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

OPERATING EXPERIENCE SUMMARY

Office of Environment, Safety and Health

Summary 2002-09
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The 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.

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Operating Experience Summary 2002-09

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EVENTS

1. EXCAVATOR BOOM CONTACTS OVERHEAD 13.8 KILOVOLT POWER LINE

On April 22, 2002, at the Rocky Flats Environmental Technology Site, the boom of an excavator contacted an overhead 13.8 kilovolt high-voltage power line, causing a visible electrical arc and tripping a substation circuit breaker. The excavator was being used to dismantle a building using mechanical shears attached to the boom for breaking up concrete. The line was checked for damage and it was returned to service a short time later. There were no injuries to the operator or equipment damage. (ORPS Report RFO--KHLL-NONPUOPS3-2002-0002)

The equipment operator was moving the excavator to position it out of the work area by extending the boom to assist in turning (see Figure 1). During one of these maneuvers, the boom contacted the power line, which was approximately 23 feet above the ground. A spotter was not used because the excavator was not expected to operate near the overhead lines.

Figure 1. Excavator with boom positioned on the ground

A similar incident was reported in Operating Experience Summary 2000-09, in which a mobile television crew was injured when their transmission antenna contacted an overhead power line. The television crew was extending the antenna mast from their truck to transmit a live broadcast when the mast contacted an overhead power line and caused a small electrical fire and explosion inside their van. A camera operator outside the truck and an operator inside the truck were taken by helicopter to a hospital for treatment of burns.

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 clearance of 10 feet is maintained.

This event demonstrates the importance of exercising extreme caution when operating excavators, cranes, front-end loaders, forklifts, and other vehicles in the vicinity of power lines. 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. The use of a spotter in this circumstance might have prevented this occurrence.

KEYWORDS: *Electric line, excavator, overhead line, electrical safety*

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

2. INADEQUATE EQUIPMENT GROUNDING RESULTS IN ELECTRICAL SHOCK

On January 29, 2002 at the Savannah River Site, a cafeteria services worker received a shock to his right hand while attempting to turn off an electric kitchen stove. The worker had seen electrical sparks underneath the 208-volt stove and decided to turn the stove control to the “off” position. Investigators later determined that the stove housing was inadequately grounded to prevent a shock. The worker did not require medical attention, but the shock to his right hand resulted in a near-miss occurrence. (ORPS Report SR--WSRC-FSSDGEN-2002-0001; final report filed March 25, 2002)

A critique of the event revealed that the stove was a replacement unit that had been installed in 2000, without upgrading the existing wiring and without verifying that the grounding was adequate after installation was complete. The electrical junction box for the replacement stove was located at the bottom of the unit and the power supply wires, inside a flexible conduit, rested against the sheet metal of the junction box.

The direct cause was a defective or failed part because the insulation on one of the power supply conductors touching the junction box had melted, causing an electrical short. Because of this short and the inadequate grounding of the stove, the worker received a shock. Daily use of the stove had generated high levels of heat for prolonged periods of time. Some of this heat apparently transferred to the junction box through conduction and melted the insulation.

The contributing cause was the electrician’s failure to verify that the stove had been properly grounded after he installed it.

The root cause of this event was an inadequate or defective design. Maintenance personnel assumed that installation of the new stove was a direct replacement of the old one. The electrician failed to consider that the existing wiring would need to be upgraded, and used the same flexible conduit and wiring that was used for the old stove.

The following corrective actions have been implemented or are underway:

- Submit a lessons-learned document to the division lessons learned coordinator for review and sitewide distribution on the necessity of conducting a design review before replacing installed industrial-class electrical equipment.
- Ensure that all industrial-class equipment in the facility is properly grounded and that circuit breaker protection is adequately rated.
- Ensure that the new stove is grounded correctly and that it has effective circuit breaker protection.

