Office of Environment, Safety and Health • U.S. Department of Energy • Washington, DC 20585

# OPERATING EXPERIENCE SUMMARY

## Office of Environment, Safety and Health

**Summary 2002-13**
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The Office of Environment, Safety and Health (EH), Office of Performance Assessment and 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.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and, time permitting, 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, 301-903-1845, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction.

The OE Summary can be used as a DOE-wide information source as described in Section 5.1.2, DOE-STD-7501-99, *The DOE Corporate Lessons Learned Program*. Readers are cautioned that review of the Summary should not be a substitute for a thorough review of the interim and final occurrence reports.

# Operating Experience Summary 2002-13

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# *EVENTS*

## 1. WORKER EXPOSED TO SILICA DUST

On February 20, 2002, at the Yucca Mountain Site, a technician received a full-shift exposure of respirable silica that exceeded the Threshold Limit Value (TLV) of 0.05 mg/m$^3$. The exposure occurred when the technician was performing geotechnical work while rock drilling was being conducted in a nearby alcove. This was a one-time exposure to the technician, and presented no immediate health hazard. However, it is important to understand that undetected, chronic exposure to silica and other respirable dusts can cause serious health problems. (ORPS Report HQ--BSYM-YMSGD-2002-0002; final report filed May 14, 2002)

A technician performed testing in the alcove wearing a personal dust sampler. Later in the day, workers began drilling holes in the rock floor, producing dust. Safety and Health personnel were not notified of this drilling; therefore, the alcove was not posted to require the use of respirators. This was directly attributed to a failure in the work control process.

During the period from February 12 to 20, 2002, Safety and Health personnel sampled the air to determine the concentrations of airborne respirable dust and silica in the work area. They collected 20 samples that included 8 personal samples and 12 area samples. Lab results from the technician's personal dust sampler showed an exposure to cristobalite at 0.06 mg/m$^3$ (TLV 0.05 mg/m$^3$); quartz at 0.02 mg/m$^3$ (TLV 0.05 mg/m$^3$); and respirable dust (particulates not otherwise specified) at 0.5 mg/m$^3$ (TLV 3.0 mg/m$^3$). The results from the other air samples were either undetectable or below the TLV. TLVs are the occupational health guidelines established by the American Conference of Governmental Industrial Hygienists to protect workers from specific airborne concentrations of hazardous materials in which exposures occur within an 8-hour day, 40-hour week, 50-week year, and over a working life of 40 years.

Post-work air sampling showed the silica limits to be under the threshold levels. Safety and Health personnel will closely monitor work activities in the alcove to ensure worker safety and to limit potential hazards from silica dust. They will also sample air in the alcove and in other areas in the facility to determine baseline limits during various work activities. Activities that generate dust require the use of respiratory protection by all workers in the affected area. The following are some of the findings that resulted from this incident.

- The drilling activity required the use of respirators; however, there was a lack of knowledge by the workers and the supervisor that respirators were required.
- Workers indicated that they lacked sufficient training as to the criteria for determining when respirators are required.
- Workers had limited knowledge of how to care for the personal air sampler units to ensure that reliable data would be collected.

Although this worker's overexposure was minimal, the Occupational Safety and Health Administration (OSHA) reports that more than two million workers in the U.S. are exposed to crystalline silica each year, resulting in about 300 deaths annually. Health hazards associated with overexposure to silica include a disabling and sometimes fatal lung disease called silicosis for which there is no cure. There are three types of silicosis, depending on the airborne concentration of crystalline silica to which a worker has been exposed.

- <u>Chronic silicosis</u>, which usually occurs after 10 or more years of overexposure,

- Accelerated silicosis, which results from higher exposures and develops over 5 to 10 years, and

- Acute silicosis, which occurs where exposures are the highest and can cause symptoms to develop within a few weeks or up to 5 years later.

Additional information on silicosis is available from the National Institute for Occupational Safety and Health (NIOSH). To obtain information on silicosis, call 1-800-35-NIOSH and follow the automated prompts. Outreach materials for OSHA's special program on silicosis may be obtained at http://www.osha-slc.gov/Silica/SeventyEight.html.

