OPERATING EXPERIENCE SUMMARY

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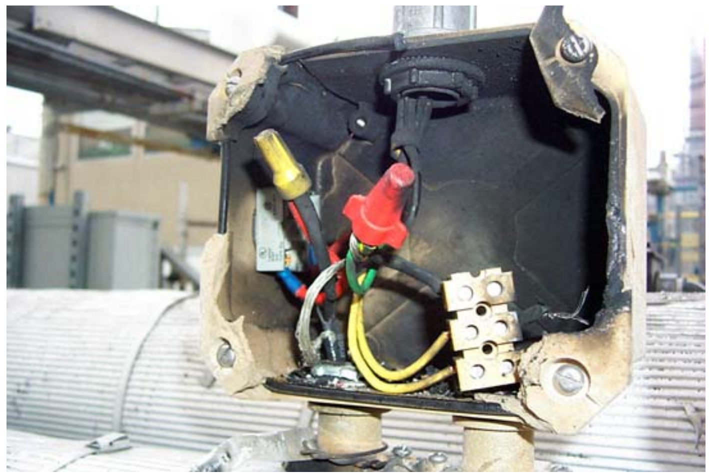

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The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy complex by encouraging the exchange of lessons-learned information 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.

The first six Just-in-Time reports were prepared as part of the 2004 Electrical Safety Campaign.

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.

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://tis.eh.doe.gov/paa/reports.html.

EVENTS

1. *AZTEC BATTERY CHARGERS MAY APPLY VOLTAGE TO METAL CASES*

On April 6, 2004, at the Hanford Site, an engineer replacing batteries in a leakage tester felt a slight "hair-raising" sensation on his arm and asked an instrument technician to perform a voltage check to verify whether there was an electrical problem. The AZTEC battery charging unit he was using was plugged into 110 VAC and connected to the leak detector to charge newly replaced batteries. An instrument technician performed a voltage check on the metal case of the tester and found that the voltage measured 63 VAC across the case to the ground. Investigators determined that the AZTEC battery charger was the source of the voltage. (ORPS RL--PHMC-PFP-2004-0006)

The AZTEC NiCad charger has a two-wire, two-prong-plug cord. The standalone cord is similar to a personal computer power cord, with a male plug on one end and a receptacle at the other that plugs into the unit (Figure 1-1). These chargers are often used to charge various general purpose batteries such as those used in the leakage tester. Figure 1-2 shows the AZTEC Model SA 45-3109 standalone battery charger the engineer used.

When the technician tested the charger, he expected a reading of 24 VDC across the charger output connector (i.e., the plug); instead, voltage measured 63 VAC. He installed a new charging unit, and the case to ground potential disappeared. Three additional faulty units were found in the facility, and all four were removed from service.

Figure 1-1. Charger plug and connector

Figure 1-2. Model SA 45-3910 Battery Charger

Investigators contacted a representative from AZTEC to determine if the manufacturer was aware of any problems with the chargers. He implied that if a power cord with a three-wire plug (one ground wire) were used, the potential for a shock hazard would be alleviated.

The technician tested all four of the AZTEC chargers in the facility, substituting the three-wire power cord, which has a ground plug, for the two-prong plug. When he connected the charger to the leak tester, there was no AC component at the charger and no potential, either AC or DC, between the case and the ground. Investigators concluded that the two-wire, two-prong power cords created the voltage excursions. They destroyed all the cords with two-pronged plugs, and supervisors directed that only three-pronged plugs are to be used in the future.

To address this and any similar problems with the charger, a new Automated Job Hazards Analysis was written identifying the potential shock hazard when using the AZTEC chargers. The work package was also modified to include a step that directs the Instrument Technician to check the battery charger with a voltmeter before connecting it to the leakage tester. Additional information about this incident is available on the Lessons-Learned website (SELLS Identifier 2004-RL-HNF-0018).

