OPERATING EXPERIENCE SUMMARY

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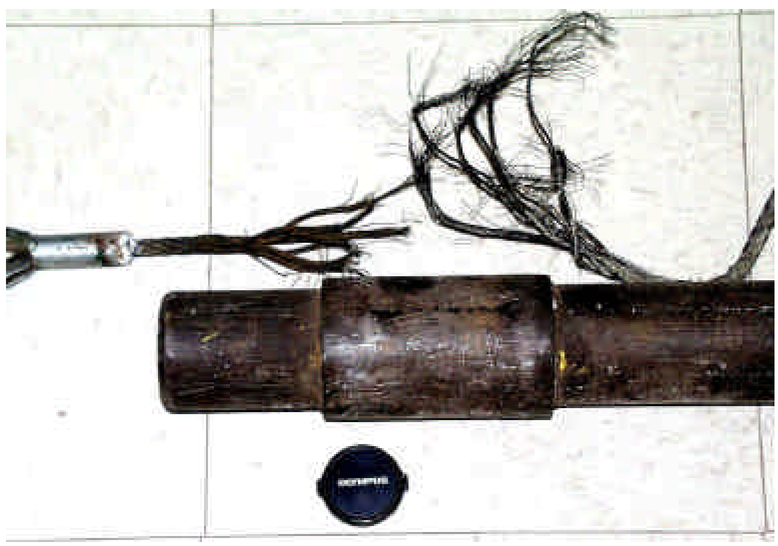

U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2002-20

October 7, 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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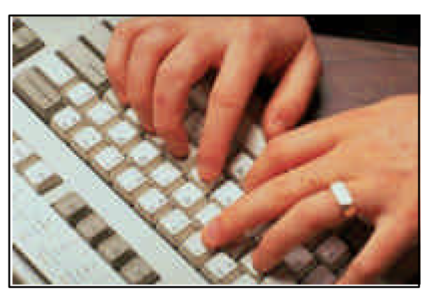

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EVENTS

1. NEAR MISS WHEN HOIST COUNTERWEIGHT FALLS

On July 29, 2002, at the Nevada Test Site, as workers were running 20-inch casing, a 3/8-inch wire cable holding power tongs (Figure 1-1) clamped to the casing parted, dropping a 25-pound counterweight about 21 feet. When the counterweight hit the tongs, both the cable and the counterweight fell to the drill rig floor, narrowly missing a power tong operator standing 2 to 3 feet away. (ORPS Report NVOO-BN-NTS-2002-0010; final report issued September 12, 2002)

Figure 1-1. The tongs and casing

In a critique the next day, investigators determined that the wire cable failed due to damage that had occurred over time. The cable, with the counterweight attached, had been in place for some time and was seldom used. Figure 1-2 shows the broken cable and the counterweight that fell.

The direct cause of this event was the failure of the cable. Although the cable was inspected before this lift, no one had checked the part of the cable that was hidden by the counterweight. Moisture buildup beneath the counterweight may have contributed to the cable's degraded condition.

Subcontractor supervisors and safety representatives attended a training session on inspecting wire cables and ropes. They will receive additional training on inspection, care, and maintenance of rigging equipment. Subcontractor management directed the use of counterweights that do not cover or obstruct the view of the wire rope cable.

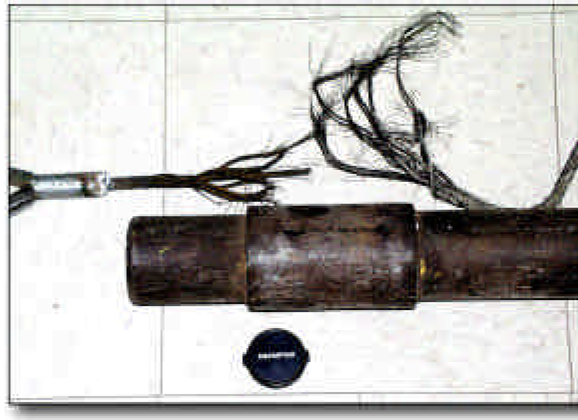

Figure 1-2. Broken cable and counterweight

In a similar occurrence involving cable inspection at the Strategic Petroleum Reserve West Hackberry Site on June 15, 2002, a workover crew was installing 4-inch drill piping using hydraulic tongs when the 5/8-inch cable carrying the hydraulic tong load failed. The tongs dropped about 2 feet downward toward the work platform. No one was injured. Although a general inspection of the work area had been performed before the lift, no one inspected the cabling. (ORPS Report HQ--SPR-WH-2002-0003)

DOE-STD-1090-2001, *Hoisting and Rigging,* Section 8.2.5.2, "Wire Ropes," states that wire ropes must be inspected at least annually, along their entire length. In addition, Section 8.2.6, "Hoists Not in Regular Service," specifies that hoists that are infrequently used must be inspected before being returned to use.