This event underscores the need for personnel to be aware of work activities around them that may produce respirable dust, and to wear respirators accordingly. Because air sampling only provides data on exposure levels after the fact, the decision to wear respiratory protection is all the more important. Workers also need to understand the function, use, and care of sampling units to ensure that accurate sampling is being performed. This event also identified a weakness in the work control process that allowed work to be performed without the knowledge of safety and health personnel, thus precluding any analysis of potential hazards such as silica dust.

***KEYWORDS:*** *Silica, exposure, silicosis, work planning, dust, respiratory protection*

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

## 2. WORKER PINNED BETWEEN RAILCAR AND LOADING PLATFORM

On April 25, 2002, at the Fernald Environmental Management Project, a hazardous waste technician was pinned between a railcar and a platform as he attempted to jump up from the tracks to avoid the moving cars. His personal air sampler and hardhat absorbed most of the impact. The engineer quickly moved the cars in the reverse direction with the trackmobile, freeing the technician. The technician was taken to an offsite hospital, where he was diagnosed with multiple contusions and released. (ORPS Report OH-FN-FFI-FEMP-2002-0016; final report filed May 22, 2002)

A work crew, consisting of hazardous waste technicians, trainees, rail operations personnel, and heavy equipment operators, met that morning for a pre-job briefing. One of the crew's tasks was to placard (i.e., label as to contents and hazards) four railcars. The railcars needed to be moved to line the two southernmost cars at a delidding platform (Figure 1). After the briefing, the conductor told one of the technicians that a fifth car needed to be moved as well, and that he and the engineer would do this before initiating railcar placarding/loadout operations.


***Figure 1. A view of the platform and trackmobile***

The work crew dressed out in protective clothing and full-face air-purifying respirators required by the radiological work permit. When the engineer entered the area to start the trackmobile in preparation for moving the railcars, she did not notice that there were five railcars instead of the customary four.

The conductor checked that the tracks were clear and radioed the engineer to begin moving the cars forward. The engineer pushed the cars forward to the platform and stopped. The conductor instructed the engineer to move forward an additional 5 feet, and then requested that she apply three-step protection so that the technicians could begin placarding. Three-step protection is the means by which rail personnel verify that the trackmobile is secured in place, and consists of placing the direction control lever and the transmission control range selector in neutral, and setting the parking brake. After this was complete, the conductor stepped between the last two cars and set the handbrake on the fifth car. He pulled the cutting lever and directed the engineer to back the cars 5 feet to separate the train from the fifth car.

Meanwhile, one of the technicians motioned to the engineer that he wanted to turn a placard, and the engineer nodded, having given three-step protection to the conductor. The technician believed that he had been given permission to complete the entire placarding task, but the engineer did not. Another technician and trainee arrived and asked the lead hazardous waste technician if they were cleared to begin placarding. Based on his observation of the first technician changing one placard, the lead technician said they could start placarding the railcars. The trainee climbed to the west platform to turn the placard. The other technician went to the north end of the platform to turn the placard on the railcar in front of the trackmobile.

The engineer could not see the technicians on the north end of the platform; the only visible technician was the first to arrive, standing away from the railcar. The conductor could not see the platform area and was unaware that others had entered and begun placarding.

The engineer looked to be sure the tracks were clear, sounded the horn, and began backing slowly. At that moment, the technician on the north end of the platform was about to turn the placard and heard the horn. He stepped up from the tracks onto the platform and tried to squeeze between the car and platform, a space of about 10½ inches (Figure 2). The cars were now in motion and the car nearest him caught his right hip and pressed him against the platform. His personal air sampler, which snapped in half, and hardhat absorbed most of the impact, and he yelled out for the train to stop.

*Figure 2. The clearance space between the railcar and the platform*

Two technicians heard the sound and saw the trapped technician. One technician ran to the trackmobile and motioned the engineer to stop. The engineer had already stopped, and after receiving direction from the conductor, moved the train forward to free the technician.

