OPERATING EXPERIENCE SUMMARY

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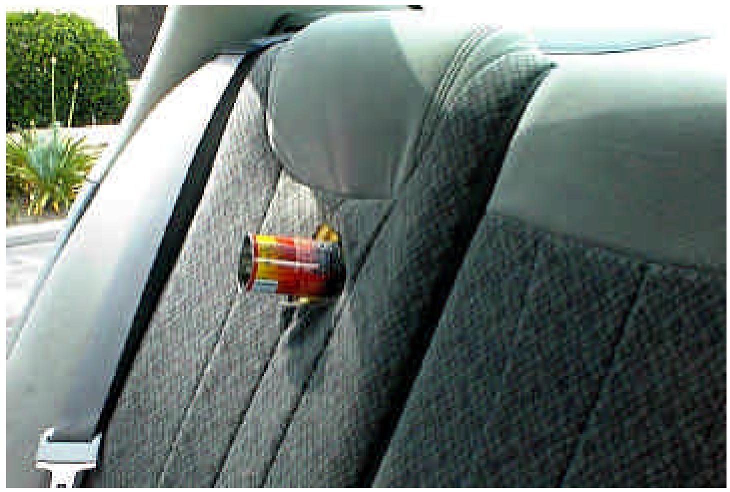

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Office of Environment, Safety and Health

OE Summary 2003-19
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The Office of Environment, Safety and Health (EH), Office of Analytical Studies, 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 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.

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.

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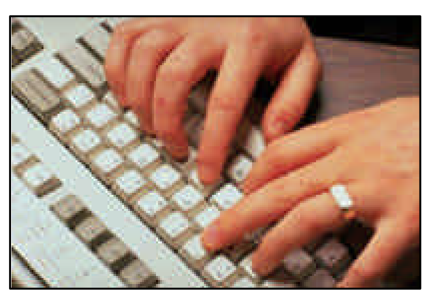

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EVENTS

1. CABINET ANCHOR BOLT PENETRATES ENERGIZED CABLE

On May 22, 2003, at the Idaho National Engineering and Environmental Laboratory, an anchor bolt was accidentally pushed through a concrete floor into an electrical raceway, shorting a 480-volt cable to ground and causing an arc/flash that tripped a circuit breaker. Workers were reinstalling a 200-pound storage cabinet following extensive equipment replacement at the Test Reactor Area, using an overhead crane to lower the storage cabinet onto existing anchor bolts. One of the holes in the cabinet base was not aligned with the corresponding bolt, and the weight of the cabinet pushed the bolt through the concrete into the raceway located just below the surface of the floor. No one was injured or received an electrical shock. (ORPS Report ID-BBWI-TRA-2003-0006; final report filed August 21, 2003)

Workers were to place the cabinet back-to-back with another cabinet that was already installed. They were lowering it onto anchor bolts that had held it in place for at least 13 years. The three workers in the immediate area at the time of the incident—two spotters and a crane operator—were wearing safety glasses and leather gloves, but no electrical-rated personal protective equipment. Figure 1-1 shows the area immediately after the incident. The cabinet is on the right; also shown are the floor anchors and the approximate location of the under-floor electrical raceway (lines superimposed after the incident). Figure 1-2 shows the burn mark on the back of the cabinet and the floor anchor that was displaced.

The raceway was installed during facility construction 46 years ago to provide a path for electrical cables to power machine tools, but the workers did not know it was in the work area. Facility procedures require a subsurface investigation when installing new anchor bolts, but not for bolts already in place.

The mounting holes for the anchor bolts were approximately 2 inches from the end of the 28-inch-long, 2-inch by 4-inch rectangular steel tubes that form the mounting base for the cabinet (Figure 1-3). The spotters were helping position the cabinet onto the anchor bolts. They lined up the mounting holes as best they could by looking down the mounting base tubes (approximately 26 inches) and "eyeballing" the relative locations of the anchor bolts and mounting holes from the sides of the cabinet. However, they were unable to see the back of the cabinet because their view was blocked by cabinet that was already installed.

