Operating Experience Summary

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Inside This Issue

Inadequate Shift Turnover Results in Serious Burn Injuries

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On January 23, 2009, at Rye House Power Station north of London, England, two workers repairing a leaking check valve (non-return valve) on a high pressure recirculation pump for a heat recovery boiler received serious burn injuries when they were engulfed by a wave of hot condensate. Figure 1-1 shows the piping and the location of the leaking valve. The workers were performing repairs from a scaffold approximately 10 feet above the floor; the most severely burned worker was trapped against the scaffold, unable to escape. A third worker, who witnessed the accident and went to the aid of the workers, was also badly burned. A video about the event can be accessed at http://www.scottishpower.com/Ryehouse_Video/default.htm.

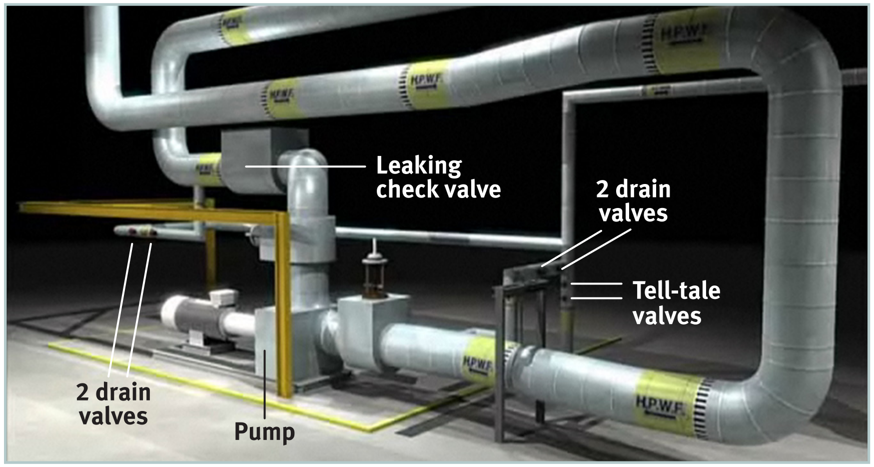

Figure 1-1. Piping arrangement
(Source: Rye House video)

Figure 1-2. Rye House Power Station

The power station, shown in Figure 1-2, is owned and operated by Scottish Power and was being prepared for a shutdown to perform maintenance in various areas, including the heat recovery boiler. The night shift duty team leader was supervising his team as well as seven members of a production staff who were preparing permits for work.

To make the system safe for the maintenance crew on the following day, the team began isolating and draining piping at 11 p.m., following shift instructions that included a detailed drainage schedule. When it became clear that the boiler pressure would not have decayed sufficiently to complete the work on the permit for the night shift, a decision was made to hand the boiler over to the day shift in a partially isolated and drained state and transfer responsibility to that shift for completing the permitted work.

At shift turnover, the night shift team leader gave the drainage schedule to the day shift team leader and explained that the boiler was only partially drained and that the open drain valves were highlighted in blue on the schedule (Figure 1-3). When the day shift team leader reviewed the schedule, he correctly determined that the two valves that were *not* highlighted in blue still needed to be opened. These so-called "tell-tale" valves provide for visual confirmation that the boiler is draining (i.e., when water stops flowing into the trench, draining is finished).

KKS Numbers	Description	Location
LAB10AA501	HP Supemeater outlet vent hand isol valve	Next to boiler stop v/v
LAB10AA502	HP Superheater outlet vent hand isol valve	Next to boiler stop v/v
HAH10AA501	HP Drum vent hand isol valve	Top, middle of drum
HAH10AA502	HP Drum vent hand isol valve	Top, middle of drum
HAD11AA501	Evaporator inlet vent hand isol valve	HP drum level L/H
HAD11AA502	Evaporator inlet vent hand isol valve	HP drum level L/H
HAC11AA501	Economiser inlet vent hand isol valve	HP drum level R/H
HAC11AA502	Econoiser inlet vent hand isol valve	HP drum level R/H
HAG33AA401	Econ recirc line drain hand isol valve	Cond tank level R/H
HAG33AA402	Econ recirc line drain hand isol valve	Cond tank level R/H
LAB10AA401	HP Superheater steam line drain hand isol	Next to boiler stop v/v
LAB10AA402	HP Superheater steam line drain motorised	Cond tank level R/H
HAH25AA401	HP Superheater outlet drain hand isol	Boiler 1st level R/H
HAH25AA402	HP Superheater outlet motorised drain valve	Boiler flash vessel
LBH14AA401	HP Superheater outlet drains drain hand isol	Boiler flash vessel
HAN31 AA401	HP Circ pump local tell-tale drain hand isol valve	At the HP circ pump
HAN31 AA402	HP Circ pump local tell-tale drain hand isol valve	At the HP circ pump

