OPERATING EXPERIENCE SUMMARY

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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.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Frank Russo, 301-903-8008, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction. If you have difficulty accessing the Summary on the Web (URL http://www.eh.doe.gov/paa), please contact the ES&H Information Center, (800) 473-4375, for assistance. We would like to hear from you regarding how we can make our products better and more useful. Please forward any comments to Frank.Russo@eh.doe.gov.

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EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health has published a series of "Just-In-Time" reports. These two-page reports inform work planners and workers about specific safety issues related to work they are about to perform. The format of the Just-In-Time reports was adapted from the highly successful format used by the Institute of Nuclear Power Operations (INPO). Each report presents brief examples of problems and mistakes actually encountered in reported cases, then presents points to consider to help avoid such pitfalls.

1. Deficiencies in identification and control of electrical hazards during excavation have resulted in hazardous working conditions.
2. Deficiencies in work planning and hazards identification have resulted in electrical near misses when performing blind penetrations and core drilling.
3. Working near energized circuits has resulted in electrical near misses.
4. Deficiencies in control and identification of electrical hazards during facility demolition have resulted in hazardous working conditions.
5. Electrical wiring mistakes have resulted in electrical shocks and near misses.
6. Deficiencies in planning and use of spotters contributed to vehicles striking overhead power lines.

The first six Just-in-Time reports were prepared as part of the 2004 Electrical Safety Campaign. In April, the Office of Environment, Safety and Health published a Special Report on Electrical Safety. The purpose of this report is to describe commonly made electrical safety errors and to identify lessons learned and specific actions that should be taken to prevent similar occurrences. This report can be accessed at http://www.eh.doe.gov/paa/reports/Electrical_Safety_Report-Final.pdf.

EH plans to issue more Just-in-Times soon on other safety issues, such as lockout and tagout, fall protection, and freeze protection. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

EVENTS

1. WORKER SCALDED WHEN HOT-WATER HOSE FAILS

On January 18, 2005, at the Naval Petroleum Oil Shale Reserves, a worker was scalded when a pressurized hose ruptured at a nozzle connection and sprayed him with hot water. The hot (160°F) water struck his chin and neck, and then ran down the inside of his coat onto his chest. He received medical treatment offsite for first and second degree burns to his neck and chest. (ORPS Report HQ--GOHQ-NPOSRCUW-2005-0001)

The worker was attempting to clean out a Free-Water Knock Out (Figure 1-1), which is a horizontal vessel used as a water separator. A chemical truck with a dual-pressure system was used to provide the hot pressurized water. The worker was standing on a ladder outside the vessel manway and using a hose with a 5-foot extension nozzle to wash down the inside of the vessel. The worker requested more pressure from the operator of the chemical truck so the spray would reach the back of the vessel. When the pressure increased, the weakened section of hose ruptured. The worker screamed, jumped off the ladder, and ran clear of the area. The operator saw the water spray, and immediately shut down the pump on the truck. The injured worker called his supervisor on his two-way radio and told her that he was going to the ES&H building for medical attention.

Figure 1-1. Vessel and injured worker's ladder

The operator and worker were using the low-pressure side on the chemical truck with a 200-psi-rated hose reel. The extension nozzle on the hose provided some backpressure and effectively reduced the size of the hose down to about a 1-inch flow. All workers had reviewed the procedure that had been developed for the task, which required them to discuss the use of all equipment and to note the equipment's last inspection. A tail-gate meeting was performed before the work took place, but there was no mention of the last time the equipment was inspected or the condition the hose.

Investigators determined that the accident resulted from deterioration of the hose from constant wear where the hose attached to the nozzle (Figure 1-2) and where it rides on the truck after it is rolled up on the reel. The deteriorated condition of the hose was noticed by the workers but never reported and repaired.

Figure 1-2. Damaged hose at nozzle connection

Investigators also determined that proper personal protective equipment (PPE) to protect the face, neck, and chest areas (e.g., rubber apron and full-face shield) was not used for the job, and that a full-face shield may not have provided sufficient protection because of the angle of the spray. Other types of PPE are being considered. In addition, investigators found that the safety relief valve was not adequate for the dual-pressure system, the pressure setting had not been checked, and the operator was not aware of the pressure rating of the hose.