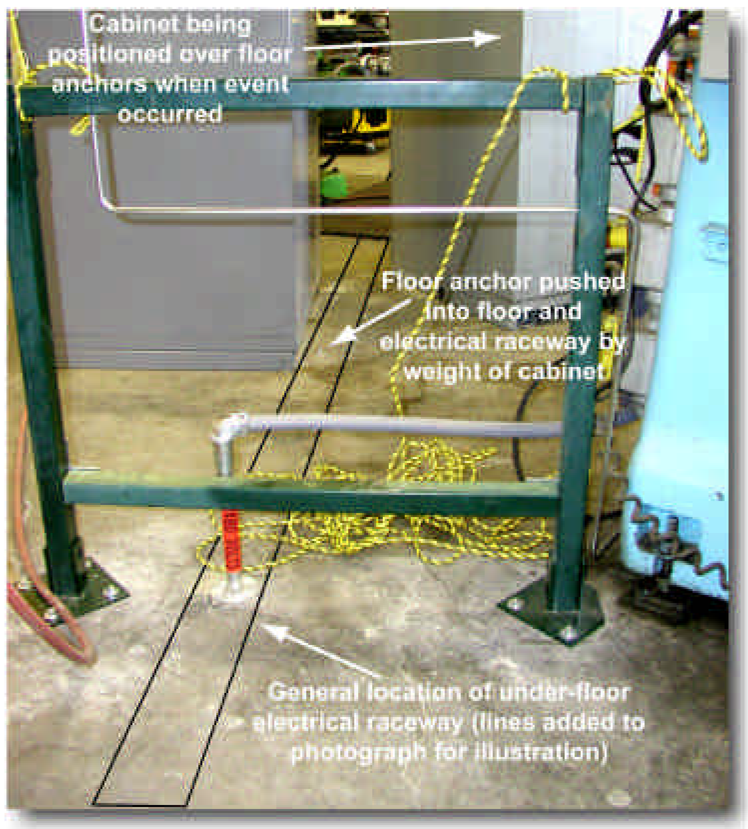

Figure 1-1. Details of the incident scene

Immediately following the incident, workers barricaded the area, and electricians installed a lockout/tagout on the tripped circuit breaker. Investigators determined that the power outage was limited to one nearby milling machine. Managers imposed a formal stop work order for reinstallation of shop equipment until the remaining exposed anchor bolts could be inspected

Figure 1-2. Enlarged view of the floor anchor and cabinet

to determine if they were located near subsurface electrical raceways.

Investigators determined that inattention to detail by the work crew was the direct cause of this occurrence. The workers had no reason to expect an electrical intrusion event if they misaligned the cabinet and the anchor bolts. However, had they taken greater care in aligning the cabinet mounting holes with the bolts, they could have prevented the incident.

Figure 1-3. Mounting hole in cabinet base

Investigators also determined that improper resource allocation by management was a contributing cause for the incident. The work order specified that equipment operators were to position and install the cabinets. Equipment operators have more experience with this type of work, and they might have been successful in aligning the mounting holes with the anchor bolts. However, qualified overhead crane operators performed the reinstallation because no equipment operators were available. Crane operators do not normally perform this type of work, and the task was more complicated than it appeared.

The root cause of the incident was a deficiency in work organization and a planning deficiency. Some time before 1989, the anchor bolt was installed too deeply in the concrete floor, directly over the electrical raceway. The anchor would not have been installed in this manner if a survey for subsurface obstructions had been performed to determine the location of the raceway.

Corrective actions identified as a result of this incident include the following.

- Revise the Machine Shop Facility Hazards List to include electrical raceways and 480-volt-ac conductors embedded in the concrete floor.
- Require subsurface surveys before making floor penetrations or attaching to any installed anchor bolts.
- Conduct a training session on this event for all appropriate personnel addressing the need to perform a comprehensive evaluation of the hazards associated with a task, to pay strict attention to the task being performed, and to stop work and seek assistance from others if unexpected conditions arise.

- Conduct a training session for supervisors on this event and on the importance of addressing "what-if" questions and accident precursor experience in pre-job briefings.

- Review the facility procedures on subsurface investigations and revise them if necessary to ensure that they provide adequate guidance to prevent the placement of anchoring hardware over shallow-placed subsurface utilities.

The DOE Office of Environment, Safety, and Health published a report entitled *A Review of Electrical Intrusion Events at the Department of Energy: 2000-2001* in June 2002. This report identifies commonly made errors during excavation and penetration work and provides recommendations. A lessons-learned report on the topic of electrical intrusions (HQ-EH-2002-01) on the Society for Effective Lessons Learned Sharing website provides an analysis and identifies causal factors on these types of events.