Several causes were identified for this occurrence. The direct cause was a communication problem. The trackmobile operating procedures specify that "each person shall request and release the Three-Step Protection from the Trackmobile engineer," although only one technician did so. However, Rail Operations management and supervisory personnel stated that the conductor is responsible for granting three-step protection, a policy which conflicts with trackmobile procedure. In addition, the hazardous waste technicians, wearing respiratory protection and equipped with two-way radios on a frequency different from that used by the train crew, were unable to communicate with the engineer directly, and had to use hand signals. The procedure governing rail radio communications, however, states that radio and hand signals cannot be combined.

The root cause of this event was a lack of enforcement of policies and procedures. Neither the railcar loading procedure nor the job safety analysis addressed the task of placarding. Implementation of rail safety requirements had become informal and deviated from rail operations procedures. Had policies and procedures been current, complete, consistent, clearly understood, and followed by all personnel, it is unlikely that this accident would have occurred.

Significant contributing causes included the following:

- an inadequate work environment for placarding railcars, as evidenced by the insufficient clearance between the railcars and the platform or space from which to quickly escape the tracks;
- the plan to move an additional car out of the building before beginning normal railcar placarding/loading activities was not understood by all members of the crew;
- the absence of the supervisor in the area at the time of the accident; and
- failure to survey railcar placarding/loading operations and procedures.

All project operations were terminated until the investigation and analyses were complete. Facility management undertook a number of corrective actions, some of which are listed below.

- The task of placarding railcars was moved to the north rail yard, and a job safety analysis and interim policy were developed specifically for placarding.
- The railcar loading procedure was revised to address deficiencies identified during the investigation; specifically, it mandates the use of high-visibility, color-coded vests for the various railcar operations personnel, a series of horn signals to indicate three-step protection release, and the issuance of a radio with a common frequency to the loadout supervisor to facilitate communication between the train crew and loadout personnel (hazardous waste technicians). Using the revised procedure, loadout personnel completed a dry run of the railcar loading evolution.
- The trackmobile procedure was revised to incorporate the horn signal criterion specified in the railcar loading procedure.
- Material changes in the facilities were reviewed to eliminate the need for personnel to cross the tracks to perform their duties, such as rerouting a waterline and moving the activation switch for the railcar misting system.

This event illustrates the importance of developing clear and complete procedures and job hazard analyses for all phases of facility operations. It is essential that all organizations involved in a work evolution be able to communicate with each other. Management should verify that all personnel have current training. Pre-job briefings need to ensure that instructions are understood by all, and, even more importantly, the work scope must remain within the parameters set in the work package.

***KEYWORDS:*** *Railcar, near miss, personal injury*

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

## 3. MISUSE OF COMPRESSED GAS CYLINDERS RESULTS IN RESPIRATORY EXPOSURE

On May 8, 2002, the Ames Laboratory was informed by a compressed gas vendor that two of its employees had been exposed to a respiratory irritant while preparing to refill an Ames Laboratory-owned cylinder with argon gas. The irritant, identified as a mixture of sulfur dioxide and helium gas, had been improperly introduced into the compressed-gas cylinder containing argon gas by Ames Laboratory researchers in violation of Laboratory procedures. Exposure to the workers was minimal. (ORPS Report CH--AMES-AMES-2002-0002)

The vendor employees were preparing a number of Ames Laboratory cylinders for refill when the two vendor employees were exposed to the irritating gas. The employees moved to a location of fresh air and after a short period of time, both returned to work. An evaluation of the cylinder found that it bore handwritten labels identifying the contents as a 1:5 ratio mixture of sulfur dioxide and helium as well as its original, professionally applied label for argon gas.