Underwriters Laboratories (UL) Standard 1659, *Standard for Safety for Attachment Plug Blades for Use in Cord Sets and Power Supply Cords*, details requirements for the blades of attachment plugs and current taps intended to be the conductors of flexible cords using crimped connections and for use on cord sets and power-supply cords complying with UL 817, *Standard for Cord Sets and Power-Supply Cords.* UL requires that any product that contains features, characteristics, components, materials, or systems that involve a risk of fire, electric shock, or injury be evaluated using the appropriate additional component and end-product requirements needed to maintain the level of safety for the user of the product.

Although no similar events were found in the ORPS database, managers at facilities where AZTEC chargers are being used should be aware that the chargers may impress voltages onto equipment cases during charging if used with two-wire, two-pronged plugs. The appropriate precautions should be taken to ensure that any potential for an electrical shock is eliminated.

This event illustrates that caution should be exercised when performing even a simple task that may have a potential for an electrical shock. It also emphasizes the importance of workers maintaining a questioning attitude and taking appropriate action if they believe a safety issue may exist. At facilities where AZTEC battery chargers are used, supervisors should ensure that a three-plug, power cord with a ground wire is used with the charger and that workers use a voltmeter to check the charger before using it.

KEYWORDS: *battery charger, power cords, shock hazard*

ISM CORE FUNCTIONS: *Analyze the Hazards, Feedback and Improvement*

2. PERSONNEL ERROR CAUSES LASER EYE INJURIES

On March 14, 2003, at the University of California–Berkeley (UC–Berkeley) for Lawrence Berkeley National Laboratory (LBNL), a graduate student suffered a temporary eye injury while manipulating a power meter in the beam path of a pulsed infrared laser beam. The student, believing the alignment task was completed, was not wearing protective eyewear when a stray beam from an optic reflected into his eyes. Fortunately, the student suffered no permanent eye injury from this incident. (ORPS Report OAK--LBL-MSD-2003-0001)

The optic was unnecessary to the setup, and it is not known how or when it was inserted into the beam path. A pre-alignment survey would have detected this optic. Although these surveys are particularly important for a multi-user system, none was performed.

Investigators determined that configuration control for the laser and optics was inconsistently applied to this multi-user system. The inserted optic was not logged in the laser use book, and the entire path of the laser beam was not enclosed. The Laboratory has taken steps to improve coordination of laser activities between LBNL and UC–Berkeley, and has enclosed laser systems where possible

Another laser incident occurred on September 9, 2003, at Brookhaven National Laboratory (BNL) when a graduate student attempted to align a Class IV Pulsed Alexandrite Laser and sustained injuries to both eyes. A Class IV laser can cause acute skin and eye damage from direct as well as scattered/reflected light. Examination by an ophthalmologist revealed that both of the student's retinas were burned. (ORPS Report CH-BH-BNL-BNL-2003-0019; final report issued December 22, 2003)

The student was not wearing protective eyewear (Figure 2-1), and the beam was reflected into both eyes, causing blurry vision and white spots. The student has regained 20/20 vision in one eye with corrective lenses, which he also wore before the

Figure 2-1. Protective eyewear

accident; vision in the other eye is still improving. He has received a medical release to drive, read, and return to work with some limitations.

The Laboratory immediately stood down all laser activities following the incident, pending a Type B investigation. The investigation revealed a number of deficiencies in configuration control.

- The student was untrained and unqualified to perform this alignment. He had observed a similar alignment only once before and had not read or signed the laser operating procedures.
- Chemistry Department personnel installed and operated the laser without having the Laser Safety Officer register it or perform a required review. The BNL Standards-based Management System requires registration of lasers and a review of the space, interlocks, and laser alignment procedures.
- The Department's laser operating procedure and roles and responsibilities documentation were out of date.
- The Department lacked a formal process for notifying the Laser Safety Coordinator or the Environment, Safety, and Health Coordinator of laser acquisitions.

