OPERATING EXPERIENCE SUMMARY

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EVENTS

1. NEAR MISS WHILE PLACING A TRENCH BOX

On July 29, 2002, as a subcontractor construction crew maneuvered a 3-ton trench box in an unshored trench, the hoisting chain snapped, and the box dropped about 1 foot, narrowly missing a worker standing in the trench. The work crew was excavating the 15-foot-deep trench to determine if there was a weakness in a DOE-owned crude oil pipeline in support of the Strategic Petroleum Reserve (SPR) West Hackberry site. The worker in the trench fell against the trench box, but was not injured. (ORPS Report HQ--SPR-WH-2002-0004)

High-resolution magnetic flux surveying equipment detected an irregularity in the DOE-owned pipeline between the West Hackberry Site in Louisiana and the Sun Oil Terminal in Nederland, Texas. A subcontractor work crew excavated at the location to uncover the pipe and determine if there was a weakness in the pipe wall. They were excavating in Type C soil (defined as the soil with the least stability in Occupational Safety and Health Administration (OSHA) Regulation 29 CFR 1926, Subpart P, *Excavations*, Appendix A, "Soil Classification"). Because the soil was not stable and the excavation was deeper than 5 feet, the work crew had to place a trench box to support the sides of the trench, as specified in 29 CFR 1926.652, *Requirements for Protective Systems*.

Figure 1-1. The original placement of the trench box in the excavation

The crew used a trackhoe lift bucket and a transportation-grade chain as a substitute chain sling, securing the box at two diagonal points to place it into the excavation. The excavation had two sloped sides, a stepped end, and a vertical end, as shown in Figure 1-1. The crew realized that the slope of the trench was greater than the 34 percent maximum for Type C soil as specified in 29 CFR 1926 Subpart P, Appendix B, "Sloping and Benching." They also knew that the vertical end (shown with a wooden mat in the figure) needed to be stepped, so they removed the trench box and excavated more soil (Figure 1-2).

Figure 1-2. The excavation after the slope was corrected

When the trackhoe operator tried to re-place the trench box, it caught on the stepped end, so he extended the trackhoe excavator arm to dislodge it. The additional force caused the box to drop off the bottom step suddenly. When the box shifted, the chain broke, dropping the trench box approximately 1 foot into the trench. No one was struck by the chain or falling trench box, but the worker in the trench lost his balance when the box dropped and he fell against it.

The West Hackberry site safety specialist convened an investigation the next day. A safety and operations team also performed a root cause investigation. These investigations identified a number of causal factors, which are described below.

The repair work was performed under a Sun Terminal work permit, and their policy does not permit the use of chains for lifting. OSHA regu-

lations permit the use of chain slings for lifting, but they must be made of alloy steel, proof-tested, and have a specific weight limit. In this case, the chain that was used was not appropriate as a lifting sling because it did not comply with any of these specifications. A contractor technical representative noticed that the chain was being used and realized that it presented a potential hazard. However, a subcontractor equipment operator/safety representative told him that the chain was suitable for use as a sling, and the work continued. The contractor will revise the support equipment manual to clearly specify acceptable types of lifting slings. They will also revise the construction subcontractor manual to clearly define procedures for offsite work locations where subcontractors perform work for SPR.

The contractor did not inspect the lifting equipment before work began. The revision to the support equipment manual will specifically clarify the requirement to inspect work at off-site locations.

The subcontractor worker should not have been allowed inside the excavation, even to help guide the trench box into place. OSHA Regulation 29 CFR 1926.652 specifies that workers must be protected from trench cave-ins by trench shields, shoring, or sloping systems before they enter an excavation 5 feet deep or greater.

A similar occurrence involving the use of improper substitutes for lifting slings took place on November 14, 1992, in which a subcontractor worker at Oak Ridge K-25 was critically injured when straps around a large polyethylene storage tank that was being lifted failed, and the tank struck the worker in the head and upper body. The worker died as a result of those injuries 5 days later. The Type A Investigation of the accident determined that the tiedown straps that were used as a lifting sling directly caused the accident. (ORPS Report ORO--MMES-K25GEN-LAN-1992-0094)

These events illustrate the importance of evaluating a job site and potential hazards before work begins. The work planning process should include the use of a safety specialist experienced in the discipline (in this case, hoisting and rigging) for the work evolution. Subcontract workers must follow site safety policies and procedures, and must use the appropriate equipment for the job. The use of an improper substitute for lifting equipment caused a fatality in the earlier event and a near miss to a serious injury in the more recent event.