Figure 1-3. Bottom of the schedule showing valves to be opened (bottom two, not highlighted in blue)
(Source: Rye House video)

Shift Instruction *Section 3*

HP Boiler drain valves

KKS Numbers	Description	Location
HAD15AA401	Evaporator outlet drain hand isol valve	Cond tank level R/H
HAD15AA402	Evaporator outlet drain hand isol valve	Cond tank level R/H
HAC35AA401	Economiser outlet drain hand isol valve	Cond tank level R/H
HAC35AA402	Economiser outlet drain hand isol valve	Cond tank level R/H
HAG22AA401	HP Circ Pump inlet drain hand isol valve	At the HP Circ pump
HAG22AA402	HP Circ Pump inlet drain hand isol valve	At the HP Circ pump
HAG22AA403	HP Circ Pump outlet drain hand isol valve	At the HP Circ pump
HAG22AA404	HP Circ Pump outlet drain hand isol valve	At the HP Circ pump
HAN40AA001	HP Circ Pump drain to flash vessel	Boiler flash vessel
LBH10AA001	HP Drum blowdown isol valve	HP Drum level R/H
LBH10AA002	HP Drum blowdown control valve	Boiler flash vessel

Figure 1-4. Top of the schedule showing handwritten notes
(Source: Rye House video)

However, at the top of the schedule there were four valves highlighted in blue (indicating that they were already open) that were accompanied by a handwritten notation in the margin that said "not open." That notation (highlighted in pink, as shown in Figure 1-4) indicated four valves that were still closed and needed to be opened to finish draining the lines.

When boiler pressure had fallen low enough, an operator opened the tell-tale valves. Instead of a flow of hot condensate, as would be expected with all open valves, all that emerged was a small amount of steam because the upstream valves were still closed. This lack of condensate flow should have been an indication that valves upstream of the tell-tale valves were still closed, but the inexperienced operator who opened the valves incorrectly assumed that the lack of flow indicated that the discharge line was already drained.

Later, when the day shift team leader inspected the tell-tale valves and saw no steam or water, he, too, assumed the discharge line was fully drained. He did not verify the status of the line, but he completed, signed, and issued the work permit to a maintenance team member and gave permission to start work on the non-return valve on the assumption that the upstream valves were open. The lack of verification led to the release of the hot condensate and the burn injuries (Figure 1-5).

The worker who was trapped on the scaffold received burns over 60 percent of his body; the other worker on the scaffold, who was able to climb down and away from the condensate, received burns over 26 percent of his body; and the worker who came to their rescue was burned as well.

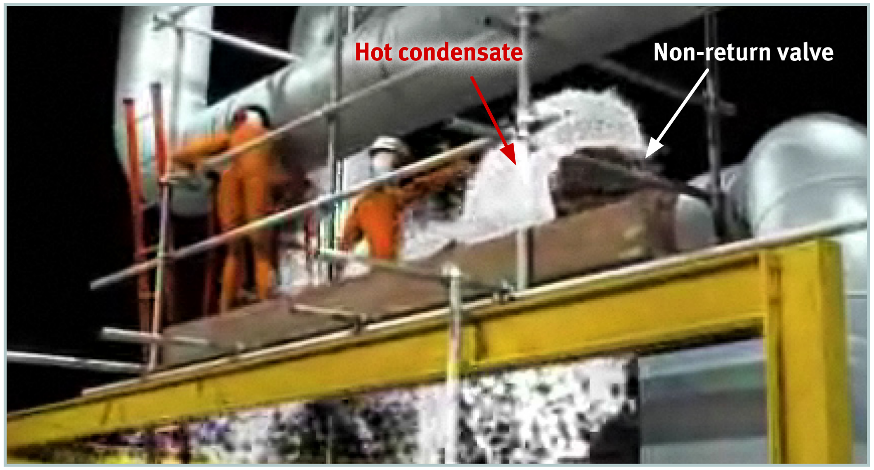

Figure 1-5. Workers engulfed in hot condensate on scaffold (animation)
(Source: Rye House video)

All three burned workers received initial treatment at the site before being taken to the hospital. After several days in critical care, the most severely burned worker remained in the hospital for 6 weeks, his co-worker was hospitalized for 2 weeks, and the worker who tried to rescue them was treated and released the same night.