These occurrences illustrate the importance of performing a thorough inspection of all rigging components before performing lifts, especially those hidden or obstructed from view.

KEYWORDS: *Wire rope cable, power tong, near miss*

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

2. STUDENT RESEARCHER RECEIVES ELECTRICAL SHOCK

On July 29, 2002, a student researcher at Pacific Northwest National Laboratory (PNNL) received an electrical shock from a faulty electrical cartridge heater. The researcher received the shock when he touched the metal edge of a fume hood with one hand while holding a stainless steel inspection mirror in the other. The mirror was in contact with a metal reactor containing the cartridge heater. The researcher had just powered on the cartridge heater when he received the 60- to 65-volt shock. Coworkers transported the researcher to a health facility, where medical staff found no injuries or other physical problems. The contractor reported this occurrence as a near miss. (ORPS Report RL--PNNL-PNNLBOPER-2002-0011; update/final report issued September 3, 2002)

Although the 200-watt electrical cartridge heaters (used to provide heat to the bench-scale reactor system) were new, investigators determined that one of the heaters had an intermittent ground fault. When the electrical cartridge heater failed, it resulted in an electrical short to the metal case of the cartridge heater, and the ungrounded metal reactor became energized.

The electrical outlets on the fume hood were not protected with ground fault circuit interrupters (GFCIs). When the researcher powered up the cartridge heater, then touched both the metal edge of the hood and the electrically energized metal reactor while holding the metal mirror, the circuit was completed. Investigators determined the researcher received 60 to 65 volts from right hand to left, based on measurements taken by an electrician following the event.

Investigators determined that the direct cause of the event was a failed piece of equipment (i.e., the cartridge heater). Inadequate or defective design was a contributing cause. The bench-scale reactor system was not grounded, and the cartridge heater was plugged into an electrical outlet that was not equipped with a GFCI. Used with two-wire circuits, GFCIs provide protection against serious injury resulting from ground-fault shock events. They sense when current passes to ground (e.g., through a person) and open the circuit, stopping all current flow. GFCIs usually act faster than a fuse, and trip at a lower current flow (4 to 5 milliamperes). Investigators judged the root cause of the event to be inadequate electrical safety administrative controls. They determined that contractor manuals and guidance documents on electrical safety lacked specific requirements for controlling electrical shock hazards when working with two-wire circuits. These documents should address using GFCIs, using properly sized fuses, and grounding conductive surfaces that could become energized.

Corrective actions resulting from this occurrence included surveying other laboratories at PNNL to identify any ungrounded electrical heaters and two-wire circuits without GFCIs. The contractor is also preparing a lessons learned report on the event, recommending use of GFCIs for all ungrounded electrical heaters. Additional requirements will also be incorporated into contractor electrical safety manuals to preclude potential electrical shock hazards when working with two-wire circuits.

In a similar occurrence at PNNL on May 15, 2002, a researcher attaching a sensor head to a partially assembled radar unit received a mild electrical shock because of an inadequately grounded electrical receptacle. The researcher was not injured. (ORPS Report RL--PNNL-PNNLBOPER-2002-0005; Operating Experience Summary 2002-14)

These events underscore the fact that the safe use of electrical equipment requires adequate grounding of the equipment and non-current-carrying metal components. GFCIs should be used to interrupt the current in a circuit before equipment damage or unsafe conditions can occur. Use of a GFCI is especially important when receptacles have two-wire circuits.

The National Fire Protection Association Standard 70, *National Electrical Code*® (NEC), provides standards for circuit and system grounding for equipment, enclosures, raceways, and receptacles in Article 250. In addition to the standards, Article 250 provides methods for proper equipment grounding and bonding. A copy of the 2002 edition of the NEC can be obtained from the purchase instructions provided at the NFPA website at http://www.nfpa.org/codes.