- Implement a management directive to require future work orders involving replacement of installed industrial-class equipment to undergo an appropriate design authority review before installation.
- Provide in-house training on electrical grounding to all Electrical and Instrumentation mechanics/electricians.

A search of the ORPS database found that two events involving faulty electrical grounding were reported in OE Summary 2000-06.

On January 7, 2000, at the Los Alamos National Laboratory Weapons Engineering Tritium Facility, facility management declared an Unreviewed Safety Question because of electrical grounding problems. This facility was built in 1985 with three electrical buses – two 208-volt buses and one 480-volt bus – that were not properly grounded when they were installed. Investigators learned that this condition was discovered when electricians began wiring new equipment to the bus ducts. The electrical buses were de-energized and repaired with the necessary grounding kits. (ORPS Report ALO-LA-LANL-TRITFACILS-2000-0001)

On June 8, 2000, at the Hanford Solid Waste Facility, an ironworker received a minor electrical shock when he touched an electrical conduit attached to the side of an office trailer with his wet gloved hands. Inadequate grounding was later identified when investigators found that a grounding screw, used to connect the neutral bus and the ground bus in the main panel, was too short and failed to connect the buses. In addition, the grounding rod at the main electrical panel was corroded. (ORPS Report RL--PHMC-SOLIDWASTE-2000-0003)

These events demonstrate the importance of verifying the existence of adequate electrical grounding when replacing or installing equipment. When replacing equipment, work planners should conduct a thorough electrical design review of existing electrical circuits to ensure that they comply with the latest National Electrical Code (NEC®) requirements for grounding and circuit breaker protection before placing the equipment in service.

***KEYWORDS**: Electrical grounding, circuit breaker, shorting, short*

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

3. USING WRONG LOCKOUT TYPE POSES ELECTRICAL HAZARD

On February 20, 2002, at the Savannah River Technology Center (SRTC), Electrical & Instrumentation mechanics installed a single-point (i.e., undocumented) lockout/tagout (LO/TO) on a motor control center cubicle with 440-volt circuits to perform work on an exhaust system fan. The motor control center houses a number of electrical circuits within the same enclosure, and the single-point LO/TO was placed on the motor control center disconnect. After opening the cabinet to verify a safe energy state, the mechanics found control voltage of 110 volts. Although no personnel injury resulted from this event, the use of the wrong type of LO/TO posed an electrical hazard to the workers. (ORPS Report SR--WSRC-LTA-2002-0004; final report filed April 25, 2002)

The mechanics stopped work and reported the discovery of voltage in the cubicle to management. A documented LO/TO was prepared, reviewed, formally approved, and installed.

The *Employee Safety Manual* states that a single-point LO/TO may be utilized for work on electrical equipment if the equipment is physically separated from other energized sources of power through permanent shielding. If multiple power sources with more than 50 volts are present, a documented lockout/tagout must be used. Because the process of installing a single-point LO/TO is less rigorous than that of a documented LO/TO, a number of limitations apply to its use. For example, under a single-point LO/TO, the worker who installs it is responsible for controlling and removing the lock and the Do Not Operate tag, as well as maintaining custodianship of the key for the duration of the LO/TO.

A critique held on February 25, 2002 identified the following corrective actions.

- Laboratory Support Division Maintenance will issue procedural guidance for establishing single-point LO/TO at SRTC facilities.
- Operations management will review this procedure to determine acceptable standards for establishing single-point LO/TOs at SRTC facilities.

The direct and root cause of this event is the failure to correctly follow established LO/TO procedures. Pre-job planners recognized the possibility of control power of greater than 50 volts in the cubicle, and the knowledge of this possibility should have caused the planners to specify a documented LO/TO. A documented LO/TO includes a formal review and approval process, and thus provides a greater measure of control of electrical hazards.

