OPERATING EXPERIENCE SUMMARY

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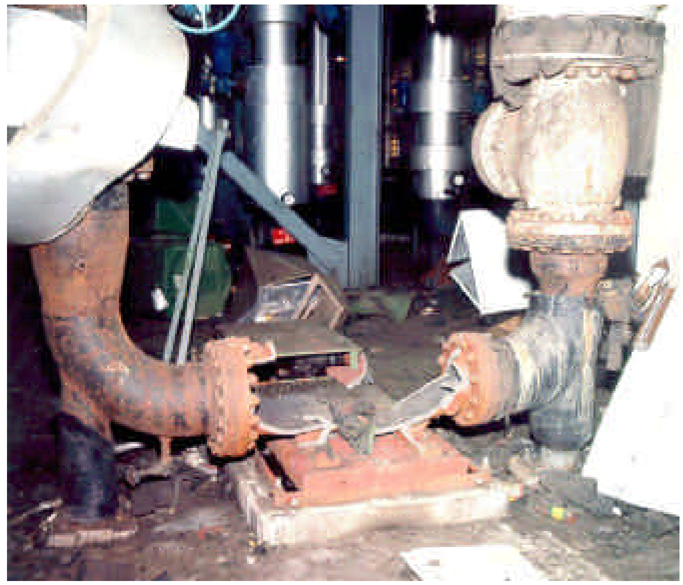

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The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy complex by encouraging the exchange of lessons-learned information among DOE facilities.

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EH PUBLISHES A REVIEW OF HOISTING AND RIGGING EVENTS

The Office of Environment, Safety and Health recently published *Department of Energy Hoisting and Rigging Events*. Hoisting and rigging activities typically involve the lifting, moving, and laying down of heavy loads. These tasks require careful planning, preparation, and implementation by a variety of individuals, including managers, work planners, supervisors, riggers, spotters, equipment operators, and maintenance personnel.

The purpose of this report is to describe the commonly made errors in these incidents and to identify the lessons learned and specific actions that should be taken to prevent similar incidents from recurring.

The report can be accessed at the URL **http://www.eh.doe.gov/HR_INPO_Style_FinalDraft_01-20-04.pdf**

EVENTS

MISHANDLING SMEAR SAMPLES RESULTS IN SPREAD OF RADIOACTIVE CONTAMINATION

On October 10, 2003, at Oak Ridge National Laboratory, a Radiological Control Technician (RCT) discovered radiologically contaminated areas in and around a radiological controls (radcon) field trailer. He immediately notified his supervisors and acted to isolate and prevent the spread of the contamination. While searching for any offsite spread of contamination, investigators discovered contaminated personal clothing at the homes of two RCTs who had performed surveys at an excavation site and processed the sample smears in the trailer on the previous day. Investigators found no contamination in either of the RCTs homes or in their personal vehicles. (ORPS Report ORO--BJC-X10ENVRES-2003-0016; final report filed January 23, 2004)

On October 9, 2003, subcontractor workers cut and capped a series of abandoned liquid low-level waste pipelines (LLWP) at two excavation sites. A typical pipeline is shown in Figure 1-1, and Figure 1-2 shows workers cutting the pipe. Subcontractor RCTs collected a sample smear from a 2-inch pipeline and dirt smears from the excavation areas to determine radiological posting requirements. An RCT wrapped the pipeline smear in three latex gloves and surveyed the smear at 2 mR/hour.

Figure 1-1. Typical LLWP pipeline

Figure 1-2. Workers cutting pipeline

The RCTs drove to the radcon trailer to process and document the samples. They counted several of the smears and determined that some were contaminated above radiological area posting limits for the excavation areas. They deposited the dirt smears in a radiological trash can and the pipeline smear inside the trailer's radiological materials area before they returned to the excavation site to post radcon boundaries. After posting the boundaries, the RCTs returned their sampling equipment and survey instruments to the trailer and left for the night.

When another RCT arrived at the radcon trailer on October 10^{th}, he source-checked the counting instrument, detected elevated background levels, and discovered 2mR/hr at the radiological trash can. The RCT removed the trash can from the trailer and placed it inside a subcontractor vehicle. He then went back to the trailer, re-surveyed it, and discovered several contaminated surfaces.