Within hours of the accident, a Panel of Inquiry was established. The Panel quickly determined that the primary cause of the accident was the failure to drain the discharge side of the high pressure recirculating pump where the non-return valve was located. The Panel also identified the following causes.

- Lockout/tagout procedures to prevent the harmful release of energy were not followed.
- The discharge lines on the high pressure system were not completely drained.
- The drainage schedule, completed tasks, and actual status of the discharge lines were not adequately communicated between shifts.
- The blue highlights on the checklist, intended to indicate already-opened drain valves, were incorrectly used for four unopened valves. Additional handwritten notes were highlighted in pink, thus causing confusion.
- The status of the drain valves that had been opened during the night shift was assumed, not verified, by the day shift team leader.
- The hazards and system status were not verified by the day shift team leader.

The Panel determined that the primary lesson to be learned from this event was that safety rules must be applied rigorously and consistently with no room for ambiguity or uncertainty. They concluded that senior authorized personnel and team leaders must ensure that everyone works safely and that they—as well as workers—should stop and seek clarification if they have any doubts about the work to be performed. They further indicated that assumptions can be life-threatening, as demonstrated by this event.

Following this accident and investigation, Scottish Power launched a project to improve the quality of shift turnover and the communication of plant status, including any evolutions that might be incomplete at the time of turnover. In addition, Scottish Power produced the video to convey the seriousness of the event to employees, contractors, and industry colleagues and to emphasize clear pre-work communications in order to prevent recurrence. The video is currently used to emphasize Rye House safety rules and as refresher training.

Other Event

Inadequate shift turnover played a part in an August 17, 2007, event at the Savannah River Site, where tritium was released inside a glovebox when workers misunderstood the status given during shift turnover and loosened a connection before evacuating and backfilling the line. Fortunately, there were no injuries. (ORPS Report NA--SRSO-WSRC-TRIT-2007-0006; final report issued October 4, 2007)

Investigators determined that the day shift had completed a loading evolution and the next shift was to perform follow-up activities. The shift turnover information included an electronic Shift Turnover Information Sheet, which showed that loading and welding on the line was complete and evacuation was in progress. The oncoming shift was to remove the reservoirs for the line from the loading manifold.

A face-to-face turnover was also conducted, and the status was reflected not only in the electronic Shift Turnover Information Sheet, but also in the Control Room Operator's (CRO) written turnover checklist and a log book entry indicating the procedure step where the off-going shift stopped. In addition, an annotation in the margin of the procedure indicated that the loading manifold for the line was ready to be *evacuated.*

Later, however, the First Line Manager (FLM) asked the CRO if the reservoirs were ready to be *removed* from the manifold, and the CRO acknowledged that they were. Based on this response, the FLM initialed the following three steps in the procedure without verifying them.

- Verify that the line has been evacuated and backfilled.
- Ensure that the loading valves have been closed.
- Obtain the supervisors' permission to remove the reservoirs from the manifold.

The FLM then instructed the operators to remove the reservoirs from the manifold. As they did so, a high glovebox activity alarm sounded; and, as they exited the room, additional alarms sounded.

Investigators determined that the information on the Shift Turnover Information Sheet displayed at shift turnover did not accurately reflect the status of the loading line. Although the oral turnover was detailed and accurate, the oncoming shift relied on the written status shown on the printed Shift Turnover Information Sheet and not on the CRO's written turnover checklist, his log book entries, or the procedure notations.

DOE Order 5480.19, *Conduct of Operations*, requires shift turnover to be conducted in such a manner that oncoming personnel do not assume duties until they and offgoing personnel have a high degree of confidence that an appropriate information transfer has taken place. The Order also states that shift turnover should include a comprehensive review of written and visual information and should be guided by a checklist. In addition, the Order indicates that the review should be followed by a discussion of status and instrumentation between the oncoming and offgoing teams, and that each operator is responsible for knowing equipment status.

