Operating Experience Summary

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Industry Tower Crane Collapses Lead to Savannah River Site Crane Shutdown

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Crane safety has been under scrutiny in recent months because of the number of crane-related deaths in places such as New York City, Miami, Las Vegas, and, most recently, in Houston, Texas. The textbox on page 3 shows the dates, locations, and the injuries and fatalities that resulted from recent events across the country.

On June 4, 2008, at the Savannah River Site (SRS), a crane operator noticed cracks in the protective coating on two legs of the turntable supports of a tower crane while performing a routine, daily inspection. SRS uses the tower crane and three track cranes for a Mixed Oxide Fuel Fabrication Facility (MOX) project. Figure 1-1 shows the tower crane (yellow) and two of the track cranes (red). The operator notified his supervisor and the crane was shut down immediately, pending further investigation. (ORPS Report NA--SRSO-MOXS-MOX-2008-0004)

Magnetic particle inspection revealed hairline cracks on two of the four turntable supports (Figure 1-2). Since the cracks were not in a load-bearing component, the manufacturer stated that the crane was safe to operate. However, because of the numerous reports of tower crane accidents across the country, management decided, as a precautionary measure, to use the crane only on a limited basis until repairs are made by MOX personnel and factory representatives following an already scheduled annual crane inspection.

One of the nation's largest mobile cranes (300 feet tall with a 400-foot boom) collapsed at a Houston oil refinery on July 18, 2008, killing four workers and injuring seven others. The massive crane fell with enough force to lift workers off the

Figure 1-1. SRS cranes at MOX Project (yellow tower crane was shut down)

Figure 1-2. Cracks on turntable of SRS tower crane

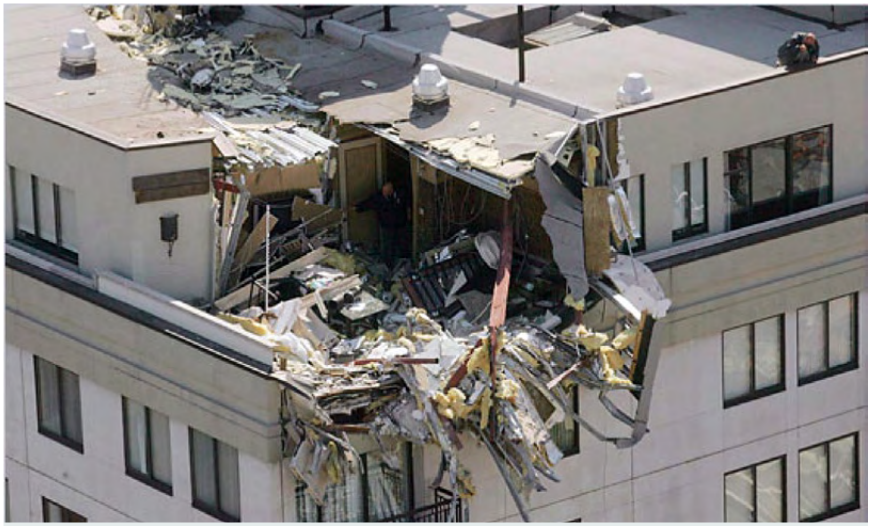

Figure 1-3. Penthouse demolished by May 30, 2008, crane collapse

Figure 1-4. Crane on ground following May 30, 2008, accident

ground and toppled across another smaller crane and a tent where workers were eating lunch. Video taken from the air by Houston television station KHOU shortly after the collapse occurred can be accessed at http://www.khou.com/video/index.html?nvid=264824. OSHA sent investigators to the scene to determine the cause of the accident.

Another recent crane accident occurred in New York City on May 30, 2008, when the working arm of a crane detached from the tower, fell, and killed two people. Figures 1-3 and 1-4 show the aftermath of that accident. Additional information about this accident is available at a New York Times blog. (http://cityroom.blogs.nytimes.com/2008/05/30/crane-collapses-on-upper-east-side/)

An earlier crane collapse in New York City on March 15, 2008, resulted in 7 deaths and injuries to 24 others, including people in the vicinity of the accident and 11 first responders. Figure 1-5 shows a section of the collapsed crane protruding from the building. The crane collapsed while workers were extending the height of the tower.