The RCT notified radcon and site managers, who mobilized additional resources, secured the area around the trailer, and conducted onsite surveys. They discovered contamination inside the trailer, on the boardwalk outside the trailer, on the gravel road in front of the trailer, and inside three subcontractor vehicles. A 370,000 dpm/large area wipe on the instrument shelf was the highest level of contamination found inside the trailer; the highest level inside the vehicles was 300,000 dpm/ $100cm^2$. RCTs secured and posted the contamination areas. Decontamination activities at the trailer are depicted in Figure 1-3.

Figure 1-3. Trailer decontamination activities

Because they found onsite contamination, managers initiated efforts to locate any offsite contamination. Investigators discovered contaminated clothing in the homes of the two RCTs, and surveys revealed a maximum level of 11,600 $dpm/100cm^2$. Post-incident bioassays revealed that the RCT who discovered the contamination in the radcon trailer had a small strontium-90 uptake. Bioassays for all other RCTs and laborers were negative.

The contractor organization assembled a team to conduct a Type B equivalent investigation. They determined that the following activities contributed to the spread of radioactive contamination.

- Workers tapped and drained the waste piping without using glovebags; even though both the Radiation Work Permit (RWP) and the Activity Hazard Analysis (AHA) specified using glovebags during line-tapping.
- Workers removed the glovebag surrounding a 2-inch pipe before cutting it. An RCT supervisor authorized the removal even though it was a violation of the RWP.
- The lead RCT asked workers to take a smear from the cut line, which was not an RWP requirement.
- The RCTs did not properly bag and label the dirt and pipeline smears.
- An RCT carried the contaminated pipeline smear into the radcon trailer with his bare hands.
- An RCT brushed a contaminated smear into the radiological trash can with his bare arm.
- An RCT moved the radiological trash can without anti-contamination (anti-C) protection.
- An RCT conducted decontamination activities inside the radcon trailer without wearing anti-C clothing and without following the RWP guidance.

The investigation team conducted a causal analysis and determined that the mishandling of the smear sample taken from inside the waste pipe was the direct cause of the spread of contamination to the radcon trailer and grounds, subcontractor vehicles, and personal clothing. Team members determined that the root cause of the event was inadequate radiological contamination control practices and that five causal factors contributed to the event.

1. Worker knowledge and understanding of radiological conditions at the worksite were inadequate.
2. Workers deviated from RWP and activity hazards analysis requirements.
3. The contaminated smear taken from the waste pipe was not required by the RWP and was mishandled by RCTs.
4. Workers did not adequately comply with radiological control procedures.
5. Contamination control at the radcon trailer was inadequate.

The team issued Investigation Report BJC/OR-1613 on November 17, 2003. The team concluded that this event was preventable and determined that improvements are necessary in all five core functions of integrated safety management. In response to the investigation team's report, the contractor prepared Corrective Action Plan BJC/OR-1687. The contractor proposed 17 corrective actions to make the following improvements to project planning and hazards control.

- Improve radiological control of smears.

- Ensure hazard documents (AHAs and RWPs) are appropriately implemented.
- Improve subcontractor work planning, hazard identification, and Integrated Safety Management System implementation.
- Ensure that personnel performing radiological work have the required training and qualifications to perform the assigned work.

Good Radiological Control Practices

- Workers and supervisors must understand and comply with approved procedures and work package documents including the requirements of RWPs and AHAs.
- Workers and supervisors should verify that all work package documents (RWPs, ALARA plans, AHAs, etc.) are consistent with regard to radiological controls
- Work package documents should contain the sampling and survey requirements necessary to implement radiological hazard controls.
- RCTs should store smears and other sample materials in compliance with radcon labeling and posting requirements.
- RCTs and site workers should clean up spills and other radioactive releases in accordance with procedures and work packages that define radiological controls.
- Workers and supervisors must understand and comply with approved procedures and work package

These events illustrate the importance of rigorous work planning and strict radiological controls in preventing the release or spread of radioactive materials. Radiological work permits and hazard analyses should be appropriately implemented and radiological sample media strictly controlled.