As a result of this event, a team of operators evaluated inspection forms to ensure that all pieces of equipment are addressed in the inspection. Regular inspections will be performed on all heavy equipment, and a complete inspection of hot-water-hauling vehicles will be performed monthly.

The danger of scalding is clearly illustrated by an industry event that occurred at a work site in Dubai, where workers were commissioning a well test package. One of the workers was scalded on his right arm and right thigh when a rubber hose burst. The worker was operating a high-pressure water pump while controlling the flow of hot water (194°F) through a rubber return hose to a tank when the accident occurred. The hose that failed (Figure 1-3) was a replacement hose that had previously been rendered unfit for use and had been taken out of service.

Figure 1-3. Failed return hose

The worker was not wearing long-sleeved coveralls, and the burns were much more severe to the arm (Figure 1-4) than to the thigh, which was protected by the layer of clothing.

Figure 1-4. Burns to right arm from hot water

The event at the Naval Petroleum Oil Shale Reserves underscores the importance of reporting and correcting known equipment deficiencies. Accidents typically occur because of (1) unsafe acts, (2) unsafe conditions, and (3) equipment failures. In this event all three apply: the workers knowingly continued to use the defective hose (unsafe act); a known deficiency (i.e., the deteriorating hose) was left unresolved (unsafe condition); the hose eventually ruptured during use, scalding the worker (equipment failure). The workers should have stopped work for their own safety and made sure the hose was replaced before proceeding with the job. Worker complacency coupled with unsafe conditions is a dangerous combination that more times than not results in an accident.

KEYWORDS: *Scalded, hose, stop work, repair, pressurized, rupture, hot water, injury, burns*

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

2. DON'T USE CHEATER BARS TO TIGHTEN CHAIN BINDERS

On January 14, 2005, at the Idaho National Laboratory, a laborer was working with two others to tie a large transformer onto a lowboy haul trailer (Figure 2-1) when a chain binder handle suddenly released and struck him in the face. The laborer received a broken nose and cuts on his face that required sutures. (ORPS Report ID--BBWI-BIC-2005-0001)

The three laborers were pushing on a piece of conduit about 4 feet long and 2½ inches in

Figure 2-1. Transformer being loaded onto trailer

Figure 2-2. Piece of conduit used as a cheater bar

diameter that they were using as a cheater bar or handle extender (illustrated in Figure 2-2) to close a lever-type, spring-load binder (Figure 2-3). Thinking the binder had closed, two of the laborers walked away. The third laborer was in a lower position holding the cheater bar.

Investigators believe that the third laborer moved up to slide the cheater bar off the binder handle. When the binder released, stored energy in the handle propelled it forcefully so that it struck the laborer on his left upper lip area, across his cheek, and on the safety glasses he was wearing. The laborer needed five internal sutures in his nose and six sutures above his left eye.

Figure 2-3. Spring-loaded chain binder

Although the investigation is not yet complete, several factors are known that likely contributed to the accident. Investigators believe that the cheater bar prevented the latching mechanism from fully engaging. The ambient temperature, which was at or near 0°F, also might have played a part in the bar's failure to engage. In addition, there was no Standard Work Plan or procedure because this task was considered skill-of-the-craft.

Corrective actions being developed include discontinuing the use of spring-loaded chain binders in favor of ratcheting load binders with a turnbuckle. Figure 2-4 shows an example of a ratcheting load binder. Because chain binders are commonly used in the trucking industry and a vendor's truck could arrive onsite with chain binders in use, drivers who come onsite with

Figure 2-4. Ratchet-style load binder

loads secured by chain binders will be required to remove and install them.

The DOE Lessons Learned database contains lessons from previous events involving chain binders. Idaho site personnel submitted a lesson in 1999 (Lesson ID INEEL-1999-429) that was taken from an internal lesson prepared at Mound. The lesson stated that from 1990 to 1999, 10 accidents were reported to the Computerized Accident-Incident Reporting System (CAIRS) describing injuries workers incurred in the process of installing or removing chain binders.

Seven of the 10 accidents involved the use of a cheater bar—a piece of pipe that was slipped over the chain binder's handle to gain additional leverage while trying to open or close it. These are generally not designed for this purpose, and, if poorly sized, they can easily slip off the handle just at the point when the most force is being applied.