CONTRIBUTING FACTORS TO AN IMPROBABLE EVENT

- Raceway for cables was installed nearly 50 years ago in the concrete floor.
- Anchor bolt for cabinet was improperly installed too close to the cable raceway.
- Workers did not know cable raceway was under the anchor bolt in question.
- Crane operators were installing the cabinet instead of equipment operators.
- Mounting hole was misaligned with anchor bolt, causing cabinet weight to be imposed on anchor bolt.

This incident underscores the fact that activities that seem to be routine and nonhazardous may often be more complex and hazardous than they appear. Work should be performed by qualified workers at all times, even when tasks are seemingly routine. To the workers involved in this occurrence, the consequences of not properly aligning the cabinet appeared to be minor (e.g. bending the bolt or damaging the bottom of the cabinet). In fact, the presence of electrical raceway just below the surface of the floor, created a sizeable hazard. The shorting of the energized 480-volt cable to ground could have caused a serious injury because the workers were handling the cabinet at the time the electrical arc/flash occurred.

KEYWORDS: *Electrical intrusion, subsurface electrical raceway, electrical safety, arc/flash event, machine tool equipment cabinet*

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

2. SAFETY ASSESSMENT IDENTIFIES THE USE OF NUMEROUS DEFICIENT SCAFFOLDS

On August 12 and 13, 2003, at the Idaho Nuclear Technology and Engineering Center (INTEC) tank farm, managers responded to the findings of a DOE safety assessment by ordering 16 scaffolds removed from service, inspected for deficiencies, and repaired before returning them to service. Inspectors from the DOE Office of Independent Oversight and Performance Assurance (OA) conducted the safety assessment on August 11, and identified 10 deficient scaffolds being used during ongoing construction work. A second inspection conducted by site Construction Services staff identified deficiencies in six additional scaffolds. Similar deficiencies were identified during a scaffold and fall protection functional assessment in December 2002. (ID--BBWI-WASTEMNGT-2003-0007)

The OA inspectors discovered numerous instances where scaffolding was not erected in accordance with INTEC scaffolding program requirements. Deficiencies included inadequate guard railing, lack of toe boards, unsecured planks, and gaps between planks and vertical side members. Examples of unsafe scaffolding (not at INTEC) are shown in Figures 2-1 and 2-2.

The inspectors expressed concern about the high percentage of deficient scaffolds and were particularly concerned about inspection tags that had been signed by competent persons, indicating that workers could safely use the scaffolding.

Figure 2-1. Example of scaffolding without handrails or toe boards

The INTEC High Level Waste Manager ordered all tank farm scaffolding to be removed from service. He also notified the director of Construction Services, who instructed his staff to inspect all tank farm scaffolds. He also directed them to identify, document, and photograph the deficiencies, then correct them and re-inspect and re-photograph the scaffolding before returning it to service.

Construction Services staff validated the OA assessment findings and discovered six additional deficient scaffolds. Deficiencies included improper ladder installation, board overhang, and tie-offs. They also conducted a site-wide scaffold review, verified the deficiencies, removed the inspection tags, and entered a safety concern in the site Issue Communication and Resolution Environment system.

Two other scaffolding issues occurred at INTEC in the last 9 months. In December 2002, a scaffold and fall protection functional assessment identified concerns with fall protection, competent-person training, and scaffold erector knowledge. In June 2003, an INTEC senior supervisor stopped work on a facility scaffold because scaffold erectors were standing on a single plank and were not wearing hardhats as required by facility procedures.

Figure 2-2. Example of scaffolding with deficient spacing

OA SAFETY ASSESSMENT FINDINGS

- Deficient plank spacing
- Inadequate guard railing
- Deficient barriers
- Toe boards absent on scaffold levels
- Inadequate inspections by competent persons who sign the inspection tags

A review of ORPS identified two recent scaffold events. On February 18, 2003, at the Hanford site, a worker narrowly escaped serious injury when he fell from an unsecured plank being used as a scaffold extension that shifted and dropped from the scaffold. The worker landed on top of manipulator arm tubes that saved him from a potentially serious 10-foot fall. Investigators determined that that the scaffold extension was improperly installed and the scaffold inspection and tagging process was inadequate. (ORPS Report RL--PHMC-324FAC-2003-0002) An article about this event appeared in the March 24, 2003, Operating Experience Summary (Issue 2003-06).