KEYWORDS: *Electrical shock, ground fault, ground fault circuit interrupter (GFCI)*

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

3. CRANE LOAD FALLS WHEN LIFTING SLINGS CUT

On August 30, 2002, at the Rocky Flats Environmental Technology Site, a load fell from a height of about 6 inches when a sharp edge on a piece of equipment being lifted by an electrical crane simultaneously cut through two new nylon slings supporting the crane load. The sharp edge also cut through two leather gloves intended to provide chafing protection before coming in contact with the slings and cutting them. No one was injured, and no equipment or structural damage was evident. (ORPS Report RFO--KHLL-NONPUOPS1-2002-0003)

Qualified riggers rigged an overhead electrical crane, rated at 10 tons, to lift a disassembled piece of equipment approximately 3 feet high by 5 feet wide by 12 feet long. They initially estimated the load weight at less than 15,000 pounds. The riggers used four wire ropes connected to two new nylon slings, each of which was rated for 16,800 pounds when rigged in a basket configuration. During lift preparations, they noticed a piece of railing on the equipment had a sharp edge, so they used two leather work gloves to provide chafing protection. As the crane began to lift the load, the edge cut through the chafing protection, cut the slings, and the load dropped.

Subsequent calculations indicated that the actual weight of the load was in the range of 26,000 to 35,000 pounds, which exceeded the rated capacity of the crane, and required using a larger-capacity crane. A more serious accident could have occurred if the crane had failed structurally with the load in the air. Electrical cranes accelerate the load being lifted more quickly than hydraulic cranes, and this may have played a role in the event. It is possible, but not likely given the weight of the load, that the leather gloves might have provided sufficient chafing protection had the load been lifted more slowly.

Although qualified riggers prepared the load for the lift, there were multiple failures in work planning and execution. First, the riggers underestimated the weight of the lift by 10,000 pounds or more. Based on the calculated weight of the load (26,000 to 35,000 pounds), the riggers should have used a larger-capacity crane. At a minimum, they should have followed the criteria for performing a critical lift. A critical lift is defined as a lift in which the piece being lifted has a weight equal to or greater than 75 percent of the lift capacity. Because the riggers significantly underestimated the weight of the load, they did not comply with these criteria, which address, among other issues, following specified lift procedures, following a checklist for planning and executing the work, and performing detailed weight calculations on the piece to be lifted. Also, the riggers performed a lifting task that was not included in the Plan of the Day, so detailed work planning for the lift was not performed.

In a recent similar occurrence on August 8, 2002 at the Stanford Linear Accelerator Center, a machinist was lifting an 8,000-pound piece of metal using a 5-ton capacity overhead crane when the two polyester lifting slings snapped, dropping the metal piece to the floor. (ORPS Report OAK--SU-SLAC-2002-0007) Also, on August 29, 2001, at the Brookhaven National Laboratory, one end of a large hadron collider magnet fell approximately 4½ feet to a concrete floor when one of two slings was cut through because of inadequate chafing protection against a sharp edge of the magnet. (ORPS Report CH-BH-BNL-BNL-2001-0023, Operating Experience Summary 2001-09)

Guidance for proper use and maintenance of lifting slings can be found in DOE-STD-1090-2001, *Hoisting and Rigging* (URL http://tis.eh.doe.gov/techstds/standard/std1090_c/toc2001.htm. Chapter 11 of this standard, "Wire Ropes and Slings," provides specific guidance on protecting slings from damage caused by sharp edges. It also identifies some acceptable chafe protection materials, including corner saddles, burlap padding, wood blocks, and leather pads.

The Occupational Safety and Health Administration (OSHA) Office of Training and Education publication, *Sling Safety* (May 1996), states that proper care and use of slings are essential for optimum service and safety. Slings must be protected from sharp bends and cutting edges by means of cover saddles, burlap padding, or wood blocking, as well as from unsafe lifting practices such as overloading. A second OSHA document, also entitled *Sling Safety,* is OSHA Informational Booklet 3072, revised in 1996. This document provides detailed information on sling types, safe lifting practices, load characteristics (e.g., size, weight, center of gravity), and the maintenance of slings. OSHA regulation 29 CFR 1910.184, *Slings,* states that slings shall be padded or otherwise protected from the sharp edges of lifted loads. This regulation also includes information on sling usage, maintenance, and sling capacity tables. OSHA regulations, standards, and guidance documents can be accessed at http://www.osha.gov/comp-links.html.

