OPERATING EXPERIENCE SUMMARY

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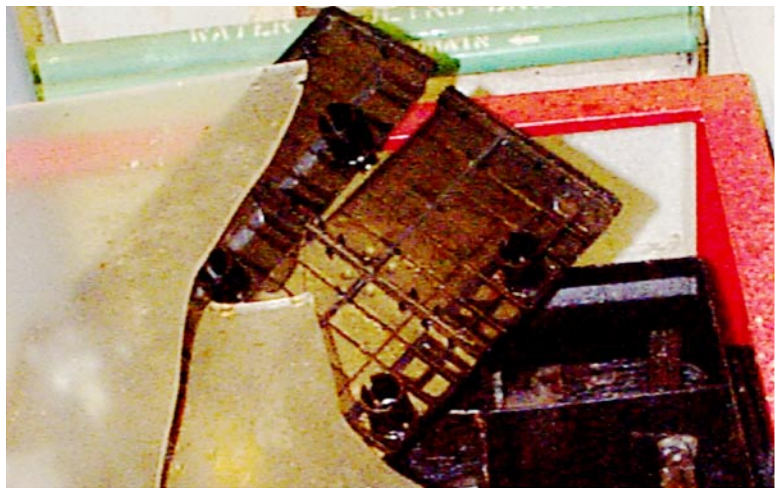

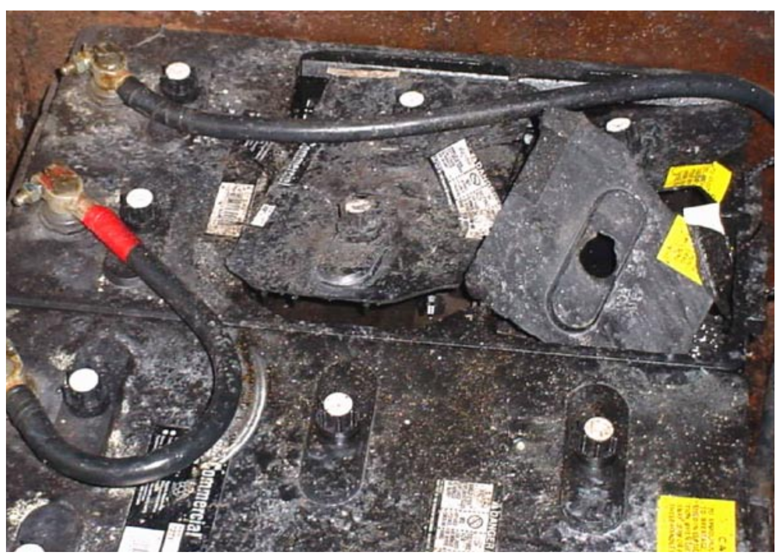

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OE Summary 2004-18

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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 recently began publishing 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. TYPE A ACCIDENT INVESTIGATION FOLLOWING FATAL FALL FROM LADDER

On July 15, 2004, at the Hanford Site, a non-government contract worker (i.e., visiting worker) assigned to prepare a mobile office for removal from the site was found lying motionless at the bottom of a ladder. The worker appeared to have fallen from the ladder; however, no one witnessed the accident. The worker suffered a serious head injury, and resuscitation efforts at a local hospital were unsuccessful. The Hanford Site Manager appointed a Type A Accident Investigation Board to analyze events leading to the fatality and to identify probable causal factors. (ORPS Report RL--PHMC-GENERAL-2004-0005)

Because there were no witnesses to the accident, the Board gathered evidence that would help them arrive at conclusions and judgments of need. Contributing factors to the accident are listed below.