Although injuries incurred in these accidents generally did not result in lost time from work, they were fairly significant and involved fractured facial bones, broken teeth, lacerations, and contusions.

A composite of recommended actions from the 10 accidents is listed below.

- Provide more comprehensive training on chain binder installation and removal, emphasizing that workers should stay clear of the area where the bar could forcefully swing around.
- Encourage the use of ratchet-type binders or nylon straps with a built-in ratchet device.
- Instruct personnel to place chains so that they have a open place to stand while installing the binders.
- Prohibit site personnel from removing chain binders from a vendor's trailer.
- Observe truck drivers as they install and remove chain binders.

Installing and removing chain binders can pose significant hazards to even the most experienced worker. Material handlers need to remain aware of their position in relationship to that of the handle should it suddenly break loose. It is safest to use the correct tool for the job; but if a cheater bar must be used, it should be used in accordance with manufacturer recommendations and within the parameters indicated above.

KEYWORDS: *Chain binder, cheater bar, spring load, handle, material handling, injury*

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

3. D&D WORKERS ENGAGE IN UNSAFE HORSEPLAY

On October 21, 2004, at the East Tennessee Technology Park, investigators learned that damage to radiation monitoring equipment (Figure 3-1) at a boundary control station resulted from worker "horseplay" during a cleanup task. All eight contractor and subcontractor employees involved in the horseplay were removed from the project. The incident created a near-miss situation and led managers to suspend all work in the area and order a stand-down. (ORPS Report ORO--BJC-K25GENLAN- 2004-0012; final report filed December 2, 2004)

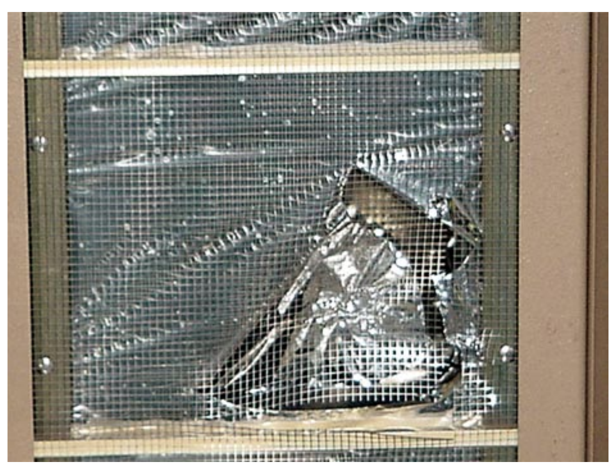

Figure 3-1. Closeup of damaged radiation monitor

The horseplay occurred in a vacant, access-controlled basement of a building scheduled for demolition. While cleaning a room in the basement, the workers found an air hose/conduit device commonly used to spray-down areas to clean them. They hooked the device to an active air line and began shooting small objects around the basement. (Figure 3-2 shows the device.) Several of the objects (Figure 3-3) shot out of the device with enough force to penetrate walls in the room, as well as a wall in an adjacent room, where combustible pressurized cylinders were stored. Serious injuries or facility damage could have resulted if the cylinders had been penetrated by a projectile. Figures 3-4 and 3-5 show damage to the walls in both areas.

The subcontractor project foreman retained the key to the basement throughout the work shift, keeping the door locked during the work day and controlling entry to the area. This ensured that there were no unannounced visits by other site or contractor personnel and created an environment that permitted horseplay among the workers to go undetected. The foreman, who not only was responsible for providing direction to team members, but also for providing feedback on unsafe acts and conditions, joined in the horseplay, including shooting some of the projectiles. Several workers chose not to engage in horseplay, but they observed it, made no effort to stop it, and did not report it.