This occurrence illustrates the importance of using the appropriate LO/TO system for the work to be performed. For electrical systems with a single energy source, a single-point LO/TO is in order, while for multiple circuits, a documented LOTO must be used. A formalized LO/TO program improves personnel safety assurance, helps prevent equipment damage, and offers better overall control over equipment and systems.

KEYWORDS: *Single-point lockout/tagout, pre-job planning, safe-energy state*

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

4. DRUM ROLLER OVERTURNS

On March 28, 2002, at the Fernald Environment Management Project, a smooth-drum roller at the On-Site Disposal Facility (OSDF) overturned with the equipment operator at the controls. The drum roller was being used to seal erosion repairs on a 20-degree slope. The operator was transported from the scene to an off-site hospital, where he was diagnosed with a bruised knee. He was released without any work restrictions. (ORPS Report OH-FN-FFI-FEMP-2002-0015)

The experienced heavy-equipment operator, who was new to the site and had just completed on-site orientation, was assigned to operate the smooth-drum roller on the slope of the south end of an OSDF disposal cell. This slope is located between the southernmost point of the cell cap and the contiguous access road that crosses to the top of an adjoining cell. The width of the slope between the cell cap and the access road is approximately 8 to 10 feet. Because the operator was new to the site, a supervisor should have observed him to ensure that he was able to properly operate the assigned equipment. Earlier that day, the operator had been observed operating a bulldozer and a scraper, and was considered to be proficient on both machines. The operator was then asked to operate a roller, which he stated he could, so a supervisor directed him to roll the slope.

Although the operator had driven a roller before on flat terrain, he had not been on sloped terrain. The operator requested directions on rolling the slope from other personnel, via his two-way radio. Another operator responded with the instructions to roll "up and down, very carefully." A laborer who was standing nearby also gave the operator hand-signal direction showing that he should roll perpendicular to the face of the slope and not parallel with the slope. The supervisor who had assigned him to operate the roller did not hear the operator's call for direction over the radio, although several other supervisory and safety personnel did, and they listened to ensure that the directions were correct. The operator later stated that he had received directions from another operator and a laborer, but felt that with the end of the work shift near and bad weather approaching; he could complete the work sooner by going parallel to the slope. Operation of the roller had not been covered during the daily safety briefing because it was not anticipated that a roller would need to be used that day.

As the operator proceeded parallel across the slope, the roller overturned and landed with the left side on the access road (Figure 1). The operator was protected within the cab of the machine by the rollover protection system, and was restrained by his seat belt. When the roller came to rest, the operator shut off the machine, released the seat belt, and moved to a safe location. No other personnel observed the rollover, and were alerted to the accident only when the operator sounded the horn.

Figure 1. The overturned drum roller

Several project personnel responded to the scene immediately. The drum roller was brought upright and moved to the base of the cell. Soil, contaminated by fluids that had leaked from the overturned roller, was removed from the area.

A safety stand-down was held the morning after the accident with all craft and supervisory personnel. The incident, probable causes, and actions to prevent recurrence were discussed. As a result of the investigation and the stand-down, the project identified the following issues that require action.

- Management will ensure that supervisors properly place their highest priority on worker safety
- Supervisors will directly observe new-hire employees operating equipment to ensure that they operate the equipment safely. The Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.120(e)(3)(iii) states, in part, that new employees working at environmental restoration sites are required to receive a "minimum of one day actual field experience under the direct supervision of a trained, experienced supervisor."
- Supervisors will observe each operator as he operates equipment and document his proficiency level on a certification form. Each operator must demonstrate his proficiency on each piece of equipment before he can operate equipment alone.
- Review all applicable work packages to ensure that the hazards associated with operating heavy equipment are known and adequately addressed.
- Establish a standard for key project personnel who will be notified in the event of an emergency.