- The worker apparently was standing on the ladder approximately 5 to 6 feet off the ground removing screws from the aluminum trim of an office trailer to prepare it for transport to its new owner. Figure 1-1 shows the ladder propped against the trailer.
- The worker had medical conditions that may have contributed to the apparent fall. Three days before the accident, he underwent outpatient exploratory surgery with general anesthesia, and reportedly he had collapsed twice the next evening.
- DOE Headquarters issued guidance in 1995 to the DOE Richland Operations Office (RL) on the disposition of excess property. This guidance stated that Hanford site personnel should move property that has been transferred to the Community Reuse Organization (CRO) to a CRO-controlled location for disposition. Had this guidance been implemented in contracting vehicles or site procedures, the visiting worker would not have been on site.
- The high temperature on the day of the accident was 98° F. The worker remarked about the heat to three different individuals that morning and stated that he became dizzy when bending over. None of the people he spoke to was sufficiently alerted to his condition to stop the work.
- Neither Fluor Hanford (the contractor responsible for managing excessed property at Hanford) nor DOE-RL had clearly defined roles and responsibilities for providing access control, safety training, or oversight to non-government contractors performing commercial work.
- Integrated Safety Management (ISM) principles did not flow down to non-government contractors in the areas of work planning, hazard analysis, development of hazard controls, and working within those controls.

Based on these contributing factors, the Board issued its report in August 2004, listing the following Judgments of Need that DOE-RL and Fluor Hanford management, in conjunction with some Headquarters elements, can implement to prevent future, similar events.

Figure 1-1. Ladder and trailer involved in the accident

- Identify the policy for, define, and establish authorities, accountability, and roles and responsibilities for non-government work activities at DOE sites.
- Establish policies for safe work performance and for applying ISM principles to site activities not governed by contract.
- Review formal and informal processes for applying ISM principles to non-government contract activity.
- Develop the personal property disposition process by formalizing and implementing procedures, training staff, and assessing program performance. Detailed procedures should address ISM, set expectations for CRO contractors, describe interfaces between involved site organizations and the CRO, and establish roles and responsibilities.
- Ensure that the site access process provides the appropriate badging, interfaces, and level of safety awareness for visitors doing work on site.
- Review the expectation for employees to stop work when they observe fitness for duty concerns as well as unsafe actions.

During the course of its investigation, the Board identified more than 20 previous falls from ladders over the past 18 months that had been reported in ORPS. Ten of the reported falls were near misses that could have served as lessons learned. OE Summary 2003-06 also reported the results of a Type B accident investigation at the Stanford Linear Accelerator Laboratory that resulted from a January 28, 2003, fall from a ladder.

This event serves as a caution that even the most straightforward events can have layers of underlying contributing factors. Not every accident can be eliminated, but management can address the underlying factors to prevent serious consequences.

KEYWORDS: *Ladder, fatality, medical condition, excessed equipment, property disposition, non-government contractor, heat stress*

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

2. ENERGIZED WIRING CUT DURING DEMOLITION

On August 30, 2004, at the Rocky Flats Environmental Technology Site, a journeyman electrician cut an electrical conduit containing energized 480-volt wiring with a cordless reciprocating saw, resulting in an electrical arc and a tripped circuit breaker. The conduit had been incorrectly marked for removal as part of an electrical strip-out evolution for building demolition. The electrician failed to perform a zero-energy verification as required before cutting. There were no injuries in this near-miss incident. (ORPS Report: RFO--KHLL371OPS-2004-0022)

The conduit to be cut extended through an overhead dry-walled ceiling, and the electrician and another worker ran a tape measure through a nearby hole to follow the conduit. They assumed that they had located the correct conduit, so the electrician entered the overhead area with his saw to cut it. He located what he believed was the conduit to be cut and confirmed that it had been marked with green tape, indicating it was cleared for cutting.

The method used to control the status of conduit in the building during demolition is marking conduit that is to remain (i.e., energized, do not touch) with red tape and conduit to be removed with green tape. The conduit the electrician cut was correctly marked with red tape as it exited a motor control center, but it was marked incorrectly with green tape on the other side of the wall in the overhead where electricians were removing conduit.

During the pre-job briefing for this work, the job foreman instructed the electricians to double and triple check all abandoned conduit before cutting. The electrician believed that he had visually verified that the conduit had been air-gapped at the motor control center panel. However, the conduit was a continuous run of approximately 12 feet directly from the circuit breaker.