After a health physicist alleged that the workers had been engaging in horseplay, investigators identified damage to the radiation monitoring equipment. Upon further investigation, they

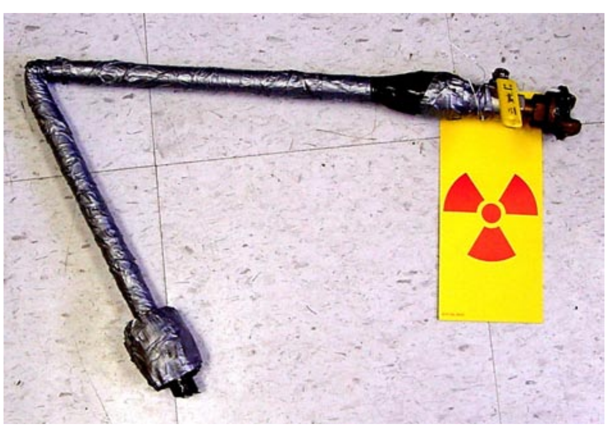

Figure 3-2. Device used to fire projectiles

Figure 3-3. Some objects used as projectiles

Figure 3-4. Wall penetrated by projectiles

Figure 3-5. Adjoining room in basement storing combustible pressurized cylinders

saw areas where projectiles had penetrated the basement walls. They notified contractor security, and security staff confiscated the workers' badges and removed all of the workers from the project. None of the workers was permitted to return to work on site.

Investigators identified several potential causal factors, including the following.

- Lack of Contractor Oversight — Because contractor workers were performing tasks on multiple projects simultaneously, the frequency of daily field visits and site walkdowns by contractor management was less than adequate. In addition, there was no dedicated project superintendent for the work.
- Less than Adequate Supervisory Experience — The foreman did not have adequate experience as an employee of the project contractor, even though he was previously judged to be competent based on observations by project management.
- Possible Personnel Conflict — There was speculation that unfriendly relationships among the workers could have contributed to "possibly aggressive" horseplay. However this could not be confirmed because work was conducted behind a locked door and was not monitored.
- Controlled Room Access — Locking the door to the room effectively prevented unannounced or impromptu visits to the work area. Workers knew when supervisors were going to enter the room.

Corrective actions included assigning both a dedicated project superintendent and an alternate to the basement cleanup project to ensure that a supervisor would be present when work was being performed in the area. Access control to the area has also been changed to allow unannounced access to the area by authorized individuals. In addition, all employees performing work in the basement area attended an awareness session that addressed reporting concerns or unsafe conditions and exercising stop-work authority.

A similar near-miss horseplay event occurred on July 12, 2001, at Oak Ridge Environmental Restoration Operations, when a bulldozer operator splashed water into the face of another heavy equipment operator who was angered by the horseplay. He reacted by rapidly reversing the direction of the earth-moving equipment he was operating, and drove directly into the path of a passenger exiting a pickup truck. The employee escaped injury only because the driver of the pickup truck pulled him back into the truck cab. Project staff terminated both heavy equipment operators, initiated a stand-down, and reminded all workers that serious injuries can result from horseplay. (ORPS Report ORO--BJC-Y12WASTE-2001-0006)

The same contractor employed the workers involved in both of these events. All of the workers involved were trained and experienced in performing work safely, and all were aware of company regulations and site policy prohibiting horseplay. However, despite their knowledge and experience the workers acted irresponsibly.

DOE employees, contractors, and the general public may report allegations of safety violations to the DOE Office of Inspector General (OIG) at 1-800-541-1625 or ighotline@hq.doe.gov. Information on ethical standards prescribed by the U.S. Office of Government Ethics may be viewed at www.usoge.gov.

These events indicate that insufficient oversight can lead to workers engaging in horseplay during work activities. Horseplay may occur even when workers are properly trained in safety policies and procedures, experienced in work tasks, and aware of the dangers of horseplay. Supervisors should ensure that all workers know the process for reporting safety concerns and exercising their stop work authority.

KEYWORDS: *Horseplay, near miss, unsafe acts, oversight*

ISM CORE FUNCTION: *Perform Work within Controls*

4. *DANGERS OF UNGUARDED ROTATING EQUIPMENT*

Unguarded rotating machinery and equipment present a danger to workers because rotating parts can entangle their clothing, resulting in severe injury, amputation, and even death. The Occupational Safety and Health Administration (OSHA) regulations for machine guarding should be followed to prevent such occurrences. However, workplace violations of these requirements are fairly common in industry. For example, many older ventilation fans are unguarded or the guards have openings that are too large.

A National Institute of Safety and Health study found that 20 to 50 percent of all machines being used are unguarded or poorly guarded. According to the Bureau of Labor Statistics, over 25,000 injury cases and 110 fatalities occurred in 2001 when workers were caught in equipment that was running. This type of hazard has also resulted in injuries and near misses within DOE. On January 21, 2005, for example, the following lessons-learned report was posted in the ES&H Lessons Learned Database detailing an event that occurred in 2003.