KEYWORDS: *Trench, trench box, excavation, near miss, subcontractor, OSHA violation*

ISM CORE FUNCTION: *Perform Work within Controls*

2. OSHA VIOLATION RESULTS IN ELECTRICAL NEAR MISS

On August 13, 2002, at the Fernald Environmental Management Project, a raised bed on a dump truck came within 6 feet of striking a 480-volt power line. In response to direction from a spotter, the truck driver immediately stopped the truck and lowered the bed before it struck the power line, averting a potential accident that could have resulted in serious injury. OSHA regulations require maintaining a minimum distance of 10 feet between any object and an energized overhead power line. (ORPS Report OH-FN-FFI-FEMP-2002-0031, final report issued October 21, 2002)

When the driver arrived at the site, a subcontractor worker escorted the truck to the dumpsite. A spotter joined them at the site to assist in positioning the truck at the precise spot where the driver needed to dump the load. On the driver's first attempt to back the truck to the correct location, the right rear wheels of the truck went into a shallow ditch, causing the truck to tilt and gouge a wooden utility pole. The driver stopped, drove the truck forward, then repositioned it for a second try. This time he successfully navigated the area, positioned the truck properly, and began dumping the load of gravel. As the load was being dumped, the driver slowly drove the truck forward and agitated the truck bed to completely empty the load.

A DOE facility representative was observing the operation with the spotter. He told the spotter he thought the raised bed of the truck was too

close to the overhead power line. By the time the spotter relayed this information to the driver, the truck had moved forward, and the Facility Representative estimated that the raised truck bed was within 6 feet (horizontally) of the overhead power line, which was about 20 feet above the road. The spotter claimed that the raised bed of the truck was at least 10 feet from the power line at all times.

A photoelectric cell controlled energy to the 480-volt line. The line was not energized at the time of the occurrence because the photoelectric cell is normally de-energized in daylight hours. However, when the event occurred, positive energy controls were not in place, and thus the line was considered potentially energized.

Investigators determined that the direct cause of this occurrence was personnel error, inattention to detail. The truck driver may not have been aware of the overhead electrical line and did not use the spotter effectively. A contributing cause was a second personnel error, communication problem. The spotter did not maintain continuous communication with the driver. Once the dumping began, the driver could not see the spotter, so could not quickly respond to the spotter's signals or directions.

Investigators determined that the root cause of the occurrence was a work planning deficiency. A formal pre-job briefing and walkdown were not conducted. Therefore, the driver and spotter were unable to identify the best path of travel, address hazards and obstacles (such as the poles and overhead wires), or establish controls to safely perform the task before work began.

The principal corrective action stemming from this event was a revision to the subcontractor's Activity Hazards Analysis for vehicles and motorized equipment. The revision includes five specific directives for spotters involved in dump truck or other delivery operations. Spotters are to direct drivers of trucks containing materials to be dumped, poured, or dropped and to conduct a walkdown of all areas not designated for vehicular traffic. They must also verify that sufficient maneuvering space around ground-level obstructions is available and that proper clearance from any overhead hazards or obstructions is maintained. Spotters are also directed to evaluate the delivery area for surface conditions that could affect safe completion of the delivery.

Three other events involving encroachment on energized electrical lines have occurred at Fernald since January 2002. Each of these events had the potential for a serious injury resulting from moving vehicles with elevated parts in close proximity with energized (or potentially energized) 480-volt overhead electrical lines. On January 9, 2002, an energized, 480-volt overhead electrical line was severed and dropped to the ground when it was snagged by the raised bed of an articulated dump truck pulling out of an exit gate. (ORPS Report OH-FN-FFI-FEMP-2002-0002) On January 31, 2002, a manlift basket that was being relocated came within about 4 feet of an energized, 480-volt overhead electrical line. (ORPS Report OH-FN-FFI-FEMP-2002-0006) On June 13, 2002, the elevated end of an empty roll-off dumpster being delivered to the site was observed to be approximately 4 to 5 feet from an overhead 480-volt lighting circuit. (ORPS Report OH-FN-FFI-FEMP-2002-0021)

Bringing a conductive object to within less than 10 feet of an energized electrical line is a violation of OSHA regulation 29 CFR 1910.333 (c)(3)(iii)(A), which states: "Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 feet (305 centimeters) is maintained."