The vendor also informed Ames Laboratory that two other cylinders bore handwritten labels, indicating that sulfur hexafluoride had been introduced. All of the cylinders were part of a shipment made from the Laboratory to the vendor on April 29, 2002. Shipping documentation from the laboratory identified the cylinders by the professionally applied labels; the handwritten ones were overlooked. Ames Laboratory and Iowa State University policy, *Gas Cylinder Safety Guidelines,* section V, "Compressed and Liquified Gas Handling," clearly specifies requirements for handling compressed and liquified gas cylinders. These requirements include the following.

- No person other than the gas supplier shall attempt to mix gases in a cylinder.
- Containers shall not be used for any other purpose than holding the contents as received.

Upon notification of the exposure, the Ames Laboratory contacted the vendor to obtain the serial numbers of the affected cylinders. Using those numbers, laboratory personnel determined the research group responsible for attaching the handwritten labels to the cylinders. The inventory of all of the group's cylinders was printed, and all of the group's cylinders remaining at Ames Laboratory were impounded. Testing of the impounded cylinders on the site has not found any additional misuse.

Laboratory personnel identified the following actions that could have prevented this occurrence.

- Line management ensuring strict compliance with Ames Laboratory's compressed-gas cylinder policy.
- Line management performing a more rigorous examination of cylinders for extraneous and unusual markings.

This occurrence demonstrates the risk associated with improperly introducing gas into cylinders containing compressed gas, particularly if the gas being introduced is different than the gas indicated on the original label. Also, compressed gas from cylinders bearing handwritten labels should be analyzed for content before shipping. DOE/EH-0527, *Compressed Gas Cylinder Safety*, provides safety information and recommendations on gas cylinder use, storage, and labeling. This Safety Notice, Issue 96-03, can be accessed through the ES&H technical information website at http://tis.eh.doe.gov/web/oeaf/lessons_learned/ons/sn9603.html.

***KEYWORDS:*** *Compressed gas cylinder, exposure, handwritten label, respiratory irritant*

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

## 4. CRANE OPERATION NEAR POWER LINE CAUSES ELECTRICAL ARC

On May 16, 2002, at an Oak Ridge nuclear waste processing facility that is currently under construction, an electrical arc occurred between a 13.8-kilovolt power line and a construction crane when the slings hanging from the crane hook swung too close to the power line. The electrical event was instantaneous as current arced to the crane and then to ground. No direct contact was made with the power lines, and there was no damage to the lines or the crane. The crane operator was performing pre-lift verification steps when he moved the boom, causing the unloaded slings to swing outward near the power lines. (ORPS Report ORO--FWEC-TRUWPFAC-2002-0001)

The crane, a Manitowoc 4000 with a 150-foot boom, was being used to place construction materials and equipment. In this instance, the crane was to lift an electrical equipment building weighing 85,200 pounds and set it onto a concrete pad. When the operator moved the crane laterally to position it for the lift, centrifugal force caused the suspended rigging to swing within 1 foot of the 28-foot-high power line, causing an electrical arc. The spotter and other personnel in the area observed the arc. Crane operation was stopped to verify that the operator, crane, and power lines were not affected. Arc strike damage was observed to the spreader slings that were suspended from the main hook. The damaged slings were removed and destroyed to prevent reuse.

The contractor conducted a critique of the event and determined that personnel error was the direct, contributing, and root causes because of the operator's inattention to the working envelope of the equipment and the environment. In addition, the abrupt motion of crane by the operator to correct for being slightly out of position may have contributed to the event, along with distractions from concurrent activities outside the crane safety zone. The contractor determined the following lessons learned from this event.

- Removal of the unloaded lifting slings from the crane hook after their use and before movement of the crane is a good practice to reduce the equipment working envelope. This is particularly true when working in a limited area.
- The potential hazards of a momentary distraction or loss of concentration during the lift preparation (vs. the actual lift) could have been more fully appreciated and mitigated by the operator, ground personnel, and management.