These events demonstrate the importance of clear communication during shift turnover and the dangers of going forward based on assumptions rather than verification. There is no room for ambiguity or uncertainty. If workers or supervisors have doubts or questions about the task ahead, they should stop and ask questions or seek clarification; there is no blame for invoking Stop Work authority or having a questioning attitude. Potentially life-altering decisions cannot be made based on assumptions.

KEYWORDS: Conduct of Operations, shift turnover, inadequate communication, LO/TO, system status, equipment status, facility status, pressurized systems, drains, pipes, boiler, maintenance shutdown, non-return valve, scaffold, injury, industry event

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

Near Miss—Worker Pinned While Working on Aerial Lift

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On May 6, 2009, at the Savannah River Site, a worker installing cross-bracing to construct a temporary work tent received a compression bruise injury while working in an aerial lift basket. The injury occurred when the basket operator extended the basket too far into a support brace and caught the worker between the basket side rail and the brace. The operator moved the basket and freed the worker immediately. The injured worker received first-aid (aspirin and cold pack) for a visible contusion on his back. However, because he was still in pain, he was later treated by the project occupational medical physician, given a prescription pain reliever, and released. (ORPS Report EM-SR--PSC-SWPF-2009-0006; final report issued June 18, 2009)

The lift was moving very slowly as the operator positioned it so the worker could bolt a support. Both the worker and the operator were watching the wheels while positioning the lift, and it took the operator a few seconds to realize that the worker had been pinned. Figure 2-1 shows the lift basket and the 3-inch aluminum pipe cross beam. (Note: The figure does not show a re-enactment of the event or the workers involved in the event.)

Neither investigators nor the rental company identified any problems with the lift during post-event inspections. However, investigators determined that the operator and worker did not properly perform the safety precaution step of using the basket arm to move into position near the tent frame, rather than driving the lift. In addition, both the operator and the worker were watching the movement of the lift wheels during positioning rather than paying attention to the location of the basket and its proximity to the tent frame, and the operator did not ensure that the lift was parallel to the frame.

Investigators determined that the cause of this event was the lift operator's inattention to the direction of travel in the area of the hazard (i.e., the tent frame). In addition, the distraction of watching the wheels and a mental lapse on the part of the operator contributed to the event.

Other Event

A similar event that resulted in injuries occurred on April 23, 2008, at Hanford. A subcontractor painter working from a boom lift was caught between the lift and an overhead pipe and received contusions to his back, chest, and jaw; a slight cut on his chin; and scrapes on his hand. In that event, the cord of a grinder looped around a toggle switch on the control panel causing the boom to rise. The painter was able to hit the stop switch and reach the controls to move the lift basket enough to free himself and lower the lift to the ground. (ORPS Report EM-RP--BNRP-RPPWTP-2008-0008; final report issued June 6, 2008)

Figure 2-1. Lift basket and cross beam

Following the Hanford event, subcontractor management issued a Safety Bulletin cautioning workers to pay attention, identify hazards in the work area, establish clear communications, and stay aware of co-workers and their safety. Both the April 2008 event and an earlier event at Hanford (July 2007) were discussed in OE Summary 2008-05. OE Summary 2006-12 reviewed several DOE aerial lift events as well as industry events that resulted in fatalities. An HSS analysis of the DOE events indicated that the root cause of half of the events involved conduct of operations failures (i.e., inadequate understanding of hazards, errors in equipment selection, procedure violations, and errors in judgment). Nearly a third of the events involved poor work planning.

According to a 2004 Center to Protect Workers' Rights (CPWR) aerial lift safety hazard alert, about 26 construction workers die each year using aerial lifts, and more than half of the fatalities involve boom-supported lifts, such as bucket trucks and cherry pickers. The CPWR alert indicates that although electrocutions, falls, and tipovers caused most of the deaths, other causes of fatalities include being caught between the lift bucket or guardrail and an object (such as steel beams or joists) or being struck by falling objects. The CPWR hazard alert also provides safety tips and information on worker training as well as maintenance and inspection of aerial lifts. The hazard alert can be accessed at http://www.cpwr.com/hazpdfs/hazaeriallifts.pdf.