A search of recent occurrences in ORPS revealed several events involving overturned equipment. At Oak Ridge National Laboratory on June 19, 2000, an operator was using a 1050 John Deere tractor when the tractor overturned as he was cutting the grass on sloped terrain. It had begun to rain shortly after the operator began mowing, and the wheels of the tractor slipped on the bank. The operator received minor injuries. . (ORPS Report ORO--ORNL-X10UTILITY-2000-0001)

On August 31, 1999 at the Rocky Flats Environmental Technology Site, a front-end loader tipped over at the Solar Ponds Plume Project Site. The operator was attempting to back up a 19-degree hill at the site, and he turned the loader parallel to the hill, causing the loader to slowly tip over. No injuries were reported, and the loader sustained only minor damage. (ORPS Report RFO--KHLL-ENVOPS-1999-0005)

These events illustrate the importance of requiring all new employees, whether experienced or not, to go through an orientation period, including direct observation by supervisors, to ensure that new workers are familiar with all facility safety requirements and equipment. Operators must be experienced in handling the equipment under the existing conditions, and they should never take shortcuts or bypass established safety procedures. .

KEYWORDS: *Heavy equipment, slope, overturn, near miss*

ISM CORE FUNCTIONS: *Analyze the Hazard, Perform Work Within Controls*

5. STEEL BAR FALLS FROM FORKLIFT AND INJURES WORKER'S FOOT

On April 19, 2002, at the Los Alamos Neutron Science Center, a worker who was spotting for a forklift operator was injured when a steel bar fell off the forklift and struck his right foot. The 250-pound bar fell from a height of 52 inches, bounced, and glanced off the toe of the worker's shoe. The steel bar measured approximately 3 inches square by 88 inches long, and was being used as a shim to provide a level platform for concrete shielding. The worker, who was not wearing safety shoes at the time of the event, was hospitalized for reconstructive surgery to the big toe of his right foot. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-2002-0001)

A team of workers was erecting beam line radiation shielding that included steel and concrete blocks weighing up to 18 tons. Figure 1 shows the steel bar (that struck the worker) positioned between large shielding blocks. The shielding blocks were stacked using both an overhead crane and forklifts. All of the workers involved in the operation were qualified forklift operators and overhead crane operators, and had been regularly involved as a team in disassembly and reassembly of shielding for over 15 years. Workers are required to wear safety shoes when engaged in lifting and shielding work.