These events underscore the need to identify all hazards during the work planning process and to implement effective hazard controls before work begins. These controls should include providing multiple spotters in situations where large equipment is being moved along narrow routes of travel or in congested areas.

KEYWORDS: *Near miss, dump truck, electrical safety, encroachment, OSHA violation*

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

3. *RADIOLOGICAL CONTROL TECHNICIAN INJURED BY MOVING MANLIFT*

On August 28, 2002, at the Paducah Gaseous Diffusion Plant, a manlift ran over the foot of a radiological control technician (RCT) as she bent down to pick up items that had fallen from her toolkit. Fortunately, no bones were broken, but the RCT's foot was severely bruised, and her skin ruptured from the pressure. (ORPS Report ORO--BJC-PGDPENVRES-2002-0018; update/final report issued October 11, 2002)

Subcontractor personnel were installing a trough to catch polychlorinated biphenyl (PCB)-contaminated liquids that leaked from uranium enrichment process equipment. To get to the job site, the manlift operator and RCT had to maneuver through a contamination control zone between two material storage areas. The path was narrow, making it difficult for the manlift operator to maneuver without encroaching into one of the roped-off storage areas. Because of the high noise level, personnel in the area wore ear protection, and the RCT and manlift operator had to communicate visually as she walked along to the right of the manlift. The manlift operator did not use a spotter while moving through the control zone.

The manlift operator was concentrating on moving through the contamination control zone without breaching a material storage area boundary. Upon approaching the worksite, the RCT walked ahead of the manlift to set her survey equipment down at the worksite. When she set her equipment bag down, some items fell out onto the floor, and she knelt down on her left knee to pick them up. The manlift operator could not see her, and drove the right front tire of the manlift onto the RCT's left foot. When he heard the RCT scream, the operator immediately stopped the manlift and backed it up.

The RCT was taken to a local hospital, treated, and released. Because the RCT wore safety shoes, her injuries, though severe, were not grave. She was placed on work restriction while she recovered from her injuries, and was released from work restriction 60 days later.

Subcontractor and contractor personnel walked down the accident scene and re-enacted the accident to determine what had happened. A critique took place the next day.

The direct cause of this event was that both the RCT and the manlift operator were focused on other tasks rather than maintaining visual contact with each other. Consequently, they were unable to communicate as they moved through the corridor. Because they did not use a spotter, the manlift operator was forced to pay greater attention to the manlift's position. The RCT assumed the operator was going to stop short of her position and she failed to maintain line of sight with the operator.

The RCTs generally did not attend the pre-job briefings or participate in job walkdowns or task planning with this subcontractor. The RCT and manlift operator in this occurrence did not discuss the difficulty of getting to the job site; therefore, the RCT was unaware of what to expect and didn't realize the potential danger of losing visual contact with the manlift operator.

The accident investigation determined the root cause to be the loss of eye contact between the RCT and manlift operator. A contributing cause was that the operator did not communicate to the RCT the exact location he would use to position the manlift in order to access the PCB trough. The work planning process failed to consider all the personnel (e.g., the RCT) who would be involved. The pre-job walkdown did not identify the hazard posed by the manlift having to navigate down the narrow, noisy corridor.

Both the contractor and subcontractor took a number of corrective actions to address this event. First, spotter support will be required for all manlift movements. The accident investigation team suggested that, in areas where audible communication is impossible due to noise, headphones should be supplied to preclude the need to rely on eye contact. The subcontractor revised the hazard analysis and work control process to require supporting personnel to participate in pre-job briefings and walkdowns to ensure that all hazards are identified before the work begins. The RCT hazard analysis was revised to address the hazardous nature of work-

ing near manlifts, and RCTs attended a training session on working near heavy equipment. In addition, the monthly safety team meeting featured a discussion of the event and guidance on the spotter requirement, and a lessons-learned entry is being made to the site's lessons learned database.