Always verify that electrical conduit is air-gapped and wiring is de-energized before cutting.

During the fact-finding meeting, participants learned that the electrician did not verify that the 120-volt circuit was de-energized before cutting (an electrical safety requirement), nor did he trace the conduit run back to its origin (circuit breaker) or to where it fed power to a transformer for lighting. The electrician stated that there was no location in the room where he could have performed a voltage check. However, subsequent to the event, a walkdown of the conduit identified an accessible port in the next room where verification could have been performed.

Investigators determined that during the marking and labeling activity another electrician had performed an inadequate walkdown of the electrical runs and incorrectly identified the conduit for removal. He labeled the conduit green above the ceiling and red below the ceiling. Compounding this mistake was the fact that there was no re-verification of the labeled conduit by a second verifier.

Corrective actions will include (1) conducting a second-check verification on marking, air-gapping, and zero-energy checks; (2) providing additional training for electricians on site requirements (focusing on walkdowns and hand-over-hand conduit tracing); and (3) putting a field engineer in place to oversee the workforce.

Two other events occurred at Rocky Flats in which conduit was incorrectly labeled and no zero-energy check was performed. On April 30, 2004, an electrician cut a conduit containing energized 24-volt wires for an operational pressure differential controller, resulting in alarms. The engineer who performed the initial walkdown for the work package inadvertently added the conduit to the removal list, indicating it should be removed. (ORPS Report RFO--KHLL-371OPS-2004-0011)

On August 15, 2002, an electrician cut conduit containing an energized 120-volt wire. Even though the conduit was "green tagged" as containing de-energized wires, the electrician failed to ensure that the wires were actually de-energized. The conduit had been green tagged before all of the requirements, such as air-gapping and voltage checking, had been completed. (ORPS Report RFO--KHLL-PUFAB-2002-0052)

In addition to conducting safe-to-work checks, it is very important to perform adequate field verifications of electrical systems. Fully inspecting all conduit branches for energized electrical hazards is essential, and failure to do so was a causal factor in another near-miss event at Rocky Flats. In that event, an electrician cut a conduit containing an unknown energized 120-volt line, generating a spark. All wires in the conduit were thought to have been checked de-energized; however, an energized wire entered the conduit at a "T" (condulet). The additional wire could have been identified if electricians had removed a cover plate on the condulet near the cut location. (ORPS Report RFO--KHLL-371OPS-2002-0039)

Safety Considerations for Electrical Demolition

- Has a thorough walkdown been performed to trace the conduit runs, verify configuration, and ensure boundaries are understood?
- Are there other circuits in the work area that must remain energized (including temporary power sources)? If so, are they correctly identified?
- Who will verify that circuits are correctly identified and de-energized?
- Have the circuits been air-gapped?
- Has a zero-energy check been performed on the circuits?
- Have all conduits and circuits been marked to indicate removal?
- Are cutting locations marked as necessary?
- Are trained electricians performing the demolition? If not are they available for support?
- Has a pre-job briefing reviewed the scope of the work and the working boundaries?
- Have all workers been reminded of their "stop work" authority?

These events underscore the importance of following all procedures and electrical safety requirements involving removal of electrical systems. Workers need to verify by physical inspection and instrument testing that the conduits and circuits are safe for cutting and removal. Workers also need to wear all appropriate personal protective equipment and maintain a questioning attitude for their own safety. The methodology for identifying and marking conduit is only as effective as the diligence of those trained and assigned to implement it.

KEYWORDS: *Conduit, energized, cut, saw, zero energy, electrical safety*

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

3. UNEXPECTED EXCAVATOR BUCKET RELEASES RESULT IN FATALITIES

Following a fatal accident caused by the unexpected release of an excavator bucket from a quick-coupling device on a hydraulic excavator, OSHA reviewed its Integrated Management Information System and identified 14 similar incidents in the last 6 years that resulted in 8 fatalities.