As the following examples show, weather issues (e.g., high winds), electrical problems, and onsite engineering can also impact the safe operation of cranes.

- High winds caused a crane to collapse at a steel mill near Baltimore, Maryland. Two workers were trapped 50 to 75 feet above the ground during a storm, but were not hurt. (http://www.wtopnews.com/?nid=111&sid=1415643)
- Three cranes in Washington State and two in California were shut down by state regulators because of electrical problems. These cranes did not meet basic code requirements and were at risk for electrical fires, failures, or shocks that could lead to dropped loads, and the electrical components had no labeling or other identification. The crane towers were manufactured by a company in China,

and an Italian company made the other parts. (http://seattlepi.nwsource.com/business/365926_cranes06.html)

- Investigation into a November 2006, crane accident that killed one person in Bellevue, Washington, determined that the crane went down because a homemade steel base that did not meet the crane manufacturer's criteria was used. (http://www.designnews.com/article/CA6542280.html)

Because of the number of recent accidents, regulatory agencies are considering whether better inspection procedures are needed. An Associated Press analysis in June found that cities and states have "wildly varying rules" governing construction cranes, and many rely on Federal guidelines that "date back 40 years" and which "some experts say have not kept up with technological advances." (http://www.cnn.com/2008/US/07/18/crane.collapse.ap/index.html?eref=rss_us)

Figure 1-5. Collapsed crane protruding from building after March 15, 2008, accident

DOE Standard 1090-2007, Chapter 15, "Construction Hoisting and Rigging," provides guidance on personnel qualifications, inspection, and testing of cranes used in construction activities. Cranes are required to be inspected and approved for operations before use, and any equipment with deficiencies that may affect safe operation is not permitted to be operated at any DOE site.

Crane Accidents (2008)

Construction crane calamities around the country have left 16 dead and more than 38 injured in recent months.

July 18: Houston, Texas — 4 dead, 7 injured

June 4: Sparrows Point, Baltimore, Maryland — No injuries

May 31: Wright, Wyoming — 3 injured

May 30: New York City, New York — 2 dead, 1 injured

May 23: Kansas City, Missouri — 1 dead, 3 injured

April 30: Annapolis, Maryland — 1 dead

April 17: Miami, Florida — 1 dead

April 9: Fort Lauderdale, Florida — No injuries

March 15: New York City, New York — 7 dead, 24 injured

The chapter can be accessed at http://www.hss.energy.gov/NuclearSafety/techstds/standard/std1090-07/chapter15_construction_equip_requirements.PDF.

The many recent tower crane collapse events are a reminder that taking a proactive approach, such as was done at SRS, can save lives and curtail worker injuries. Before using any tower crane, it is essential that it be properly inspected. Precautions should be taken to ensure that weather-related events, such as wind or lightning, do not impact safe operation of equipment and that all electrical components meet applicable codes.

KEYWORDS: Tower crane, collapse, injury, fatality, inspection, MOX, hoisting and rigging

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

Can It Happen Here? SRS Takes Proactive Steps to Minimize Potential for a Liquid Radioactive Waste Spill

2

In July 2007, a spill of about 85 gallons of tank waste from a ruptured dilution hose occurred at the Hanford site. Within days of reviewing the ORPS report on the event, Savannah River Site (SRS) management questioned whether there could be a similar event at SRS and conducted a self-assessment of the SRS Tank Farm programs to determine the potential for a similar event.

The initial SRS assessment focused on engineering and design rigor and controls in the site Liquid Waste Operations (LWO) organization. This assessment focused on previously performed assessments and on problem reports entered into their Site Tracking, Analysis, and Reporting (STAR) database to determine if similar issues had been identified at SRS.

The initial LWO assessment identified two separate evaluations that had been performed: one on evaporator design and operation; and, more significantly, one on waste transfer controls. Combined, these evaluations included a total of 173 lines of inquiry. The lines of inquiry confirmed the effectiveness of previously established Specific Administrative Controls in the Tank Farm Technical Safety Requirements (TSR), including requirements for over-pressurization evaluations.