KEYWORDS: *Radiological contamination, smears, radiological work permits, RWP, activity hazard analysis, AHA, hydraulic isolation*

ISM CORE FUNCTIONS: *Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls, Provide Feedback and Continuous Improvement*

2. VALVE LINEUP ERRORS CAUSE NEAR MISSES

On July 21, 2003, at the Oak Ridge Y-12 Site, a brine pump overheated after being operated with its suction and discharge valves closed. The pump had been running dry for several hours when it was discovered. Two operators performed a pump rotation and failed to verify the valve position before returning the pump to service. (ORPS Report ORO--BWXT-Y12SITE-2003-0028) In late June, 5 weeks earlier, a similar error occurred at another Y-12 facility. In this case, the pump had run dry for 2 hours and had become hot enough to melt and char part of the foam insulation covering. The melting insulation created a visible haze near the pump. (ORPS Report ORO--BWXT-Y12SITE-2003-0024). Both of these events were classified as near misses because of the potential for serious injury.

These two events are very similar to a 1998 event, where a pump casing failed catastrophically (Figure 2-1). The resulting explosion moved the pump motor 8 feet from its foundation, moved an adjacent pump motor 2 inches, and shattered the glass window of a control room (Figure 2-2). One operator received minor cuts on the face and chest from flying glass. A Type C accident investigation followed. Investigators concluded that the explosion occurred because the pump had been run with both its suction and discharge valves closed, increasing the pump's internal pressure to as high as 3,000 psi. Investigators also identified a number of other conduct of operations issues that led to the accident. (ORPS Report ORO--LMES-Y12SITE-1998-0039)

Figure 2-1. The scene of the 1998 event

In all three of these events, operators made valve adjustments, but did not verify the valve positions before restarting the pump, allowing pressure to build up. Other conduct of operations issues that were identified in these events are listed below.

Figure 2-2. The control room window was shattered

- ***July 2003 event***
  - The pump discharge pressure gauge was inoperable, preventing operators from observing pump discharge pressure when starting the pump.
  - The operating procedure did not clearly delineate the normal pressure and temperature ranges for the brine pump.
- ***June 2003 event***
  - The status board for the fan room equipment was ignored because it was known to be unreliable.
  - At the beginning of the shift, the operator was given an additional task to complete that delayed his starting work for about an hour, so he felt pressured to work faster to catch up.
- ***August 1998 event***
  - Operating procedures were cancelled because they were inaccurate, but were not replaced.
  - Facility operators did not consistently implement detailed standing orders for building rounds and inspections. As a result, they were not completely and continuously aware of facility equipment and system status.
  - Facility personnel did not complete planned maintenance in a timely manner, and maintenance activities were inadequate. Facility personnel placed the brine pump and motor in a maintenance status in 1997 because of earlier vibration problems, and maintenance was deferred because of low priority. They had placed deficient material tags on both the pump and motor, but had not issued a formal lockout.

– Facility operators did not maintain adequate equipment status information. A status board showed that the pump was in a maintenance status when it failed. It also showed inconsistent alignments for pumps ready for service, one of which investigators determined was completely isolated. Operators expressed low confidence in information provided by status boards.

– Another operator did not notice that the flow was less than would be expected if the pump were operating normally.

– Operators did not conduct an adequate shift turnover. An operator started the pump at 2:30 pm as part of a test following chiller maintenance. When shift change occurred at 3:00 pm, the operator assuming duty did not receive a direct turnover from the off-going operator and did not notice that the pump was running. The pump failed at approximately 4:30 p.m.

– Utility operators received inadequate training. Training and retraining programs for utility operators lacked repetition and hands-on practice.

Corrective actions included repairing or replacing all inoperable pump pressure gauges and status boards, briefing operators, providing refresher training, and revising operating procedures to specify normal pressure and temperature readings.

A number of tank transfers at Savannah River resulted from similar deficiencies in conduct of operations. Although they were not near misses, they involved significant quantities of potentially hazardous materials. Examples are summarized below.