Similar events have also occurred at DOE sites in the past. On February 5, 1999, at Los Alamos National Laboratory, a research associate received a laser burn to his left eye from a diffusely reflected beam from a Class IV titanium-sapphire laser. At the time of the incident, the research associate and a co-worker were replacing optics in an optical train external to the laser. Neither worker was wearing protective goggles as required. (ORPS Report ALO-LA-LANL-FIRNGHELAB-1999-0001)

Another incident occurred in 1991 at Sandia National Laboratory–Livermore during an alignment. A laboratory employee who was not wearing protective eyewear was flashed in the left eye with diffused light when the laser beam struck a cut surface in the side of an aluminum beam alignment target. The target had originally been properly anodized to prevent reflecting of the beam; however, when the notch was cut reflective edges remained on the cut surface. The employee was aware that procedures called for coating the reflective edges with a non-reflective coating, but continued with the alignment procedure. Examination revealed no damage to the employee's eye. (ORPS Report ALO-KO-SNL-LVMRSITE-1991-0006)

In all four events, the injuries and near misses resulted from procedural errors and failure to wear appropriate protective eyewear. A DOE lessons learned report (1999-KO-SNL-0001) recognizes that the most accidents when working with lasers involved accidental eye exposure during beam alignment. Misaligned optics and failure to wear available eye protection were also common causes.

These types of occurrences are avoidable if laser safety requirements are followed. At Sandia, laser safety training and the development and implementation of Technical Work Documents (Safe Operating Procedures) are mandatory before personnel work with Class IIIB and Class IV lasers. Using appropriate eye protection is also mandatory when working with these lasers.

TECHNIQUES FOR PERFORMING LASER ALIGNMENTS SAFELY

- View the laser with a TV camera.
- View the laser with an image-converter view.
- Use a low-power alignment laser.
- Remove watches, rings, badges, and other reflective objects.
- Use beam blocks (secured to the table) to control reflections. This includes blocks for upward-directed beams.
- Wear laser protective eyewear.
- Have all unnecessary personnel leave the room or area.
- Identify and control stray beams.
- Reduce the primary beam power.
- Insert fluorescent material into the beam.

DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, endorses the exposure limits and technical requirements in ANSI (American National Standards Institute) Z136.1, *Standard for Safe Use of Lasers*. This standard provides guidance for safely using lasers and laser systems by defining hazard control measures for each class of laser. Laser classifications are used to signify the level of hazard inherent in a laser system and the extent of safety controls required. Lasers are grouped into four classes, from Class I (the least hazardous) to Class IV (the most hazardous). The standard also includes tables that summarize the maximum permissible exposure (MPE) level of laser radiation to which a person may be exposed without hazardous effects or biological changes in the eye or skin. MPE is determined by the wavelength of the laser, the energy involved, and the duration of the exposure.

A number of good practices to prevent laser accidents are identified by Lawrence Livermore National Laboratory, in guidance found at http://www.llnl.gov/es_and_h/hsm/doc_20.08/doc20-08.pdf

The most hazardous activity when working with lasers is beam alignment, and laser operators are advised to consider the techniques for performing safe alignments provided in the textbox.

Even when accessible radiation levels are considered to be safe, it is a good practice for laser personnel to wear eye protection when lasers are in use. Prescription eyewear should also be provided for those who need it. This eyewear is issued to one individual user, based on a current prescription (no older than 1 year).

In addition to eyewear, there are circumstances when protective clothing is warranted. Such clothing is necessary for operations in which direct-beam ultraviolet exposures exceed 10 seconds. Face shields and garments that cover bare skin must be worn. Clothing made from flame-retardant fabrics or from fabrics not easily ignited, such as silk or close-knit wool, should be worn during operations involving exposures to visible and infrared lasers where accessible beam irradiance exceeds 2 watts/cm^2.

Laser beam alignment presents a number of potential hazards. Careful adherence to safe practices, combined with use of protective eyewear at all times, will substantially reduce the number of injuries and near misses that can occur.

KEYWORDS: *Laser, eye protection, eye injury*

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

3. LACK OF GROUND FAULT PROTECTION LEADS TO FAILURE OF HEAT TRACE JUNCTION BOX

On February 16, 2004, at Oak Ridge National Laboratory, an operator investigated an unusual noise emanating from a heat trace junction box in an office trailer and found that the cover had burst, scattering pieces around the trailer. Operations personnel covered the box with plastic to protect it from the environment and applied a lockout/tagout to the system. Investigators believe that moisture intrusion near the 240-volt power source caused a ground fault in the heat trace line, which led to the box overheating and bursting. (SELLS Identifier Y-2004-OR-BJCOP-0301)