The sling failure occurrences at Rocky Flats, the Stanford Linear Accelerator Center, and the Brookhaven National Laboratory underscore the need to (1) use qualified riggers for rigging loads (2) accurately determine the weight of the piece to be lifted, (3) follow appropriate lift planning and execution procedures, (4) use proper chafing protection where sharp edges contact slings, and (5) make use of the available information on sling safety from DOE-STD-1090-2001 and the relevant regulations and standards published by OSHA.

KEYWORDS: *Hoisting and rigging, lifting sling, sling safety, chafing protection*

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

4. SYSTEM MODIFICATIONS COMPROMISE FACILITY CONFIGURATION MANAGEMENT

On September 13, 2002, at the Hanford Tank Farms, configuration management deficiencies associated with modifications being made to a Master Pump Shutdown System (MPSS) prompted facility management to submit an occurrence report. The report documented one of several incidents that apparently resulted from configuration management deficiencies related to MPSS modifications from early July to early September 2002. (ORPS Report RP--CHG-TANKFARM-2002-0098)

The MPSS is designed to shut down all transfer pumps if any one of several leak detectors actuates on the discovery of a leak in a transfer pipe. Construction project personnel apparently made changes to components and systems outside MPSS boundaries, without the knowledge of facility operations personnel, in the following instances.

- On July 3, an electrician discovered a change in field circuitry configuration related to the MPSS modifications. A functional test had to be halted.
- On July 9, workers discovered an unanticipated field configuration (wiring had been removed from a relay). This configuration change potentially invalidated previous functional tests.
- On August 23, an exhauster failed to start because personnel working on the MPSS modification project had removed a neutral wire.
- On September 6, facility personnel could not perform a leak detector functional test because they could not clear a leak detector alarm condition. They discovered that relays needed to energize the circuit had been removed, initiating the alarm condition.
- On September 7, during execution of a work package, the plant configuration was found to differ from that shown on the facility drawings.

Any one of these five configuration management problems alone would not have been a cause of great concern. However, collectively, these incidents reveal a pattern of configuration management deficiencies that represents a concern and requires attention.

Facility management assigned a team to investigate the series of events. Normally, when a system will be impacted by construction (as in the case of the existing MPSS), operations personnel declare it inoperable and turn the system over to the construction organization until the work is completed. Facility operations personnel would not attempt to use the system until the construction organization formally returned the system to facility operations.

However, in this instance, the MPSS being modified was not turned over to the construction project because operations personnel needed the system to support ongoing transfers between tanks. The investigation team determined that this attempt to create a hybrid partial construction/partial operation status for the MPSS led to multiple configuration management deficiencies.

The team assigned to investigate the configuration management deficiencies at the Hanford Tank Farms concluded that attempting to perform modifications on a system in an operating facility requires very close (and frequent) communication and coordination among all involved parties. When performing a complex project, such as the MPSS modifications, it is extremely difficult to communicate the precise status of the work as it progresses. It would have been preferable to suspend operations and turn the system over to the construction project organization until the work was completed and functional tests successfully performed. Then the system could have been returned to the facility operations organization.

Three DOE references can be consulted for guidance on how to design and implement an effective operational configuration management program. DOE-STD-1039-03, *Guide to Good Practices for Control of Equipment and System Status*, addresses, among other topics, status change authorization and reporting (section 4.1), equipment and system alignment (section 4.2), work authorization and documentation (section 4.7), and temporary modification control (section 4.9). DOE-STD-1073-93, *Guide for Operational Configuration Management Program*, provides detailed guidance to DOE and contractor personnel on the development and implementation of an operational configuration management program, including its two adjunct programs, the design reconstitution program and the material condition and aging management program. The attachment to DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, in chapter VIII, "Control of Equipment and System Status," notes that good operating discipline should ensure that facility configuration is maintained in accordance with design requirements and that the operating shift should know the status of all equipment and systems at all times.