- On August 13, 2003, during a transfer of nitric acid from a dissolver to a hold tank, an operator noticed that the level in a filtrate tank had decreased unexpectedly. An investigation concluded that the operator performing the transfer had inadvertently opened the wrong valve which was about ½ inch away from the correct one. About 6 liters of acid were transferred to the wrong tank. (ORPS Report SR--WSRC-HBLINE-2003-0007)

- On August 17, 2003, when operators resumed material transfer to a tank after flushing the jet, 1,474 gallons were erroneously transferred to another tank. Investigators found that the assigned operator had not closed a valve specified in the procedure because that step in the procedure had been marked "N/A," leading to confusion. (ORPS Report SR--WSRC-HTANK-2003-0032)

- On October 20, 2003, operators were transferring 19-liter batches of 8-molar acid to a hold tank. On the second transfer, the control room operator directed the transfer to the wrong tank, which overflowed into the tank sump. (ORPS Report SR--WSRC-HBLINE-2003-0009)

- On December 9, 2003, operators were starting up the filter deionizer system following repair of a leak. When they started the system, celite (diatomaceous earth/soda ash) solution splashed out onto the floor and onto the operators' shoes and pants. An investigation of the event disclosed that the operators had misaligned the valves. (ORPS Report SR--WSRC-RBOF-2003-0003)

Training, experience, and dedication of operators and maintenance personnel are extremely important in the operation of complex facilities. Nevertheless, workers are vulnerable to distraction and complacency, as well as emotional and physical stresses that can affect both judgment and performance. The practice of independent verification and self-checking can provide the last defensive barrier to error. Independent verification is the practice of checking a given task for conformance to established criteria by a qualified person other than the one who performed the task. No matter how proficient a worker is, he or she can make mistakes, but it is unlikely that two workers will independently make the same mistake.

Self-checking is a risk management tool designed to reduce human error by teaching workers to focus their attention on the details of the task at hand and positively identify the correct unit, train, or component. The Stop, Think, Act, and Review (STAR) technique is a mental checklist operators can use to reinforce good work practices before, during, and following performance of a task.

SELF-CHECKING (STAR Program)		
S	STOP	Identify potential obstacles and eliminate distractions.
T	THINK	Review the intended action and expected responses.
A	ACT	Perform the intended action.
R	REVIEW	Compare the actual response to the expected response.

These occurrences illustrate the importance of attentiveness to the task at hand, even if the task is routine and has been performed many times before. Operators should know what they are to do, check the operating procedures, and verify that valves are correctly aligned before restarting a system. If there is any doubt or confusion, operators should consult with their supervisors. Also, instrumentation and control equipment should be kept in good working order. Emphasis on independent verification and self-checking by management and supervisory personnel can reduce conduct-of-operations errors. Training personnel to self-check planned actions can be a large factor in reducing operator errors. When coupled with verification of planned actions by an independent, qualified individual, the likelihood of personnel errors is significantly reduced.

KEYWORDS: *Conduct of operations, valve, transfer, pump, near miss*

ISM CORE FUNCTION: *Perform Work within Controls*

3. NEW FURNACE IS PROBABLE CAUSE OF CARBON MONOXIDE EXPOSURE

On November 20, 2003, at the Los Alamos National Laboratory (LANL), an employee received emergency treatment for suspected carbon monoxide (CO) exposure after he experienced headache and nausea. The employee had been working alone in a carpenter shop for about 3 hours when he experienced the symptoms and reported to the Occupational Medicine Facility. He was then transported by ambulance to the Los Alamos Medical Center, where he was treated and released. Blood samples taken from the employee were inconclusive, but carbon monoxide exposure appeared to be the likely cause. (ORPS Report ALO-LA-LANL-FIRNGHELAB-2003-0013)

Facility management personnel suspect that the direct-fired heating system in the building may be the source of the carbon monoxide. Building construction was completed in 2003, and there are indications that the REZNOR® Model DV-115 furnace (Figure 3-1) may not have been installed in accordance with the manufacturer's specifications.

The investigation into the event is ongoing and formal findings will be made available when the investigation is complete. As part of the investigation, the building has undergone an extensive air sampling effort by the Industrial Hygiene and Safety Group. Air sampling of the employee's office from November 11 to November 20 showed between 10 and 15 ppm CO, and sampling from Dec. 1 to Dec. 8 showed concentrations of CO ranging from 20 to 30 ppm. According to the American Council of Governmental Industrial Hygienists (ACGIH), the maximum acceptable CO level is 25 ppm averaged over an 8-hour work period, and 1,200 ppm is

Figure 3-1. Direct-fired furnace (on right)

considered immediately dangerous to life and health.