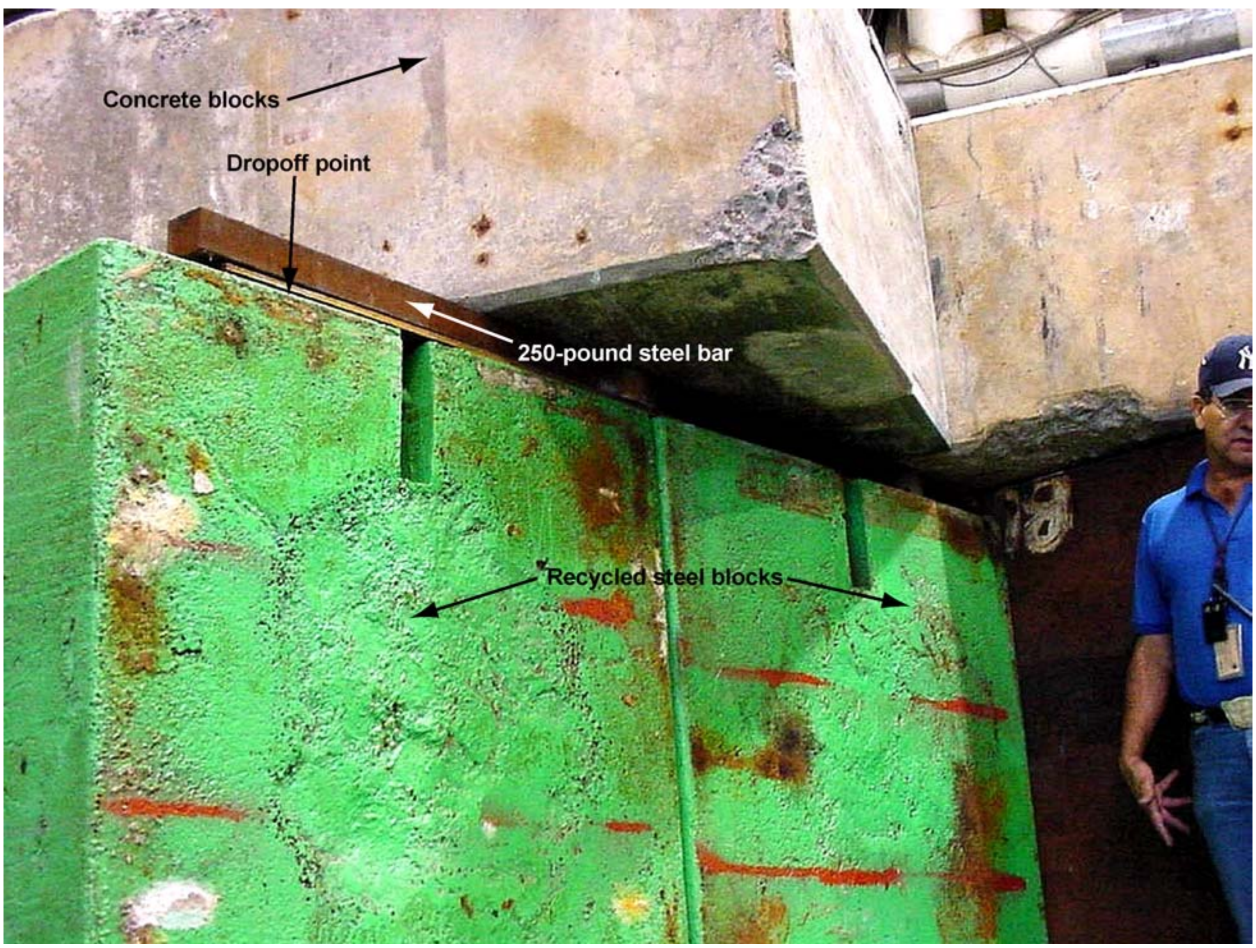

Figure 1. Steel bar between shielding blocks and position of the spotter

During this particular operation, an equipment operator moved a 4-ton capacity forklift into an alcove that required the forklift to enter at an angle because of its large size and limited space in the alcove. The steel bar was positioned across both tines of the forklift towards the tips of the tines. When the operator drove the forklift up to the dropoff point on top of a large shielding block, the worker who was a spotter directed him to back up a few inches. The spotter was standing on top of a ledge created by the stacked shielding block located below the dropoff point. The spotter and a second person intended to slide the steel bar from the forklift tines to its resting place on top of the shielding block. However, when the forklift backed up, the left tine (driver's perspective) was positioned immediately above the top of the shielding block while the right tine was several inches away from the shield block. When the spotter attempted to move the steel bar toward its resting place, it dropped between the tine and the vertical shield block, bounced, and struck the spotter's right boot in the area of the big toe.

The injured worker initially told his coworkers that he was not injured, but soon indicated that he felt pain in his right foot. A coworker then drove him to the Los Alamos Medical Center Emergency Room, and he was later transferred to a second hospital for foot surgery.

Information from the National Safety Council shows that only one out of four victims of job-related foot injuries wear any type of safety shoe or boot. The following table provides examples of workplace foot injuries.