KEYWORDS: *Configuration management, system modifications, system operability*

ISM CORE FUNCTIONS: *Define the Scope of Work, Perform Work within Controls*

5. POTENTIAL PROBLEMS WITH HEAT COLLECTORS ON FIRE PROTECTION SPRINKLERS

On July 19, 2002, the Nuclear Regulatory Commission (NRC) issued an Information Notice, *Potential Problems with Heat Collectors on Fire Protection Sprinklers*, after NRC fire protection engineers and inspectors raised technical concerns regarding the ability of sprinklers that rely on metal plates (commonly referred to as heat collectors, shown in Figure 5-1) to activate. (NRC Information Notice 2002-24)

Figure 5-1. An upright sprinkler with a heat collector

Heat collectors were intended to reduce the time a fire takes to activate sprinklers that are located too far below a ceiling. Most of the heat energy rises past sprinklers in this area, preventing or delaying their activation. Locating a sprinkler close to the ceiling ensures that it will be in the hot gas layer, thus minimizing activation time and enabling the sprinkler to provide a fully developed water spray pattern to control the fire. In addition, the water from the sprinkler prevents flashover by cooling the upper gas layer and prevents structural collapse by cooling structural steel supports.

In the late 1970s and early 1980s, some sprinkler system designers and fire protection engineers believed that sprinklers could be located far below the ceiling if heat collectors were placed above. They reasoned that heat and draft from the fire plume could cause water droplets to evaporate before cooling the plume and that the great distance between sprinklers and floor-level combustibles could aggravate the problem of ensuring that the correct sprinkler water density is available. Therefore, they installed heat collectors to allow the sprinklers to be closer to the combustibles at floor level.

Other sprinkler system designers and engineers felt that ceilings were too congested with cable trays, conduits, piping, and ductwork. They believed sprinklers should be mounted below ceiling-level obstructions to develop adequate spray patterns.

Hughes Associates, Inc. conducted small- and large-scale testing for the Rocky Flats Plant to determine if heat collectors directed enough of the convective heat of the fire plume past sprinklers to activate them. They also studied the effect of using a quick-response sprinkler in lieu of a standard-response sprinkler with a heat collector. Their findings were documented in a January 1990 report, *A Study of the Utility of Heat Collectors in Reducing the Response Time of Automatic Fire Sprinklers Located in Production Modules of Building 707.* The results of their tests are summarized below.

- Heat collectors with the edges turned down at the sides produced dead air space, creating a longer response time than sprinklers with a flat heat collector.
- Heat collectors must be in the plume to be effective. If the centerline of the fire is more than 1 to 2 feet from the edge of a flat heat collector, a standard-response sprinkler may take longer to respond, regardless of its thermal sensitivity.
- If a fire is midway between two sprinklers, the sprinklers may not respond at all (regardless of the size of the heat collector) because the sprinklers are not exposed to the convective heat flow.

The Department of Energy has addressed this issue by inspecting facilities and removing heat collectors where discovered. For more information on DOE's response to this issue, please contact Dennis Kubicki at 301-903-4794.

The NRC is concerned about the adequacy of sprinklers with heat collectors because their inspectors found a lack of technical documentation, testing, or engineering evaluation to justify the installation of heat collectors at some nuclear facilities.

During plant walkdowns, NRC inspectors identified other heat collector concerns. One concern is the location of sprinklers with heat collectors below the primary combustible source (e.g., cables installed in cable trays). In this configuration, the sprinklers would not activate if a cable fire occurred. Other concerns relate to the configuration and orientation of heat collectors over sprinklers. Inspectors discovered some heat collectors tilted at an angle over the sprinklers or installed sideways. The technical concern is that tilted or vertical heat collectors over sprinklers could obstruct or deflect the spray pattern of the sprinklers (provided the sprinklers activate), preventing the sprinkler from effectively controlling the fire. Figure 5-2 shows how an improperly placed heat collector can obstruct the sprinkler spray pattern.

Figure 5-2. Heat collector obstructing sprinkler spray pattern

Ceilings are a fundamental means of directing heat to the sprinklers located closest to the fire by terminating the vertical movement of convective heat energy and causing it to flow past the heat-sensitive element on the sprinkler. The effectiveness of sprinklers with heat collectors installed far below the ceiling has not been demonstrated, and could impair sprinkler system response. Also, fire areas with large amounts of combustible materials located above the sprinkler may not be adequately protected.

The NRC Information Notice contains additional background information on heat collector concerns and references applicable National Fire Protection Association codes. A copy of the Notice can be obtained from the NRC website at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/2002.

KEYWORDS: *Fire protection, sprinklers, heat collectors*

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