDS	Material Safety Data Sheet
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control