OSHA regulations for aerial lifts are outlined in 1926.453, *Aerial Lifts*, Subpart L, "Scaffolds" (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10754) and in 1910.67, *Vehicle-mounted Elevating and Rotating Work Platforms* (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9732). An OSHA Quick Card, available at http://www.docstoc.com/docs/9666/OSHA-QUICK-CARD-AERIAL-LIFTS-SAFETY-TIPS, lists the following aerial lift safe work practices.

- Ensure that workers who operate aerial lifts are properly trained in the safe use of the equipment.
- Maintain and operate elevating work platforms in accordance with the manufacturer's instructions.
- Never override hydraulic, mechanical or electrical safety devices.
- Never move the equipment with workers in an elevated platform unless this is permitted by the manufacturer.
- Do not allow workers to position themselves between overhead hazards, such as joists and beams, and the rails of the basket. Movement of the lift could crush the workers.
- Maintain a minimum clearance of at least 10 feet from the nearest overhead lines.
- Always treat power lines, wires and other conductors as energized, even if they are down or appear to be insulated.
- Use a body harness or restraining belt with a lanyard attached to the boom or basket to prevent workers from being ejected or pulled from the basket.
- Set the brakes and use wheel chocks when on an incline.
- Use outriggers, if provided.
- Do not exceed the load limits of the equipment. Allow for the combined weight of the worker, tools, and materials.

Accidents involving aerial lifts can be deadly or can result in serious or life-threatening injuries. It is essential for workers to pay close attention to their surroundings and be alert to any hazards when performing tasks that require use of an aerial lift. It is also important to implement all safety steps when positioning the lift and lift basket and to ensure that the placement of the lift and the position of workers in the basket are correct with respect to the area where work is to be performed.

In most cases, the lift should only be driven to move it from one location to another or for gross adjustments in position. Once the lift is driven into position, positioning of the basket using hydraulics provides the safest control near the work area.

KEYWORDS: Aerial lift, basket, injury, pinned, bucket truck, cherry picker

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

3 Rigger Severs Thumb While Removing Chain Between Trucks

On December 18, 2008, at Oak Ridge National Laboratory, a subcontractor rigger off-loading a tree from a flatbed truck started to remove a tow chain attached between a flatbed truck and a track loader before the vehicles had come to a complete stop, and his right thumb tip was severed when the chain suddenly tightened. The rigger was transported to a local hospital for treatment and released the following day. (ORPS Report SC-ORO--ORNL-X10BOPLANT-2008-0007; final report issued May 26, 2009)

After a crane had lifted the tree out of the truck bed, the truck driver attempted to drive out from under the suspended tree, but the ground was wet and the truck could not gain sufficient traction. The rigger decided to have an accessible track loader provide a tow assist for the truck until it could be moved. He obtained a chain and attached it to hooks located on the front of the truck and on the track loader, then moved about 10 or 15 feet from the vehicles and motioned the two operators to move. The track loader backed up to remove slack from the chain and then pulled the truck until it could move under its own power. According to other workers at the jobsite, when the truck began to move freely, the rigger signaled both drivers to stop. However, the truck apparently had slowly moved forward after the signal, causing slack in the chain. The rigger began to remove the chain before both vehicles came to a complete stop, and the chain suddenly tightened, removing the slack and severing the tip of his thumb.

Investigators learned that when the rigger gave the signal to stop, the track loader operator was looking away from the rigger to see if there was anything in his path, so he did not see the signal. The truck driver was looking through his rear view mirror at another subcontractor worker, who was motioning for the driver to move forward to clear the suspended tree. Neither of them noticed that the rigger had signaled them to stop.

Investigators determined that the rigger, who was highly experienced and understood the dangers of pinch points and control of energy sources, spontaneously decided to remove the chain without confirming that both vehicles had come to a stop and that it was safe to remove it.

In addition, the decision to use the track loader to help gain traction for the truck was not properly planned to ensure clear, mutual communication between the rigger and the two operators and between him and the other rigger who signaled the truck driver to move. The lack of communication led to both vehicles continuing to move after the rigger thought that he had signaled them to stop, and the rigger did not confirm that his communication had been received and understood by the two operators.