A separate sampling effort directed toward measuring natural gas levels showed higher readings in the heated shop space than in the unheated equipment room, where the furnace and associated gas connections are located. This result points toward incomplete combustion rather than a gas leak, as direct-fired heaters do not depend on conventional heat exchange, but instead directly heat room air with flame heat from a gas burner. Because there is no separation between the air to be heated and the combustion chamber, direct-fired units depend on significant outside air to provide for proper combustion and dilute its byproducts.

The requirement for sufficient air exchange is explained in the manufacturer's *Space Heating Manual*. The manual states that direct heating should be limited to certain types of buildings where large volumes of air are admitted to the heated space as a normal part of the building's function. The ventilation in the carpenter shop was designed to be provided by a high-capacity exhaust system that removes machinery exhaust and carpentry-work byproducts such as sawdust. However, the exhaust system was not operating at the time because the equipment is not in use.

The LANL heating and ventilation subject-matter expert assessed the furnace installation to ascertain if it was installed according to specifications and in conformance with appropriate building codes. He determined the outside air inlet was about 25 percent smaller than specified by the manufacturer. This could have led to incomplete combustion and production of excessive CO. Investigators are reviewing whether reduced air inlet size, inoperative machinery exhaust, recycled air through the direct-fired heater, or a combination of these three factors caused the CO levels in the building to gradually increase.

LANL managers have identified five other buildings equipped with similarly vented heaters. Indoor air-quality monitoring is being conducted in each of these buildings, and CO/combustion gas monitoring alarms will be installed as appropriate. In some cases, auto-shutoff systems will also be installed on the heating systems. The air inlet for the heater involved in the event will also be enlarged.

As direct-fired systems in the occupied buildings are located, industrial hygienists will provide indoor air-quality monitoring to assess sub-alarm levels of hazardous gases and identify any required facility heater maintenance.

On January 12, 2004, a carbon monoxide emission involving a gas-fired heater occurred at LANL. A supervisor noticed a gas-like odor in a shop area and notified industrial hygienists who were in the area monitoring for carbon monoxide as a result of the November 2003 incident. Air samples indicated approximately 60 ppm of carbon monoxide on the first floor of the building, 100 ppm directly behind the indirect-fired heating unit, and 80 ppm about 5 to 10 feet from the unit. Pipefitters found a crack in a heat exchanger that apparently allowed the emission of carbon monoxide. Workers, who usually spent no more than 30 minutes in the shop each day, exhibited no symptoms of carbon monoxide exposure. (ORPS Report ALO-LA-LANL-ADOADMIN-2004-0001)

Faulty heating systems are often the cause of carbon monoxide poisoning, which can result in a severe illness or death. Improper fuel air mixture, insufficient ventilation of combustion gases, or insufficient fresh air intake can quickly cause any enclosed space to become filled with this deadly gas. If even one of these conditions exists, the possibility of carbon monoxide poisoning is greatly increased, but any combination of the three can lead to a serious health threat or even death.

OSHA requirements in 29 CFR, 1917.24, *Carbon Monoxide,* state that the carbon monoxide content of the atmosphere in a room, building . . . or any enclosed space shall be maintained at not more than 50 ppm as an 8-hour average area level and that employees shall be removed from the enclosed space if the carbon monoxide concentration exceeds a ceiling of 100 ppm. OSHA also requires testing to determine carbon monoxide concentration when necessary to ensure that employee exposure does not exceed these limits. These requirements, as well a fact sheet on carbon monoxide poisoning are available on the OSHA website.

These events illustrate the need to inspect direct-fired heaters, as well as other types of heating systems in occupied areas, to ensure they have sufficient air exchange for safe operation, are installed and operated according to manufacturers' specifications, and are properly maintained. Carbon monoxide detectors or automatic shut-off systems should be installed in buildings where possible.

KEYWORDS: *Carbon monoxide, asphyxiation, health hazard, ventilation, exhaust*

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

4. RECENT HOISTING AND RIGGING EVENTS RESULT IN NEAR MISSES

Eight hoisting and rigging events occurred in the first 8 weeks of 2004, three of which were reported as near misses. These near miss-events occurred during crane movement when crane components hit obstructions. Although none of the cranes was under load when the incident occurred and two were in transport, collisions involving moving cranes are dangerous and can result in equipment damage or personnel injury. These types of events are preventable with proper planning, communication, and attention to detail.