Quick couplers are after-market devices that enable contractors to quickly make attachment changes on hydraulic excavators. Most quick couplers have a lifting eye that is used for lifting materials (Figure 3-1). When the bucket is removed, the lifting capacity of the excavator is increased by the weight of the bucket, and the operator's line of vision is improved during lifting. Many contractors like to use a large bucket for the bulk of the digging, changing to a smaller bucket for fine tuning and work in tight areas. Quick couplers also allow the operator to replace a bucket attachment with various other attachments.

The fatal accident that prompted the OSHA review occurred at a commercial site in

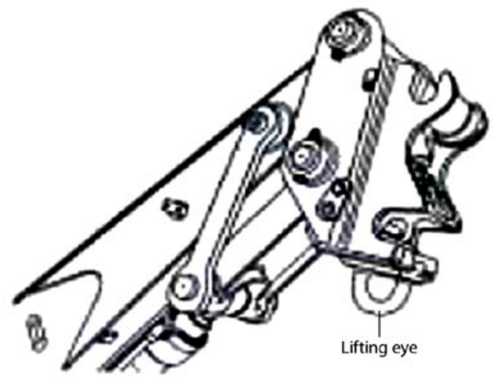

Figure 3-1. Lifting eye

Wisconsin, where a contractor was installing water mains and lateral service lines. After excavating the lateral line, the excavator operator changed buckets using a quick coupler to resume digging the main water line. When the operator swung the excavator to continue excavating the main line, the bucket detached from the quick coupler and rolled or slid into the lateral excavation. The bucket struck a worker who had entered the lateral excavation site to install the piping, killing him. Investigators determined that a locking pin, used to prevent accidental release of the bucket attachment, had not been manually installed on the coupler.

In many cases, unexpected bucket releases appear to be the result of users failing to properly engage and lock the quick couplers. Manufacturers of quick couplers recognize the hazards of unexpected releases of the bucket or attachments from these couplers, and most of them provide users with a retrofit locking pin (Figure 3-2). The pin is inserted manually behind the front or rear lever of the couplers to prevent unintended releases.

The National Institute for Occupational Safety and Health (NIOSH) has also studied the hazards associated with hydraulic excavators. The NIOSH publication, Preventing Injuries When Working with Hydraulic Excavators and Backhoe Loaders (DHHS Publication No. 2004-107), describes a fatal accident involving a laborer who was struck by the bucket of a hydraulic excavator.

The victim, a co-worker, and an operator were using an excavator equipped with a quick-disconnect bucket to load concrete manhole

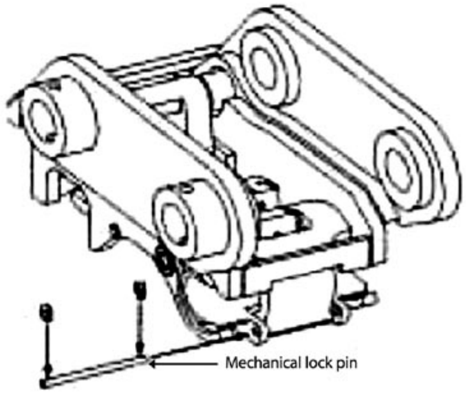

Figure 3-2. Retrofit lock pin

sections onto a truck. The victim was on the ground connecting the sections to the excavator while his co-worker was on the truck waiting to disconnect the sections after loading. The operator positioned the excavator bucket near a manhole section while the victim attached a three-legged bridle to the manhole section to lift it. The bucket unexpectedly disconnected from the excavator stick, struck the victim, and killed him. Figure 3-3 shows the bucket on the ground after it detached from the excavator stick.

Unintended releases of buckets from quick couplers appear to continue because not all users are aware of the hazard. Workers and contractors may not know that manufacturers have retrofitted existing couplers, designed new, improved quick-coupler systems, and developed safe-use and operating procedures for the couplers. In addition, some users fail to retrofit the quick coupler with locking pins, and some are not sufficiently trained on installing and testing these couplers.