Injuries	**Common Causes**
Crushed or broken feet, amputations of toes or feet	Feet trapped between objects or caught in a crack, falling heavy objects, moving vehicles, conveyor belts
Punctures of the sole of the foot	Loose nails, sharp metal, or glass objects
Cuts or severed feet or toes, lacerations	Unguarded machinery, chain saws, rotary mowers
Burns	Molten metal splashes, chemical splashes, contact with fire, flammable or explosive atmospheres
Electric shocks	Static electricity, contact with sources of electricity
Sprained or twisted ankles, fractured or broken bones because of slips, trips, or falls	Slippery floors, littered walkways, incorrect footwear, poor lighting

The Occupational Safety and Health Administration (OSHA) states in 29 CFR 1910.136, *Occupational Foot Protection*, that the employer shall ensure that all employees use protective footwear when working in areas where there is a danger of foot injuries. Additional information on protective footwear can be found in OSHA booklet 3077, *Personal Protective Equipment*. OSHA regulations, standards, and publications can be accessed at the OSHA website at www.osha.gov.

This event underscores the importance of wearing the required personal protective equipment. In this event, if the worker had been wearing steel-toed safety shoes instead of standard work shoes, he may not have suffered such a severe injury. Workers who are exposed to potential foot injuries from falling or rolling objects, materials piercing the sole of the shoe, or exposure to electrical hazards are required to wear protective footwear. When working in an area where there is a potential for falling, rolling, or puncture hazards, foot protection can be afforded by wearing steel-toe safety shoes or add-on devices such as metatarsal guards, metal foot guards, puncture-proof inserts, or shin guards. Safety shoes and safety boots can not only prevent injuries, but can reduce the severity of an injury. Safety shoes must meet requirements specified in the American National Standards Institute (ANSI) Standard Z41-1999, *Personal Protection – Protective Footwear*.

KEYWORDS: *Injury, safety shoe, foot, falling object, personal protective equipment*

ISM CORE FUNCTION: *Perform Work within Controls*

6. BERYLLIUM SURFACE CONTAMINATION FOUND IN LEASED BUILDING

On April 9, 2002, DOE Richland Operations Office (RL) learned that surfaces in a leased building at Hanford, Washington were contaminated with beryllium at levels above the free release limit of 0.2 micrograms per 100 square centimeters (µg/100cm^2) specified in 10 CFR 850, *Chronic Beryllium Disease Prevention Program*. This building had been leased from late 1994 until early 2002 to a private business whose aluminum extrusion operations purportedly involved trace quantities of beryllium. (ORPS Report RL--PHMC-COMMLEASE-2002-0001)

The leased building is a 1950s-era attachment to an older structure that machined and canned uranium fuel rods, with traces of beryllium involved in process. Operations ceased in both structures in the early 1980s. In June 1994, in anticipation of leasing the newer structure, baseline surveys were conducted for asbestos, PCBs, lead, solvents, radiological contamination, and safety issues. However, beryllium was not considered because beryllium processes had not occurred in this portion of the building, and the survey predates 10 CFR 850 and heightened awareness of beryllium hazards. An analysis of new hazards from the proposed lessee operation was performed and a five-year lease was signed in August 1994, which required compliance with applicable federal, state, and local laws and regulations, and did not specifically address DOE requirements. An agreement was reached that federal OSHA would assume jurisdictional authority.

In July 1997, the temporary Notice DOE N 440.1, *Interim Chronic Beryllium Disease Prevention Program,* was issued, which established new requirements for the identification, evaluation, and control of beryllium. This was followed in December 1999 by issuance of 10 CFR 850, which contained specific values for action levels (i.e., 0.2 µg/m^3 airborne) and surface contamination free release (i.e., 0.2 g/100cm^2) values. Additionally, a surface value of 3µg/100cm^2 was specified as a cleanup criterion for facilities working with beryllium. There is no general conversion factor from surface contamination to airborne concentrations.

In March 1998, the lessee performed air samples for beryllium and found that their operations complied with the OSHA permissible limit of 2 µg/m^3 of air, in that no airborne beryllium was found. No surface contamination surveys were conducted because there was no OSHA requirement to do so. The lessee did not relay this information to RL until January 2002.