The initial assessment also included a transfer vulnerability review (configuration and operation) of positive displacement pumps (PDP) used for liquid waste and confirmed that all the necessary controls were in place. The assessment confirmed that the Consolidated Hazard Analysis Process established appropriate controls for treatment of flush/dilution water connections in the high-level waste system.

Improvement opportunities were identified through the initial assessment efforts, including a revised design review guide and checklist to specifically address the reverse operation of PDPs. Although the initial assessment indicated that the potential for a similar event was unlikely, site management decided to bring in an external group of subject matter experts to further assess the adequacy of existing LWO controls for waste transfer operations and recommend measures that would minimize the potential for a spill. The external review team evaluated liquid waste operations based on the following Integrated Safety Management System perspective.

- Identify/Analyze Hazards — Does the LWO configuration (as currently installed or as potentially modified) preclude a similar event?
- Develop/Implement Controls — Would LWO administrative controls (particularly the transfer control process) serve as an effective barrier?
- Perform Work within Controls — Would the LWO conduct of operations culture and work practices likely intercept an event like this?

The external team determined that the physical configuration of the current LWO waste transfer system should preclude a similar event. They also determined that a key distinction for the LWO transfer control process was that multiple layers of assessments, reviews, and final acceptance levels in the LWO process provide a dependable barrier that addresses obvious off-normal configurations. The external team believed that the conduct of operations culture at LWO, which includes elements such as abnormal condition drills, training, and human performance initiatives, is a barrier to a similar event.

Based on their review, the external review team recommended that SRS management take the following actions.

1. Expand the Extent of Condition review beyond PDPs to other motive forces.
2. Expand the evaluation of transfer control barriers for probable off-normal conditions.
3. Focus oversight on the evaluation and control of future "temporary" configurations for accelerated tank closure activities.
4. Continue oversight and assessment of the existing waste transfer control program to ensure it is retained in place for the balance of tank closure activities.
5. Re-evaluate the initial assessment and actions against the Hanford Type A investigation report when it is issued.

SRS senior management initiated several avenues of information sharing to ensure a prompt understanding of developing lessons learned and "best practices" from the Hanford event. An SRS LWO Engineering contact point was named to share processes, and SRS participated on the Office of Environmental Management, Office of Operations Oversight, review team at Hanford. These information paths were used to further validate both the internal and external assessment results at SRS LWO. DOE-Savannah River (DOE-SR) and Westinghouse Savannah River Company senior management were briefed on the results of the review of the initial LWO actions and the recommendations of the external review team.

Before issuance of the Hanford Type A Accident report in September 2007, both the internal and external reviews were completed, and the external review team's recommendations had been implemented. However, part of the safety culture at SRS is to "think the problem through thoroughly"; so, after the Type A report was issued, management initiated a site-wide assessment based on the Accident Board's Judgments of Need (JONs) to evaluate related programs and processes for similar vulnerabilities in an effort to more fully answer the question, "Can it Happen Here?"

For the site-wide assessment, contractor and DOE-SR senior management developed a total of 48 lines of inquiry for the 5 program areas addressed in the Type A Accident Investigation Report JONs: engineering, industrial hygiene and medical programs, emergency management, work control, and management systems. Five teams were tasked with assessing these areas to identify both high- and low-risk vulnerabilities, and to develop any necessary action items.

Although findings indicated that SRS programmatic controls are robust, the teams identified some areas that could benefit from improvement, primarily in the areas of industrial hygiene/medical programs and work control. They found, for example, that some minor industrial hygiene response actions were not identified in procedures and that the policy to stop work, warn others, isolate spill, and minimize spread was not described in current procedures. In the work control area, more specificity was added to procedures for open window radiological surveys; continuing training was revised to address control room chart monitoring and equipment changes; and improvements were made to address TSRs during procedure development. All of the identified actions are currently being completed.

For more information about the SRS review, contact Bob Hinds at (803) 208-1157 or by e-mail at robert.hinds@srs.gov.