On September 10, 2003, a near-miss incident occurred at the Lawrence Livermore National Laboratory (LLNL), when a worker's sweatshirt came in contact with the exposed rotating shaft and keyway of an operating fan unit. The entangled sweatshirt twisted and pulled the worker forcefully toward the fan. The worker braced himself against nearby piping and tore his sweatshirt and the shirt he was wearing underneath (Figure 4-1) until he was free. The worker's injuries were minor, but they resulted in lost and restricted workdays. (ORPS Report OAK--LLNL-LLNL-2003-0031)

Following the incident, a team conducted a site-wide survey of rotating equipment at LLNL. Using a master equipment list, the team surveyed similar equipment and identified a small population that was unguarded. The Safety Manager generated job orders to immediately repair the equipment or install machine guarding.

Figure 4-1. Remains of shirt and sweatshirt

When the accident occurred, the worker and a co-worker had just finished repairing a water leak on a Heating, Ventilation, and Air Conditioning (HVAC) unit that was located in a limited space. Investigators determined that the direct cause of the accident was lack of a guard on the exposed rotating shaft, which protruded beyond the existing machine guard (Figure 4-2). They also determined that the work activity was deficient in that it did not include plans for mitigating hazards. The work area was not normally an occupied space and therefore the rotating shaft hazard was not common knowledge. Safeguarding the HVAC equipment in an enclosed location did not prevent exposure to unguarded hazards within the enclosure.

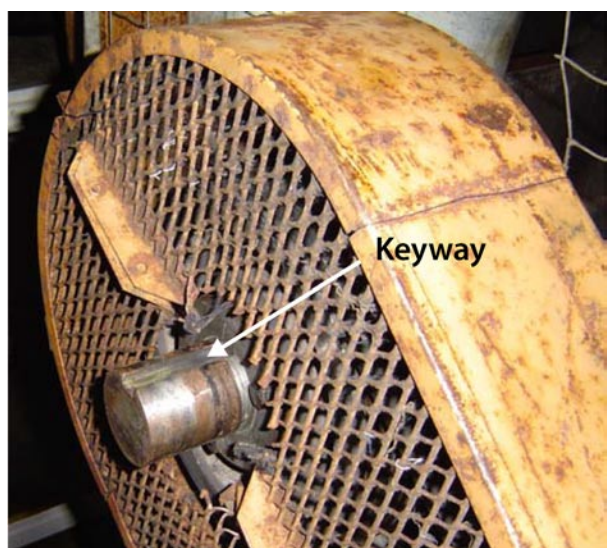

Figure 4-2. Exposed rotating shaft and keyway

Other causal factors included the following.

- The worker wore a loose fitting sweatshirt around rotating machinery.
- The workspace was difficult to access and maneuver in.
- The rotating shaft was difficult to see because of poor lighting.

A similar event occurred on March 27, 1998, at the Ames Laboratory, where an electrician was severely injured when part of his jacket became entangled with the exposed rotating shaft of a supply fan. The electrician required immediate life-saving surgery and later needed additional surgery to save his arms. The accident resulted in 549 lost workdays. (ORPS Report CH--AMES-AMES-1998-0002)

The electrician and a co-worker were evaluating a smoke detector located inside a supply fan room. They had turned off the fan at a control panel outside the room and entered while the fan was coasting down. The injured electrician was carrying a ladder near the shaft end when his jacket came in contact with the rotating shaft (Figure 4-3) and became entangled.

Figure 4-3. Exposed shaft end of the fan unit

A Type B Accident Investigation Board determined that the Laboratory's corrective actions for machine guarding deficiencies identified during previous assessments failed to prevent recurrence. Other causal factors included the following.

- Laboratory personnel failed to ensure the equipment was safely configured.
- Hazards in the fan room were not adequately assessed.
- Walk-through inspections failed to identify the exposed rotating shafts.
- The electrician's unbuttoned jacket increased the likelihood of entanglement.

Based on the Board findings, Ames Laboratory personnel installed protective guards over fan shafts (Figure 4-4) and inspected other fan units for similar conditions.