Another event involving accidental contact with energized power lines was reported in Operating Experience Summary 2002-09. On April 22, 2002, an excavator being used to dismantle a building at the Rocky Flats Environmental Technology Site contacted an overhead 13.8-kilovolt power line, causing a visible electrical arc. The operator had extended the boom of the excavator to assist with turning when it struck the power line, which was 23 feet above the ground. A spotter was not being used. (ORPS Report RFO--KHLL-NONPUOPS3-2002-0002)

The Occupational Safety and Health Administration regulation 29 CFR 1910.333(c)(3)(iii)(A), *Vehicular and Mechanical Equipment*, states that any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a minimum clearance of 10 feet is maintained. DOE-STD-1090-2001, *Hoisting and Rigging* (formerly *Hoisting and Rigging Manual*), section 9.5.2, provides guidance on operating mobile cranes near power lines and transmission towers. In addition, section 9.5.1(o) warns of the phenomenon of centrifugal force that can occur when moving the boom of the crane.

These events illustrate the importance of exercising extreme caution when operating cranes and other pieces of equipment in the vicinity of power lines. Operators need to ensure that the cranes are operated within the safe working envelope of the equipment and the environment. Also, operators should recognize that unloaded, under-the-hook rigging can swing outward during boom movement and challenge the safe working envelope. Pre-job briefings, facility procedures, and training programs should emphasize the dangers associated with these types of operations. Many events have occurred because equipment operators were not aware of potential hazards around and above them.

***KEYWORDS:*** *Electric line, crane, overhead line, electrical safety, hoisting and rigging*

***ISM CORE FUNCTIONS:*** *Analyze the Hazards, Perform Work within Controls*

## 5. NEAR MISS FROM CUTTING ENERGIZED HEAT TRACE LINE

On May 28, 2002, at the Hanford Tank Farms, a maintenance worker in the process of disconnecting a pump skid cut through heat trace wires that were assumed to be de-energized by the associated lockout/tagout. The worker observed sparks when the line was cut with a hand-held band saw, resulting in the immediate tripping of a 120-volt circuit breaker. It was discovered that the heat trace wires were powered by a separate tank farm electrical system. The worker was not wearing personal protective equipment because the work team assumed that they were not at risk. No injuries resulted from this event. (ORPS Report RP--CHG-TANKFARM-2002-0054)

A lock and tag administrator had reviewed the scope of work for equipment deactivation. After walking down the job, he established a specific lockout for de-energizing electric power consistent with the planned scope of work. The work package was released, and a pre-job briefing that included a discussion of the lockout/tagout plan was conducted before starting the work.

The work crew established the electrical lockout as required by the work package and performed a zero-energy check on the load side of the locked-out circuit breaker to confirm that the line was de-energized at that point. The workers then proceeded to disconnect tubing, conduit, and heat tracing as described in the work instructions. While cutting through the heat trace on a ½-inch tubing line with a band saw, the electrician noticed an unusual amount of sparking and informed his supervisor. The electrician and the supervisor investigated and found a tripped breaker in an energized electrical panel.

During the event critique, it was learned that this type of work was normally performed only after locking out the main circuit breaker that provides power to pumps, controls, heat tracing, and other electrical equipment in the area. In this case, maintenance and operations supervisors determined that opening the main breaker would interfere with other ongoing work, and a decision was made to lock out an alternate breaker believed to control the heat tracing as well as other electrical service. The supervisors thought this was a safe alternative that would allow other ongoing work to continue.

At other locations in the tank farm, the heat trace wire was powered through the alternate breaker; however, this particular system was of an earlier, different design, where the heat trace wires were powered through a different breaker. The lockout/tagout administrator was familiar with the system design in the other locations, and assumed incorrectly, after reviewing drawings that did not illustrate the details of the heat tracing system, that the system being worked on had the same heat trace system design.

The direct cause of this event was the failure to de-energize the circuit supplying power to the heat trace line. Existing drawings did not adequately depict the routing or the energy source for heat tracing, and human errors were made in allowing the work to proceed based on incorrect assumptions made in an attempt to compensate for inadequate information. A contributing cause was the fact that the work was behind schedule, and there was a sense of urgency related to performing the work on the swing shift on the day of the event. Figure 1 shows the heat trace wires after they were cut.