The proactive and in-depth approach taken by SRS management to assess their programs and processes for similar vulnerabilities is a positive step toward ensuring safety for site workers, the public, and the environment. Sharing lessons learned and applying them at other sites enhances safety across the Complex.

KEYWORDS: Type A accident, hazardous waste spill, engineering controls, design controls, barriers, Conduct of Operations

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

Legacy Beryllium Contamination at Lawrence Livermore National Laboratory

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On December 14, 2007, at Lawrence Livermore National Laboratory (LLNL), seven workers handling ductwork were potentially exposed to legacy beryllium. Three of the workers had removed and transported the ducting; two had cut and welded it; and two had performed maintenance work in the room after the ducting was removed. The potential for beryllium contamination was not discovered until the ducting was returned to the room. The room was immediately posted as a beryllium work area, and the workers were notified of a potential exposure and the option for being tested for beryllium sensitization. None of the workers involved in the incident appeared to be sensitized, and there were no measured exposures. (ORPS Report NA--LSO-LLNL-LLNL-2007-0059; final report issued April 24, 2008)

The duct had been swiped for radioactive material before sending it for machining, but was not tested for beryllium residue. Swipe results for beryllium taken after the incident indicated that the section of the ductwork that was transferred to other facilities had a level of 0.02 µg/100cm^2, which was below the release limit of 0.2 µg/100cm^2; however, levels above the release limit were found on the external surfaces of the other ductwork in the room (0.33 µg/100 cm^2 and 0.12 µg/100cm^2), as well as in other areas of the room.

Beryllium contamination was found on ductwork and lighting fixtures after the event, although the room has been cleaned approximately four times over the past several years. However, the room usually was swiped down only to about the 8-foot level. Investigators learned that a scheduled pre-work walkdown did not occur and that contamination on surfaces above the 8-foot level was not considered during job scoping. They also learned that the ducts were not evaluated for beryllium contamination because an earlier release of beryllium controls was assumed to include the entire room, not just normal work surfaces. Weakness in the work control process and lack of communication between facility personnel were identified as the root cause of this event.

On October 12, 2007, legacy beryllium contamination above the 0.2 µg/100cm^2 release level was found in another building at LLNL during an ongoing statistical survey on legacy beryllium contamination. Out of 1,107 samples taken in the building, 83 had levels ranging from 0.2 µg/100cm^2 to 3.12 µg/100cm^2. Additional surveys performed to characterize the extent of contamination found areas where contamination ranged from 0.2 µg/100cm^2 to 56 µg/100cm^2. Access to the work area was restricted until additional controls could be implemented and further characterization could be performed. A few months later, on April 14, 2008, work was paused in the building when a report that a worker's personal air monitor indicated exposure to beryllium was received. (ORPS Report NA--LSO-LLNL-LLNL-2007-0046)

On April 4, 2008, workers were pulling cables from ducts and were not wearing respirators. The work was being conducted in the building under a 100 percent personal air monitoring strategy, but (in accordance with the work control documentation) worker's judgment of cleanliness was linked to the use of respirators. The workers decided that respirator protection was not required. However, when sample results from their personal air monitors were reviewed later in the month, one worker's personal air monitor showed an 8-hour time-weighted average of 0.25 µg/100cm.

Investigators concluded that relying on worker's judgment was not sufficiently conservative when determining whether or not respirators should be worn, and a more stringent work control that required 100 percent respirator use was implemented.

Although traditional monitoring for beryllium contaminants has focused on areas where beryllium work was performed, a recent LLNL Lessons Learned, *Reanalyze Hazards in Your Work when New Information is Received*, indicates that discovery of beryllium at upper elevations at LLNL has led the Laboratory to monitor areas outside of normal work-process zones (e.g., at upper elevations) in facilities where beryllium is currently handled or was previously handled. The lessons learned also stresses that a timely response to lessons learned from other sites across the complex and proper communication and follow-up of survey results could have prevented uncontrolled beryllium work, as they provided opportunities to re-analyze hazards to determine whether existing work controls are sufficient. (Lessons Learned ID: LL-2008-LLNL-03)

An Office of Health, Safety and Security (HSS) *Safety Advisory*, published in February 2008 (No. 2008-07), identified concerns about the potential exposure of workers to beryllium during routine activities that were not associated with beryllium work. The advisory states that 15 incidents had been reported to ORPS over the previous 3 years. Of these, two involved beryllium exposure; nine involved beryllium contamination; four involved posting, labeling, and implementation issues; and one involved the unexpected discovery of beryllium. The advisory includes a list of 11 questions that management should address, as well as a similar 9-question list for supervisors and workers. Among the questions are the following.