On December 3, 2002, at the Rocky Flats Environmental Technology Site, a steel plate slipped from a lifting fixture and swung into a scaffold causing it to partially tip over. The scaffold came to rest against a large metal press. A worker on the scaffold narrowly escaped serious injury by holding on to the scaffold and stepping on to the metal press. He climbed down from the press after his coworkers attached a portable ladder to the press. Investigators determined that the scaffold configuration did not meet OSHA standards for height to base ratio exceeding 4:1. Only one outrigger was used because of space constrictions, and the scaffold was not secured to the wall. (ORPS Report RFO--KHLL-D&DOPS-2002-0001)

The Department of Labor estimates that 2.3 million construction workers (65 percent of construction industry workers) frequently work on scaffolds. Protecting these workers from scaffold-related accidents would prevent 4,500 injuries and 50 deaths every year, saving American employers $90 million in lost workdays. In a recent study by the Bureau of Labor Statistics, 72 percent of workers injured in scaffold accidents attributed the accident to the planking or support giving way or slipping or to being struck by a falling object.

OSHA standards for scaffold construction can be found in 19 CFR 1926, Subpart L, "Scaffolds." An OSHA publication, *Guide to Scaffold Use in the Construction Industry* (OSHA 3150, 2002 Revised), is available at http://www.osha.gov/Publications/osha3150.pdf

PRECAUTIONS FOR WORKING ON SCAFFOLDS

- Notify supervision of any problems or questions concerning the scaffold.
- Ensure the scaffold has been inspected and approved for use.
- Do not modify or change the scaffold without approval.
- Do not allow tools, materials, or debris to accumulate on the scaffold.
- Do not climb "X" braces. Use access provided.
- Do not use ladders or makeshift devices on top of scaffolds to increase the height.
- Do not overload the scaffold; always stay within the working load limit of the scaffold.
- Use a tag line when hoisting material onto a scaffold.
- Do not work on a scaffold in high winds or when covered with ice or snow.

These events underscore the importance of erecting and inspecting scaffolds in accordance with facility procedures and OSHA standards. Scaffolds are to be erected, moved, dismantled, or altered only by experienced and trained employees who have been selected for that work by a competent person. The competent person should be knowledgeable of scaffolding standards and procedures, capable of identifying existing and predictable hazards, and authorized to take prompt corrective measures. Employees who use scaffolding should be trained in the nature of scaffold hazards; the correct procedures for dealing with hazards; the correct procedures for erecting, disassembling, and moving scaffolds; the design criteria, maximum intended load capacity, and intended use of the scaffold; and any other pertinent requirements.

KEYWORDS: *Scaffold, fall protection, competent person*

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

3. AEROSOL CONTAINERS INSIDE VEHICLES MAY EXPLODE IN HOT WEATHER

A recent Safetygram published by ALCOA Rockdale Operations, Rockdale, Texas, cited two incidents in which aerosol cans exploded inside closed vehicles on hot summer days. Fortunately, no one was in either car when the cans exploded, but both vehicles were damaged.

Aerosol cans carry a warning that they should not be exposed to prolonged sunlight or stored at temperatures higher than 130°F, but there is no specific warning against storing them in vehicles during hot weather. The ALCOA Safetygram cautioned against keeping items such as cans of WD-40®, Fix-A-Flat®, hair spray, or deodorant in a vehicle in hot weather and included photographs showing the damage that occurred when aerosol containers exploded. Figure 3-1 shows an aerosol can embedded in the rear seat of a closed-up car after it exploded on a day temperatures reached 100°F.

In the second incident, a can of deodorant stored in the back of a car parked in the hot sun exploded and shattered the rear window (Figure 3-2). A similar incident occurred several years ago at the Nevada Test Site, where two aerosol cans of dust remover burst inside a parked vehicle and blew out the window. The manufacturer's data indicated that a temperature of

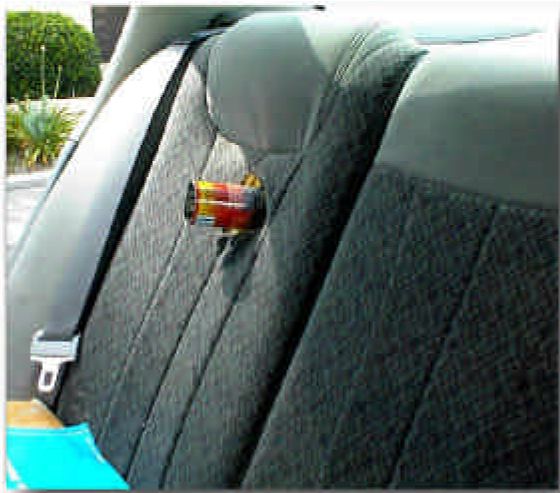

Figure 3-1. Exploded aerosol can embedded in rear seat

greater than 130°F inside the vehicle would produce pressures of more than 266 psig within the cans.