Subsequent to the event, compensatory measures taken included the following.

- Immediately stopped work and placed the work site in a safe condition.
- Immediately suspended electrical work requiring lockout/tagout placement pending the outcome of a review by the Event Investigation Team.
- Revised a site document entitled *Use of Insulated Tools for Energized Electrical Work* to include the following requirement:

  "If safe condition checks or safe to work checks associated with [controlling organization] lockout/tagout and authorized worker lock and tag cannot be performed at the component or on the equipment where the exposure to electrical energy could occur (i.e., where the conduit is to be cut), the job will be treated as work on energized equipment and an energized electrical work permit is required."

This event highlights the need to positively identify, from electrical drawings if possible, the source of electrical power to any electrical lines that are to be cut. If the drawings are not sufficiently detailed to allow positive identification of the associated power source, the next higher level of electrical circuit breakers should be locked out, even if this means interrupting ongoing work. In any case, it is a good practice to require workers cutting electrical conduit or wires to wear properly rated personal protective equipment, even if the supervisors and workers are confident that the risk exposure is small.

The EH Office of Performance Assessment and Analysis analyzed 63 electrical intrusion events reported in the Occurrence Reporting and Processing System from January 2000 through December 2001. This study was initiated because trending analysis revealed an increase in the frequency of these events during the third and fourth quarters of calendar year 2001. Problems revealed by the 63 analyzed intrusion events included inadequate or inaccurate as-built drawings, procedure noncompliance, blind penetrations, lack of zero-energy checks, and inadequate component marking. A lessons-learned report on this topic (Identifier HQ-EH-2002-01) can be accessed from the Society for Effective Lessons Learned Sharing website at http://tis.eh.doe.gov/ll/listdb.html. The results of the analysis are also summarized in a DOE EH Special Report, *A Review of Electrical Intrusion Events at the Department of Energy: 2000 – 2001*, published by the Office of Performance Assessment and Analysis, June 2002.

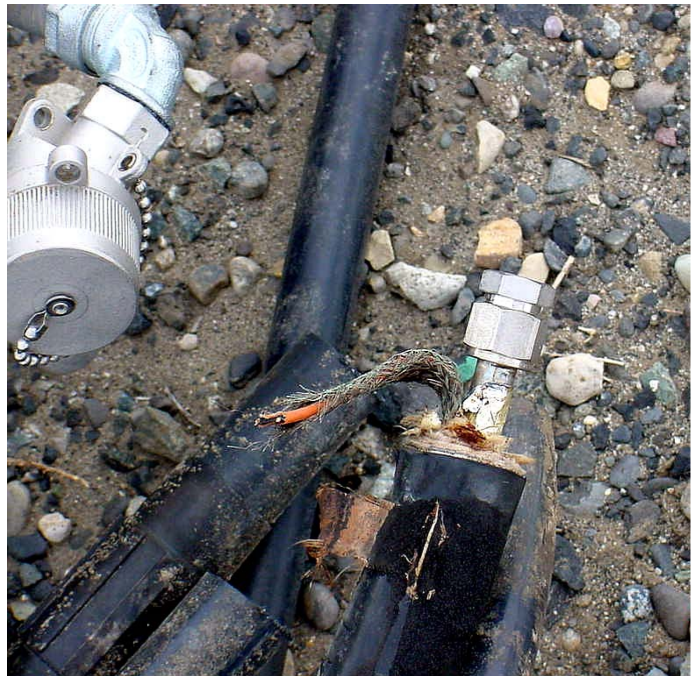

***Figure 1. The cut heat trace wires***

In spite of the visibility given to the electrical intrusions issue by the lessons-learned report and the EH Special Report, these events continue to occur. For example, on June 21, 2002, at the Idaho Nuclear Technology and Engineering Center, a, backhoe severed an energized 110-volt line during excavation. (ORPS Report ID--BBWI-LANDLORD-2002-0005)

***KEYWORDS:*** *Electrical safety, cutting electrical conduit, shock hazard, near miss*

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