Figure 3-1 shows the junction box after the cover burst. When maintenance workers inspected the junction box and removed the piping insulation from the box to the power source, they determined that the heat trace had been installed

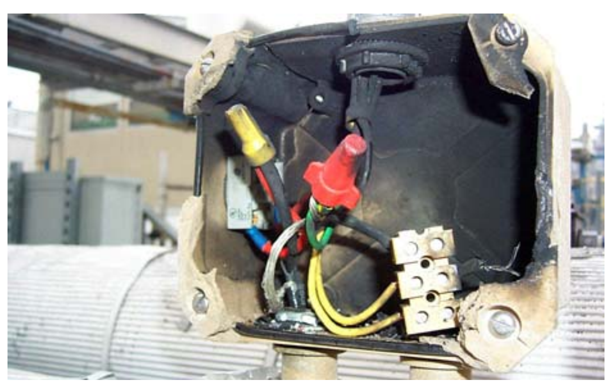

Figure 3-1. Junction box after the incident

correctly with aluminum tape over the heating cable running the length of the pipe. However, they saw one section of pipe where the heat trace had been burned.

Because they found no evidence of a short circuit, and the 20-amp circuit breaker did not trip, the maintenance workers believe that moisture entered the copper bus wire causing a ground fault in the heat trace line that spread the entire length of the heat trace, following the wiring to the next junction box. As the junction box overheated, the pressure of gases within the box caused it to burst and the electrical junction to

Figure 3-2. Shattered junction box cover

arc and fail. Figure 3-2 shows the pieces of the cover after workers retrieved them. Investigators determined that the most likely cause of the incident was the lack of ground fault protection for the heat trace. The system was installed in the mid-1980s under an electrical code that did not require ground fault protection. However, the current National Electrical Code® (NEC) requires ground fault protection, and newer maintenance manuals for the system recommend it when the power source will be exposed to moisture or water. Ground fault protectors will be installed on all heat trace systems currently in use at the site. More information and additional photographs on this event are available from the Lessons-Learned website (SELLS identifier Y-2004-OR-BJCBOP-0301).

An event that occurred on July 13, 2003, at the Savannah River Site, resulted from an incorrectly installed heat trace system for a recovery gas dryer system. In that event operators received reports of a peculiar odor coming from the new heat trace system about 2 hours after it was energized. Smoke coming from the piping insulation activated a smoke alarm. As firefighters removed sections of insulation from the heat-traced piping, flames developed. (ORPS Report SR--WSRC-TRIT-2003-0006)

Engineers checked the ground fault circuit breakers supplying the heat trace and determined they did not contribute to the event. Investigators later determined that the heat trace was not properly designed and installed. A length of piping was double-traced, rather than single-traced, and the thermocouple that controlled the temperature was too far from the double-traced area. This resulted in a hot spot that exceeded the design heat input.

The 2002 NEC details construction, installation, and safety requirements for electrical power conductors and equipment used in residential and industrial applications. The Code is very clear, and Article 427, *Fixed Electric Heating Equipment for Pipelines and Vessels,* cites the requirements for each component used in field-fabricated pipe tracing applications.

GOOD PRACTICES FOR HEAT TRACING SYSTEMS

- Ensure that heat trace system installers follow the NEC, state and local codes, and manufacturers' instructions and have proper ground fault protection.
- Ensure that heat trace systems are tested and inspected for proper operation and included in a preventive maintenance program.
- Ensure that seals and gaskets around junction boxes and control panels have not deteriorated, resulting in water intrusion and creating a potential fault condition.

Paragraph 427.22 of the NEC, "Equipment Protection," states that ground-fault protection of equipment shall be provided for electric heat tracing and heating panels. The NEC also requires the use of a ground-fault breaker for electrical heating requirements. Grounding requirements are detailed in 427.23, "Grounding Conductive Covering." The paragraph states that electric heating equipment shall . . . have a grounded conductive covering in accordance with either 427.23(A) or 427.23(B). Paragraph 427.23 (A) states that heating wires or cables shall have a grounded conductive covering that surrounds the bus wires, if any, and their electrical insulation. Paragraph 427.23(B) states that heating panels shall have a grounded conductive covering over the heating element and its electrical insulation on the side opposite that attached to the surface to be heated.