The National Highway Traffic Safety Administration states that temperatures in a closed vehicle increase very quickly on sunny days, climbing from 78°F to 100°F in just 3 minutes and to 125°F in 6 to 8 minutes. When the liquefied gas propellant used in aerosols is heated, vapor is produced inside the can, causing the pressure to rise very quickly. A temperature rise to only 86°F can double the pressure inside the can. Prolonged exposure to high temperatures, particularly in a closed vehicle parked in direct sunlight, can turn an aerosol container into a time bomb.

Figure 3-2. Shattered rear windshield following aerosol can explosion

A search of the ORPS database revealed a near-miss event involving another heat-related aerosol can explosion. On May 24, 2001, at the Hanford River Protection Project, an aerosol can blew out the rear window of a government vehicle. Maintenance workers had stored several aerosol cans behind a seat in the interior of the vehicle. Ambient temperatures in the area reached 101°F, causing the contents of the can to expand in the heat and explode. The explosion shot the can through the window like a small missile. Electricians found the ruptured can on the ground outside the vehicle surrounded by glass shards. They also found three other aerosol cans ruptured inside the vehicle. Although the only damage was to the vehicle, serious injury could have occurred had personnel been in the vicinity when the can exploded. (ORPS Report RP--CHG-TANKFARM-2001-0039)

A lessons-learned report about the event at the River Protection Project can be accessed from the SELLS website at http://tis.eh.doe.gov/ll/listdb.html. Recommendations from that report include inspecting all vehicles to check

PREVENTING HEAT-RELATED AEROSOL EXPLOSIONS

- Do not leave aerosol containers in a vehicle where they can be exposed to sunlight.
- If an aerosol container must be stored inside a vehicle, place it in an industrial cooler and slightly open one or more windows.
- Read caution statements on all aerosol products and take the recommended actions.

for stored aerosol cans, removing them, and storing them in cool areas.

These incidents demonstrate the importance of proper storage of aerosol cans containing products used for household or industrial applications. The heat generated inside a closed-up car parked in direct sunlight for only a short time may be enough to increase pressure in the container to the extent that it explodes. Managers and supervisors should ensure that employees using aerosol products review and understand the applicable Material Safety Data Sheets.

KEYWORDS: *Aerosol cans, heat expansion, pressurized air*

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

4. SMALL GASOLINE-POWERED ENGINES CAN PRESENT A CARBON MONOXIDE HAZARD

On September 3, 2003, the National Institute for Occupational Safety and Health (NIOSH) posted a safety and health topic on their website regarding hazards of carbon monoxide (CO) poisoning from the operation of small gasoline-powered engines. The report states that many people have been poisoned by carbon monoxide while using gasoline-powered tools such as high-pressure washers, concrete-cutting saws, power trowels, floor buffers, welders, pumps, compressors, and generators in buildings or semi-enclosed spaces. Carbon monoxide can rapidly accumulate to dangerous or fatal concentrations within minutes, even in areas that appear to be well ventilated. Examples of such poisonings include the following.

- Five workers were treated for carbon monoxide poisoning after using two 8-horsepower, gasoline-powered pressure washers in a poorly ventilated underground parking garage.

- A worker in an indoor water treatment plant lost consciousness while trying to exit from a 59,000-cubic-foot room where he had been using an 8-horsepower, gasoline-powered pump, even though doors adjacent to the work area were open while he worked.

- A plumber experienced a severe headache and dizziness and began acting erratically while using a gasoline-powered concrete saw. The plumber was in a basement with open doors and windows and a cooling fan.

- A farm owner died of carbon monoxide poisoning while using an 11-horsepower, gasoline-powered pressure washer to clean his barn. He had worked about 30 minutes before being overcome.

These examples show that carbon monoxide poisoning can occur in a variety of work settings, over different time periods, and with different types of ventilation. While people were incapacitated within minutes inside areas with closed doors and windows; opening doors and windows or operating fans does not always guarantee a safe working environment.