In June 1999, in anticipation of the issuance of 10 CFR 850 and the sitewide beryllium characterization effort, DOE contractors collected 88 surface wipe samples in the unoccupied older structure, which had housed beryllium operations. One sample exceeded the detection level of 0.5 µg/100cm^2. Air samples detected no beryllium. The leased portion of the building was not included in the characterization surveys because no beryllium processes had occurred there and the building was leased to a private company who was presumed to be subject to OSHA worker safety regulations.

In January 2002, the lessee notified DOE of its intent to vacate the leased space. At that time, RL learned that alloys used in the lessee process reportedly contained beryllium, and DOE obtained copies of the 1998 lessee sampling reports. RL determined that the leased space should be sampled to characterize any residual beryllium contamination that might be present as a result of past operations (whether by the lessee or DOE). Their surface sampling indicated that 21 of 94 wipe samples were above 0.2 µg/100cm^2, with the highest at 0.991 µg/100cm^2. The source of the beryllium contamination (whether attributable to DOE or to lessee operations) remains in question. On April 15, 2002, the DOE

Office of Environmental Management reported that no Hanford facilities, including the leased space, were ever transferred to OSHA for regulatory oversight.

This event underscores the need to perform thorough baseline characterizations prior to, and upon completion of, lessee operations. It is also of paramount importance that all associated risks with proposed lessee operations are understood, and that corresponding language is incorporated into contractual terms of the lease. Additionally, it must be recognized that safety and health requirements to which the lessee is to be held are dependent on the regulator, which in some cases may not be known before initiation of the lease.

KEYWORDS: *Beryllium, leases*

ISM CORE FUNCTION: *Analyze the Hazards*

7. POSITIVE BIOASSAY RESULTS FROM FAILED GLOVEBOX GLOVE

On July 27, 2001, at the Rocky Flats Environmental Technology Site, bioassay sample results from an exposed worker indicated an uptake with a committed effective dose equivalent of 310 millirem. The source of the contamination was determined to be a hole in a glovebox glove at the Solid Waste Facility. The hole was not readily visible, and could be detected only when the glove was severely stretched. The glove was removed and replaced with no additional spread of contamination. (ORPS Report RFO--KHLL-SOLIDWST-2001-0051; final report filed April 2, 2002)

On May 10, 2001, the worker was performing decommissioning and decontamination activities that involved pulling a cord through the glovebox. He was wearing personal protective equipment as specified by the radiological work permit, which did not require the use of respiratory protection. After completing the work and removing his arms from the glovebox gloves, he surveyed his arms and hands and detected contamination. Radiological control technicians identified 7,000 dpm/100 cm^2 alpha contamination on the upper arm below the shoulder of the worker's anti-contamination coveralls. The contaminated coveralls were removed and contained. No contamination of the skin or modesty clothing was identified, and no air monitors alarmed. Intake calculations from nasal and mouth smears indicated a potential uptake in the range of 100 millirem to 1 rem. The individual was sent to internal dosimetry for further evaluation, and subsequently was restricted from working in the radiological area pending evaluation of bioassay samples. Follow-up bioassay samples were evaluated in accordance with internal dosimetry procedures.

The direct and root cause for this incident was a small pinhole in the upper arm of the glovebox glove, near the edge of the glove port.

This occurrence illustrates the importance of thorough self-monitoring before exiting a controlled area to ensure that any contamination present is detected. Although not a procedural requirement, good radiological practice dictates that workers survey their arms from hand to shoulder following operations in radioactively contaminated areas. In this event, the worker’s use of proper survey techniques and the prompt and appropriate response of radiological controls personnel when the contamination was detected prevented it from spreading. This event also underscores the importance of appropriate testing of glovebox gloves. The testing of glovebox gloves needs to be performed to the same rigor that the gloves are to be used. The gloves need to be pressurized and stretched to verify their integrity and to determine their usefulness.

KEYWORDS: *Contamination, glovebox glove, intake*

ISM CORE FUNCTION: *Perform Work within Controls*