Figure 4-4. Fan with guard installed over shaft end

The following events involving rotating equipment at DOE facilities also resulted in injuries.

On September 1, 1999, at the Rocky Flats Environmental Technology Site, a process specialist sustained lacerations to three fingers when his anti-contamination glove and cotton liner became entangled in a rotating pump shaft. The process specialist had placed his gloved hand on or near the pump to determine if it was operating during a waste transfer operation. The pump was installed in the early 1950s and equipped with a shaft guard from the manufacturer, but the guard had a 3-inch by 6-inch opening to allow the shaft to be seen. Additional guarding was installed as a corrective action. (ORPS Report RFO--KHLL-NONPUOPS2-1999-0003)

On August 30, 1999, at the Idaho Nuclear Technology and Engineering Center, a carpenter was exposed to an unguarded blower motor fan belt while working on a scaffold railing near the motor. Because the power transmission belt was unguarded (Figure 4-5), the carpenter should have placed his lock on the motor power supply to ensure his safety. However, he did not recognize that the transmission belt was a potential hazard. (ORPS Report ID--LITC-LANDLORD-1999-0012)

Figure 4-5. Blower motor with unguarded fan belt

Any machine part, function, or process that can cause injury must be guarded. Even new equipment may not have all the guards required by OSHA, thus making it the employer's responsibility to add necessary guarding. If you can reach around, underneath, through, or over a guard, it is not effective.

Some hazards are subject to the "seven-foot rule," which requires enclosures or guarding if they are located less than 7 feet above the floor or platform level. Guards should have ½-inch or smaller openings.

Areas Requiring Guarding

- **Point of operation** — Any point where work is performed on the material, such as pressing, cutting, shaping, boring, or forming stock.
- **Power transmission apparatus** — All components of the mechanical system that transmit energy, such as flywheels, pulleys, belts, shafts, connecting rods, couplings, cams, spindles, chains, cranks, and gears.
- **Other moving parts** — All parts of the machine that move while the machine is working, such as rotating, reciprocating, and transverse moving parts and mechanisms.

The U.S. Department of Labor Standards Bulletin, *The Principles and Techniques of Mechanical Guarding*, states: "Any rotating object is dangerous. Even smooth, slowly rotating shafts can grip clothing or hair. Accidents due to contact with rotating objects are not frequent, but the severity of the injury is always high."

Facility personnel responsible for industrial safety should conduct periodic walk-downs to identify safety hazards associated with rotating equipment and should review the following guidance and ensure it is reflected in equipment configurations and administrative controls.

- 29 CFR 1910.212, *General Requirements for all Machines*, states that methods of machine guarding shall be provided to protect employees in the area from hazards such as rotating parts.

- OSHA publication 3067, *Concepts and Techniques of Machine Safeguarding*, 1992, states that any machine part, function, or process which may cause injury must be safeguarded. This publication describes various hazards of mechanical motion and presents techniques for protecting workers.

- 29 CFR 1910.219, *Mechanical Power—Transmission Apparatus*, states that projecting shaft ends shall present a smooth edge and shall not project more than one-half the diameter of the shaft unless guarded by non-rotating caps or safety sleeves and that unused keyways shall be filled or covered.

It is important to point out that sole reliance on the OSHA requirements for machine guarding should be avoided because these minimum requirements may not always reflect latest industry practice. For example, the allowance for shaft-end projections does not completely eliminate the hazard, but installing a guard does. When considering machine guard choices, one should also consult the latest versions of the American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME), such as ASME B15.1-2000, *Safety Standard for Mechanical Power Transmission Apparatus.*

These events underscore the importance of recognizing and guarding hazardous rotating equipment. All motion hazards should be guarded by physical barriers. Locating equipment in limited-access areas does not prevent exposure to motion hazards within these areas. In the absence of engineered barriers, access to such areas should be restricted, controlled, and properly posted.

KEYWORDS: *Rotating equipment, injury, shaft, machine guarding*

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

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
SELLS	Society for Effective Lessons Learned

Units of Measure	
AC	alternating current
DC	direct current
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards 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
RCRA	Resource Conservation and Recovery Act
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement

Miscellaneous	
ALARA	As low as reasonably achievable
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