Carbon monoxide is a poisonous gas that can cause illness, permanent neurological damage, and death. Because it is colorless, odorless, and nonirritating, exposed individuals can be overcome without warning. Often there is little time before they experience symptoms that inhibit their ability to seek safety.

Carbon monoxide inhibits the ability of blood to carry oxygen to body tissues and vital organs. When carbon monoxide is inhaled, it combines with the oxygen-carrying hemoglobin of the blood to form carboxyhemoglobin (COHb). How quickly this builds up is a function of concentration (in parts per million) of carbon monoxide inhaled. A 25 percent concentration of COHb results in nausea and serious headache, with quick recovery after treatment with oxygen or fresh air. A concentration of 50 percent or greater will result in death. Because COHb levels are not easily measured outside the medical environment, toxicity levels are usually measured in airborne concentration levels.

A review of ORPS for carbon monoxide exposures caused by internal combustion engine exhaust identified events similar to those in the NIOSH report. The DOE-reported events included the use of gasoline-powered saws, paint

PPM	Time	Symptoms
35	8 hours	Max exposure allowed by OSHA in workplace over 8-hour period
200	2 – 3 hours	Mild headache, fatigue, nausea, and dizziness
400	1 -2 hours	Serious headache – other symptoms intensify
800	45 minutes	Dizziness, nausea, and convulsions. Unconscious within 2 hours and death within 2 -3 hours
1,600	20 minutes	Headache, dizziness, and nausea. Death within 1 hour
3,200	5–10 minutes	Death within 1 hour
6,400	1–2 minutes	Death within 25 – 30 minutes
12,800	1–3 minutes	Death

sprayers, air movers, pumps, and floor sweepers. In addition, workers were exposed to carbon monoxide from larger engines in manlifts, forklifts, trucks, and tractors using gasoline (69 percent), propane (26 percent), and diesel (5 percent) fuels.

Sixty-three percent of the events resulted from equipment operation inside buildings where carbon monoxide was allowed to accumulate because of inadequate ventilation. Other events occurred because equipment was operated near building intakes allowing exhaust to enter the ventilation systems. In two events, engine exhaust entered air compressor intakes, contaminating breathing air systems.

PREVENTING CARBON MONOXIDE POISONING IN THE WORKPLACE

- Install and use ventilation systems that effectively remove CO from work areas.
- Do not operate engines near building air intakes and windows.
- Consider using electric-, battery-, or air-powered equipment rather than gasoline-powered equipment.
- Prohibit the use of gasoline-powered engines or tools in poorly ventilated areas.
- Test the air regularly in areas where CO may be present (e.g., confined spaces).
- Provide personal CO monitors with audible alarms if potential exposure exists.
- Maintain equipment that produces CO in good working order.
- Educate workers about the sources and conditions that can result in CO exposure, including symptoms and controls.

The majority of exposures at DOE have resulted from the use of manlifts inside buildings. For example, on April 25, 2003, at the Lawrence Livermore National Laboratory, work crews using a manlift to check smoke detector heads near a ceiling were exposed to increased levels of carbon monoxide. One worker was administered oxygen. Monitoring indicated 850 ppm carbon monoxide at ground level. (ORPS Report OAK--LLNL-LLNL-2003-0017)

A grim reminder of the dangers of carbon monoxide stemmed from the damage caused by hurricane Isabel on the east coast. Fatalities from carbon monoxide poisoning were reported in two incidents in Maryland involving the use of gasoline-powered portable generators following electrical power outages. In both incidents, authorities discovered portable generators operating in the basement of the homes. Two adults and a 3-year-old girl were asphyxiated, and two other adults were treated for carbon monoxide poisoning. A fact sheet on carbon monoxide poisoning is available from the OSHA website.

These events illustrate the potential hazards of operating equipment powered by internal combustion engines in poorly ventilated areas. In many cases workers do not realize that small gasoline-powered engines and tools present a serious health hazard. They may develop a false sense of safety because they've operated the equipment under similar conditions without incident. Construction and demolition activities throughout the DOE complex can present a work environment where using small gasoline powered equipment (e.g., saws, compressors, and generators) is necessary. The safety implications of their use should be considered when conducting job hazards analyses.

KEYWORDS: *Carbon monoxide, asphyxiation, health hazard, engine, ventilation, enclosed space, exhaust*

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