Figure 3-3. Excavator and dropped bucket

An OSHA Safety and Health Information Bulletin, *Hazards of Unintended Release of Buckets from Quick Couplers on Hydraulic Excavators,* urges employers to inspect quick couplers and take appropriate measures to prevent unintended bucket releases. The bulletin also includes sketches of a retrofit locking pin and the correct pin insertion points. OSHA suggests taking the following precautions to prevent unintended bucket and attachment releases.

- Inspect all quick couplers to determine if they are subject to unexpected release hazards and whether the manufacturer has provided a locking pin and procedures for manual installation.
- Obtain and install manufacturer-recommended retrofits, including positive locking pins and other devices.
- Consider using newer-model quick couplers specifically designed to prevent unintended releases.
- Follow manufacturer's recommendations for maintenance, inspection, and installation of quick couplers.
- Test coupler and attachment connections every time an attachment is made.
- Train workers on using quick couplers correctly, making visual inspections, and following procedures for engaging attachments and testing connections.

These events indicate that when quick-coupling devices are used on excavators all precautions should be taken to ensure the safety of workers. Quick couplers should be inspected to ensure that the retrofit pins are available and installed, and the manufacturer should be contacted to obtain the pins if necessary. Workers who use hydraulic excavators with quick couplers should be alerted to the possibility that connected attachments can unexpectedly release if necessary corrective actions have not been taken, and supervisors should detail actions for preventing unintended releases.

KEYWORDS: *Excavator, quick coupler, quick disconnect, fatality, bucket, drop*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Provide Feedback and Continuous Improvement*

4. NEAR MISS: LEAD-ACID BATTERY FAILURE

On July 15, 2004, at the Savannah River Site, a battery for a standby diesel generator failed during a diesel start test, resulting in the spill of approximately 24 ounces of battery electrolyte (sulfuric acid). The battery had been in service beyond its warranty period when an internal failure occurred. There were no injuries as a result of this event. (ORPS Report SR--WSRC-FBLINE-2004-0004; final report filed September 30, 2004)

Maintenance workers were in the process of conducting a no-load test of the diesel generator following preventive maintenance on the battery and battery charger. When the diesel start signal was initiated, they heard a loud "bang" at the battery box and saw liquid leaking from the box. Figure 4-1 shows the battery box. A sizzling, electrical noise could be heard coming from the batteries, so they opened the battery disconnect switch to isolate the batteries from the diesel start circuit, and the electrical noise ceased. The workers initiated a spill response, and responders positioned spill control pillows and applied soda ash to the spilled liquid to neutralize the electrolyte.

Figure 4-1. Battery box containing failed battery

As part of the investigation, the failed battery was shipped to NAPA Batteries/Exide Technologies (manufacturer) for examination. The manufacturer found advanced grid corrosion, positive grid growth, cracked positive grid frames, and open welds; all of which are consistent with batteries that have served their expected life. The 30-month battery had been in service for 38 months. Investigators believe that constant charging current could have contributed to internal component degradation that ignited hydrogen gas inside the battery. Figure 4-2 shows a close-up of the failed battery.

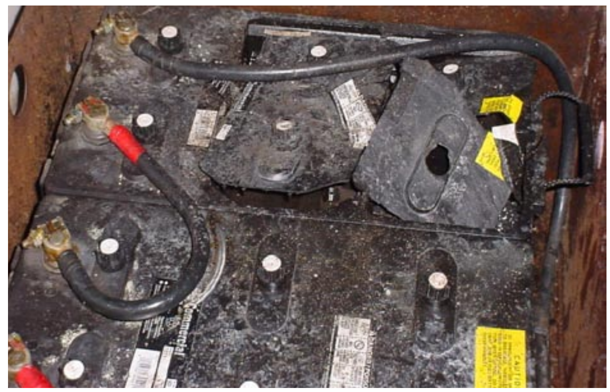

Figure 4-2. Damaged top of failed battery cell

Corrective actions included evaluating the adequacy of the preventive maintenance frequency for battery replacement based on the published warranty life. The service life of similar batteries in other systems/plant areas where catastrophic failure is possible will also be evaluated. Consideration will be given to replacing NAPA batteries within 30 months from initial installation. Some systems use Caterpillar batteries, and they will replaced within 36 months of installation.