On February 26, 2004, at the Los Alamos National Laboratory, the boom of a mobile 90-ton crane struck an energized 13.2-kV overhead power line. All three phases of the distribution line were severed, and the crane boom and cable received heat damage from the resulting electrical arc, requiring replacement. (ORPS Report: ALO-LA-LANL-LANL-2004-0005)

The crane operator was in a cab separate from the driver and was having difficulty lowering the boom to clear the 30-foot-high power line. The operator tried to alert the driver by sounding a horn on the crane, but the driver was unable to stop the crane in time.

On February 10, 2004, at the Savannah River Site, the boom of a mobile 90-ton crane struck an overhead power line causing an electrical arc between the boom and the line. There were no injuries, but the electrical insulation on the power line was damaged in two places. Rigging and Heavy Equipment personnel were maneuvering the crane around a sharp turn and through a fence gate at the time of the incident. The overhead line provides 480-volt power to street and fence lighting. (ORPS Report: SR--WSRC-HTANK-2004-0007; final report filed February 17, 2004)

Investigators determined that the overall planning activity for moving the crane was inadequate. Work planners did not consider the close proximity of the overhead line and other obstructions or the type of maneuvers necessary for larger cranes to enter the gate. Additionally, a pre-job walkdown was not performed to identify potential hazards/obstacles. Had a walkdown been performed, it probably would have prevented this event.

On January 13, 2004, at the Idaho National Engineering Laboratory, a bridge crane collided with the raised derrick of a drill rig parked in a mechanic bay. The impact bent the 480-volt electrical conductors running along the side of the 5-ton crane. There was no electrical shock or uncontrolled source of energy because the insulation remained intact on the buss bars. (ORPS Report: ID--BBWI-CFA-2004-0001; final report filed February 11, 2004)

Investigators determined that the equipment mechanic, who was moving the crane, did not see the derrick because he focused his attention on negotiating equipment on the shop floor and not on overhead hazards. In addition, the equipment mechanic did not notice that another mechanic had raised the derrick into the crane's movement of travel. He also failed to tell the other mechanic that he was moving the crane over the bay where the drill rig was being re-cabled.

The other five hoisting and rigging events included falling cables and rigging from a cable drum (OAK--ETEC-GENL-2004-0001); falling clamps, cables, and block assembly from a drill rig (RL--PHMC-GPP-2004-0001); malfunctioning controls on a reverse boom crane (RFO--KHLL-PUFAB-2004-0001) and on a personnel hoist (OH-FN-FFI-FEMP-2004-0001); and maintenance issues involving defective hoist brake shoes and grease on a main hoist brake (ID--BBWI-ATR-2004-0001).

In January 2004, the Office of Environment, Safety and Health published *Department of*

Energy Hoisting and Rigging Events, a special report that describes commonly made errors for events reported from January 1, 2001, through December 31, 2003. The report also includes lessons learned and specific actions taken to prevent similar events from recurring.

The report discusses problems that have occurred because of failing to think through the lift before execution; inadequate work planning and control; deficient work practices (a major event contributor); failure to properly assess rigging equipment before use; and less than adequate maintenance of hoisting and rigging equipment that resulted in equipment failures and dropped loads.

The report also includes a valuable section that addresses safety responsibilities for all personnel who are typically involved in hoisting and rigging activities. This section provides a list of questions developed from hoisting and rigging lessons learned that should be asked by managers, work planners, supervisors, riggers, equipment operators, spotters, and maintenance personnel before performing a lift. The following are example questions that could have prevented the near-miss events.

- Have crane paths been analyzed and determined safe?
- Have communications between spotters and equipment operators been checked?
- Have potential obstructions been identified and compensated for?

The special report can be accessed at the Office of Environment, Safety and Health website http://tis.eh.doe.gov/paa/reports.html.

These events underscore the continued need for careful planning, preparation, and implementation by hoisting and rigging personnel to ensure that loads are lifted and placed safely. The seemingly simple task of lifting an object is more complex in nature and therefore necessitates the need for an effective hoisting and rigging program. The ability to safely move materials from one location to another is a vital part of many activities throughout the DOE complex.

KEYWORDS: *Hoisting, rigging, crane, load, lift, hook, winch, derrick*

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