Management

1. What are we doing to determine if older facilities with an uncertain history of use are free of beryllium contamination?
2. Have we developed statistical survey methods and plans to assess suspect facilities for beryllium contamination?
3. Are the locations of contaminated facilities and equipment identified to workers and posted?
4. Have we made available to our workforce the engineering and administrative controls and protective equipment needed to work safely?

Supervisors and Workers

1. Are jobs screened for potential beryllium exposure when work packages are developed?
2. Do we need respiratory protection and other PPE and special procedures for the job?
3. Have surface swipes been taken to ensure a controlled work environment?
4. How do we know if beryllium dust or particles are not hidden in equipment or crevices in formerly contaminated areas?

The Safety Advisory can be accessed at http://www.hss.energy.gov/CSA/csp/advisory/SAd_2008-01.pdf.

A December 2006, *Safety Bulletin*, "Beryllium Awareness" (No. 2006-07), discusses beryllium, its hazards, and the Chronic Beryllium Disease Prevention Program. The textbox, taken from that Bulletin, lists both engineering and administrative controls for controlling beryllium hazards. The bulletin is available at http://www.hss.energy.gov/csa/csp/safety_bulletins/SB_2006-07_final.pdf.

Comprehensive work planning and hazard communication are essential elements of preventing occupational exposures to beryllium, and workers should be aware of the risks and required to implement the appropriate protective measures, such as wearing respirators, when working in areas where there is the potential for exposure to legacy beryllium.

The requirements for the Department's beryllium disease protection program are found in 10 CFR 850, *Chronic Beryllium Disease Prevention Program (CBDPP).* It can be accessed by visiting http://www.gpo.gov/nara/cfr/waisidx_01/10cfr850_01.html.

The regulatory requirements of 10 CFR 850, cross-references to DOE directives and industry consensus standards that contain detailed guidance for implementing specific requirements in 10 CFR 850, and explanations and examples for meeting the basic requirements for developing and implementing a CBDPP are outlined in *Implementation Guide for Use with 10 CFR 850* (DOE G 440.1-7A). To access the guide, go to http://www.hss.energy.gov/HealthSafety/WSHP/be/guide/beguide/beguide.html.

These events illustrate the need for taking all necessary precautions in areas where there is a potential for worker exposure to legacy beryllium. It is essential that work planning include pre-job walkdowns and that all areas that may be contaminated are identified during job scoping. If there is even a minimal chance that they may be exposed to beryllium, workers should not assume that a work area is "clean," but should take a more conservative approach and wear appropriate PPE.

Controlling the Hazards

Engineering Controls

- Enclose beryllium work.
- Use local exhaust ventilation with HEPA filters.
- Use wet machining techniques.

Administrative Controls

- Provide training to individuals exposed to beryllium.
- Post warning signs and labels in beryllium areas.
- Clean active beryllium areas after each shift.
- Treat beryllium cleanup material as contaminated.
- Use PPE (i.e., respirators, gloves, protective clothing).

KEYWORDS: Beryllium, exposure, contamination, ductwork, PPE

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

The Office of Health, Safety and Security (HSS), Office of 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.

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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

Units of Measure	
AC	alternating current
DC	direct current
mg	milligram (1/1000th of a gram)
kg	kilogram (1000 grams)
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
TWA	Time Weighted Average
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
JSA	Job Safety 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
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement
RCRA	Resource Conservation and Recovery Act
TSCA	Toxic Substances Control Act

Miscellaneous	
ALARA	As low as reasonably achievable
HEPA	High Efficiency Particulate Air
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
SME	Subject Matter Expert