Two other battery-explosion events occurred at Savannah River in 2001. On August 22 and 29, batteries exploded during the startup of identical diesel-powered air compressors. The battery manufacture (Douglas) discovered a manufacturing defect. The Douglas batteries used in diesel generator applications were replaced with NAPA batteries. (ORPS Reports SR--WSRC-FSSDGEN-2001-0001 and 0004)

Similar events resulting from aging and inadequate preventive maintenance occurred at the Idaho National Engineering and

Environmental Laboratory (INEEL). On July 16, 2001, while performing a weekly preventive maintenance start of a diesel fire pump, an explosion occurred in one of the two independent banks of 12-volt batteries. The explosion expelled debris and battery acid, which struck the mechanic who was attempting to start the engine. Investigators determined that the battery end-of-life cycle resulted in the failure. The battery had been in service for almost 8 years. One of the cells had very low electrolyte levels and a specific gravity of 1.02, while other cells were over 1.25. The low level of electrolyte allowed chemical buildup on the top of the plates sufficient enough to allow an arc to occur. (ORPS Report ID--BBWI-RWMC-2001-0016)

On March 8, 1999, a battery exploded while workers were starting a diesel-driven fire pump for a weekly test run at INEEL. An operator was 20 feet away when the battery ruptured, spilling a quart of acid on the floor. The battery had not been inspected for 18 months and had been in service for 5 years. Figure 4-3 shows the damaged battery bank.

Figure 4-3. Damaged plastic cover over battery bank

An inspection of the battery indicated that the electrolyte levels were low and corrosion had formed around a fractured bus bar inside the battery. The battery manufacturer believes that low electrolyte contributed to lead corrosion and expansion inside the battery case that fractured the bus bar. The fractured bus bar produced an arc that ignited battery gases when the operator attempted to start the diesel fire water pump. (ORPS Report ID--LITC-CFA-1999-0003)

Battery overcharging can also lead to failures from the buildup of explosive hydrogen gas, as shown in the following Hanford events. (SELLS Identifier: 2000-RL-HNF-0034) On January 27, 2000, the cell caps blew off of a battery on a standby diesel export pump. Investigators concluded that sediment buildup in a battery cell caused it to short circuit resulting in an overpressure condition. On April 13, 2000, a battery on a different diesel exploded, blowing pieces off the top of the battery. The pieces were contained by a Plexiglas® battery enclosure. In both events, the batteries were overcharging. Operator round sheets did not identify normal charging voltage and amperage; therefore, excessive charging rates went undetected.

Battery life span depends on usage. Only about 30 percent of all batteries actually reach their stated service life. Eighty percent of all battery failures result from sulfation (lead sulfate) buildup that can harden on the plates of a partially or fully discharged battery. As batteries age, corrosion on the plates can increase and reduce the distance between positive and negative plates. Cells begin to degrade and battery voltage will drop, causing the battery charger to produce more current that could boil off electrolyte, thus exposing the tops of the plates.

DOE-HDBK-1084-95, *Primer on Lead-Acid Storage Batteries*, provides information on the operation, construction, and maintenance of lead-acid batteries. A good maintenance and inspection program should be based on the recommendations in ANSI/IEEE Standard 450, *IEEE Recommended Practices for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations* and on those in DOE-STD-3003-94, *Backup Power Sources for DOE Facilities*.

These events illustrate the need for proper service and inspection of lead-acid batteries and the importance of monitoring service life. When properly maintained batteries can function for many years, but replacement should be considered as batteries approach the end of the manufacturers' specified service life.

KEYWORDS: *Battery, acid, rupture, hydrogen, electrolyte, failure, inspection, maintenance, near miss*

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
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
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control