A similar occurrence took place at the Fernald Environmental Management Project on June 5, 2002, where a fork truck struck a hazardous waste technician who inadvertently stepped into its path. The fork truck operator and the technician did not see each other before the accident occurred, and were unable to react in time to avoid collision. The hazardous waste technician's right arm was scraped and bruised. (ORPS Report OH-FN-FFI-FEMP-2002-0017)

These events illustrate the importance of identifying all potential hazards before work begins. For the purposes of hazard analysis, work includes the process of getting personnel and equipment to and from the job site as well as the tasks at the job site, and should be evaluated accordingly for potentially hazardous conditions. All personnel involved in a work evolution should be involved in pre-job briefings and walkdowns so that they understand the hazards they may encounter. Work planners should ensure that personnel are able to clearly communicate with each other, and should specify the use of spotters wherever possible to assist operators in maneuvering heavy equipment.

KEYWORDS: *Manlift, heavy equipment, injury*

ISM CORE FUNCTION: *Define the Scope of Work, Identify the Hazards, Develop and Implement Hazard Controls*

4. *NEAR MISS WHILE WORKING NEAR 480-VOLT CABLE*

On September 25, 2002, at the Hanford Site, a worker received a mild shock while clearing out backfill sand underneath a 480-volt electrical conduit. The worker was assisting in the removal of a metal T-post from a conduit trench that had been installed to support the conduit. During attempts to remove the post, a fin (welded or bolted protrusions on the post shaft) cut into the conduit, contacting the wires inside and damaging them. Although no injuries resulted from this event, it constitutes a near miss to a serious injury. (ORPS Report RP--BNRP-RPPWTP-2002-0011)

High-density polyethylene electrical conduit had been laid in the trench several weeks earlier. The backfill operation was nearing completion, and workers were beginning to remove the T-post supports. They had cut a tie-wire attaching the T-post to the conduit, and a worker was trying to pull the post out of the ground. When he could not remove it, a second worker came to help, and both workers rocked the post back and forth, attempting to pull it from the ground. When the second worker noticed that one of the fins on the post was making contact with the conduit, they stopped rocking and pulling the post.

The first worker began to clear the backfill sand beneath the conduit with his hand and felt a mild shock, which he described as a "tingle." The workers immediately stopped work and informed the job supervisor. He locked-out and tagged the 480-volt conductor. The supervisor noticed that the breaker had not tripped and observed no evidence of electrical arcing between the conduit and the T-post fin. Figure 4-1 shows the T-post and attached fins.

Figure 4-1. T-post and attached fin

The following day, workers removed more sand from beneath the conduit to allow a visual inspection. They discovered that the conduit was damaged, and one phase of the three-phase line

was compromised. They also found two cuts in the conduit, each approximately 1 inch long. One of the cuts went through the 0.25-inch conduit wall.

The contractor's incident investigation report stated that the root cause of the occurrence was "performing work out of sequence." The workers should have removed the T-posts before the backfill sand was sufficiently deep to make removal difficult. A contributing cause was inattention to detail in failing to recognize that the fin could cut into the conduit and failing to prevent its contacting the conduit wall.

The contractor identified several corrective actions in the incident investigation report. These included (1) conducting meetings to inform all crafts personnel about the occurrence and the potential hazards related to the use of T-posts, (2) inspecting all site excavations to identify any similar conditions, (3) re-evaluating support devices for installation of utility lines to ensure that the devices will not inflict damage when being used or removed, and (4) ensuring that temporary supports are removed from newly installed utility lines before they are backfilled.

In June 2002, the Office of Environment, Safety and Health issued a special report entitled *A Review of Electrical Intrusion Events at the Department of Energy: 2000-2001* that analyzed 63 electrical intrusion events reported in the Occurrence Reporting and Processing System from January 2000 through December 2001 (URL http://tis.eh.doe.gov/paa/reports.html). These events included accidental contact with energized underground utilities during excavation or penetration of embedded concealed utility lines within structures. Problems identified in the special report included inaccurate as-built drawings, noncompliance with procedures (e.g., no lockout/tagout used when procedurally required), lack of zero-energy checks, and inadequate work practices.