Corrective actions for this event included conducting a human performance analysis to evaluate the performance error and determine if performance management followup actions were required. In addition, subcontractor workers attended a safety briefing in which clear communication between multiple workers involved in the same task was reinforced, as well as a briefing that stressed the importance of real-time, ongoing analysis of work conditions, hazards, and work controls during execution of work tasks. A lessons learned on this event is available in the DOE Lessons-Learned database. (Lesson ID: 2009-UTB-ORNL-0020)

Other Event

A similar event that resulted in a worker fracturing his foot occurred at Y-12 on February 12, 2008. A crew member left the work area to retrieve a pair of snips when he could not break one of the two bands holding a bundle of 16-inch-long beams. Before the crew member returned to the work site, an iron-worker, acting as a spotter, flagged a forklift operator to separate the beams in the banded bundle, but he did not first verify that both ends of the bands had been cut. Because both bands were not broken, the beams were not straight when they were lifted, and stress on the remaining band caused it to break, causing the beams to begin sliding off the forklift. When the ironworker attempted to slide the beams back onto the forks, one of them rolled out of the bundle and hit him in the left foot, fracturing it. (ORPS Report NA--YSO-BWXT-Y12CM-2008-0002; final report issued March 26, 2008)

Investigators determined that this event occurred as a result of inadequate communication between workers and a mental lapse on the part of the ironworker that led him to incorrectly flag the forklift operator to proceed with the lift.

In both of these events, workers apparently had a mental lapse, which led to an error in judgment that contributed to the accident. According to an article in *Incident Prevention*, OSHA has stated that "80 to 95 percent of all accidents occurring in industry are related to human error." (http://www.incident-prevention.com/component/zine/article/79-putting-mind-over-human-error.html)

The article, entitled "Putting Mind Over Human Error," describes the following three levels of thought management that can help gauge the level of attentiveness.

Automatic Thinking—Automatic is the lowest level of thought management. When in automatic level, people operate out of habit. They continue to take actions without actively thinking about what is going on or what might happen, and they make the assumption that they are in a safe place. Because a lack of readiness to respond exists when in automatic thinking mode, the risk is much higher for a human error or accident to occur.

Focused Thinking—Focused thinking is the active thinking level. When focused, people are fully conscious of what is occurring and attentive to situations and events. Through controlled focusing, people can pay attention to challenges, situations, and events and begin to manage them to achieve a productive outcome.

Options Thinking—This is the third and highest level of thinking. Creativity, a standard at this level, contributes greatly to the problem-solving effort. New information and ideas emerge, diminishing human errors by lowering their risk of occurrence. At this level, accidents and injuries decline and productivity increases.

The *Incident Prevention* article concludes with the following: "Before starting a task, raise your awareness level to focused, maintain active thinking, and keep your head and hands in the same place until the task is complete."

Both the Oak Ridge and Y-12 events also involved less than adequate communication, which was the topic of an article in OE Summary 2009-05. The textbox on the next page lists some effective communication methods that were listed in that article.

Chapter IV in Attachment 1 to DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, states:

> Oral instructions should be clear and concise. In all communications, the sender and intended receiver should be readily identifiable. Instructions involving the operation of equipment should be repeated by the receiver to the extent necessary for the sender to ensure the instructions are correctly understood.

Effective Methods of Communication

- Carefully specify what key information needs to be communicated.
- Repeat key information, both orally and in writing.
- Allow sufficient time for communication, particularly at shift turnover.
- Encourage two-way communication with both the giver and recipient of the information taking responsibility for accurate communication (i.e., repeat back).
- Encourage workers to ask for confirmation, clarification, and repetition.

The Order can be accessed at http://www.directives.doe.gov/pdfs/doe/doetext/oldord/5480/o548019c2.pdf.

When engaged in any work task, it is essential to remain focused and to evaluate any change in conditions for newly introduced hazards so that appropriate hazard controls can be implemented before the work task continues. Clear two-way communication is also essential to safety, particularly when vehicles or heavy equipment is involved. Spotters should always ensure that their directions have been communicated, understood, and acted upon for their own safety and the safety of others at the worksite.

KEYWORDS: Rigger, flatbed truck, track loader, injury, communication, work controls

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