A lessons-learned report on this topic (HQ-EH-2002-01) can be accessed from the website of the Society for Effective Lessons Learned Sharing at http://tis.eh.doe.gov/ll/listdb.html. Information on electrical safety practices in DOE can be found in the EH-33 *Electrical Safety Report,* dated May 21, 1999, and in the DOE Handbook DOE-HDBK-1092-98, *Electrical Safety* (URL http://tis.eh.doe.gov/techstds/standard/hdbk1092/hdbk1092.pdf).

Electrical intrusion events, such as the occurrence at the Hanford site, illustrate the importance of detailed job planning, compliance with procedures, and use of work controls during construction activities. Line management is responsible for ensuring adequate planning and control of work activities. Continuing electrical intrusion occurrences at DOE sites indicate that managers and first-line workers need to re-emphasize the importance of comprehensive work planning, compliance with procedures, and implementation of effective work control practices.

KEYWORDS: *Electrical safety, excavation, conduit, electrical penetration, near miss*

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

5. *NEAR MISS: ANGLE IRON EJECTED FROM DEBRIS CONTAINER*

On October 25, 2002, at the RMI Decommissioning Project in Ashtabula, Ohio, immediately after workers had loaded and compacted steel sheeting into an intermodal (i.e., truck/rail) shipping container, a 1/8-inch by 8-inch, 25-pound angle iron was ejected from the container. The angle iron struck a corner of the window frame on the excavator, breaking but not penetrating the window, and thus missing the operator and a spotter assisting in the debris loading operation. This event constitutes a near miss to a serious injury. (ORPS Report OH-AB-RMI-RMIDP-2002-0006)

The workers were using the excavator to load the shipping container with demolition debris. After striking and breaking the excavator window, the angle iron fell to the ground approximately 8 feet outside the nearest wall of the shipping container. Figure 5-1 shows a similar container partially filled with debris. Figure 5-2 shows a similar Bobcat® excavator/debris loader

Figure 5-1. RMI intermodal shipping container

with a clamp attachment for grappling debris. The excavator operator was sitting in the cab approximately 1 foot from the window. It is likely that the flying angle iron would have struck the operator if the cab window had not protected him.

Work was immediately suspended and discussions were held with the workers involved to attempt to re-create the sequence of events. The spotter was the only other person in the immediate area. Because the operator could not see over the side of the container from the excavator cab, the spotter was positioned on a set of portable steps to the left of the excavator and at one end of the container.

The ejection of material from a debris container during loading is a very rare occurrence, and hundreds of intermodal containers have been loaded with similar material at this site without a similar event. Nevertheless, several changes have been made to the debris container loading process to reduce the probability of a similar event in the future. These changes include:

- Placing a sheet of Duraplex® (1/8-inch thick, ISO 9002-certified, meeting ANSI 2.97 specifications) over the excavator windows as added protection for the operator.
- Placing a rope barrier with restricted access signs around the container loading area to keep non-essential personnel out of the immediate area during loading operations.
- Providing the loading spotter with a higher set of steps and moving these steps as far away from the loader as practicable, while still allowing the spotter to perform the function of assisting the excavator operator.
- Placing relatively high-density metal pieces (like angle irons) only in the bottom half of the debris container.
- Loading relatively lightweight material (e.g., sheeting) in the top half of the container whenever possible.
- Refraining from sliding loaded items from side to side (or end to end) in the container using the excavator claw-hook or bucket.
- Placing only light pressure in a downward direction to compact the material in the container.

Figure 5-2. RMI excavator/debris loader

A search of the Occurrence Reporting and Processing System revealed only one similar occurrence. Several years ago, at the Fernald Environmental Management Project, workers were lifting scrap metal with a hydraulic grappling unit when a piece of steel conduit was ejected from the grappler, flew approximately 30 feet through the air, and struck a worker in the back. Investigators determined that the work plan did not include establishing safe distance requirements other than maintaining a safe distance from the swing radius of the grapple arm. (ORPS Report OH-FN-FFI-FEMP-1997-0004)

These events underscore the need to define the scope of a job hazards analysis to include not just those hazardous events that have occurred at a specific site, but less likely events as well. Personnel at other DOE sites who load intermo-

dal shipping containers with construction or demolition debris are advised to evaluate and consider implementing some or all of the seven corrective actions listed above.

KEYWORDS: *Intermodal shipping container, ejected material hazard, debris loading*

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