These events illustrate the necessity of ensuring that all heat trace systems are installed properly and in accordance with NEC requirements. The required ground fault protection should be provided for all heat trace systems and is essential when the systems will be used for moist or wet service.

KEYWORDS: *Heat trace, junction box, ground fault circuit interrupter, GFCI*

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

4. DOE JOINS NATION IN DECLARING MAY ELECTRICAL SAFETY MONTH

May is National Electrical Safety month, and the Deputy Secretary of Energy has designated it as Electrical Safety Month for DOE as well. During the month, the focus will be on promoting electrical safety across the complex to increase awareness about the risks of workplace electrical hazards and encourage complex-wide dissemination of lessons learned and best practices to minimize them. Although DOE has not had a fatality stemming from an electrical event since 1997, electrical near misses continue to occur at a frequency of two per week across the complex. The Deputy Secretary, during a complex-wide video conference with DOE managers, stated that electrical safety performance needs improvement.

In just the first quarter of 2004, 29 electrical safety events were reported; 16 of them were near misses. Seven of these events resulted in the electrical shocks described below.

1. A technologist at Sandia National Laboratory–Albuquerque received an electrical shock from the discharge of capacitors in a high-voltage power supply while he was setting up an explosive test. (ORPS Report: ALO-KO-SNL-2000-2004-0001)

2. A welder at Argonne National Laboratory–East received an electrical shock while using an arc welder without adequately grounding the work. The shock started in his right index finger, went across his chest, and down his left arm. (ORPS Report: CH-AA-ANLE-ANLEPFS-2004-0002)

3. A vendor employee at Oak Ridge Y12 received an electrical shock while testing electrical controls on a hydraulic press when he touched an energized wire on a terminal strip with his little finger. (ORPS Report: ORO--BWXT-Y12NUCLEAR-2004-0007)

4. A researcher at Ames Laboratory received an electrical shock when he touched a 110-volt wire while inserting foam insulation into an energized relay box without authorization. (ORPS Report: CH--AMES-AMES-2004-0001)

5. An instrument technician at Hanford received an electrical shock when the back of his hand touched a 110-volt terminal while troubleshooting an alarm module. (ORPS Report: RL--PHMC-FFTF-2004-0001)

6. A subcontractor at Hanford received a mild shock while removing a 90-volt DC plug-in power cord to two Servo motors for a concrete saw because the cable connectors were not effectively grounded. (ORPS Report: RL--PHMC-CENTPLAT-2004-0001)

7. A laborer at Rocky Flats received a minor shock while disassembling office cubicles because an unidentified 110-volt circuit was not isolated. (ORPS Report: RFO--KHLL-FACOPS-2004-0001)

In April 2004, the Office of Environment, Safety and Health published an Operating Experience and Lessons Learned Report, *Electrical Safety*, as part of an electrical safety campaign. The report is based on a review of over 200 electrical events that occurred during 2002 and 2003. Thirty-five of these events involved electrical shocks, and six resulted in electrical burns.

The report addresses events at DOE facilities that occurred while performing electrical, non-electrical, and excavation/penetration work, as well as those that occurred during vehicle movement near overhead power lines. Several examples are cited for each of these work activities. Commonly made electrical safety errors, along with measures for their prevention, are also identified in the report.

Electrical Safety also includes a valuable section addressing safety responsibilities for all workers who perform tasks that may involve electrical hazards. The section provides a list of questions (developed from lessons learned) that managers, work planners, supervisors, electrical workers, non-electrical workers, vehicle drivers/equipment operators, and spotters should ask before performing electrical work. Answering these questions before work begins may prevent electrical shocks. The following are some examples of the questions listed in the report.

- Has approval been given to work on energized equipment/circuits?
- Has personal protective equipment been provided or have other measures been taken to prevent risks from undetected energized circuits?
- Have checks been made to verify that electrical circuits and equipment are not left in an unsafe condition?

The report on electrical safety can be accessed at the Office of Environment, Safety and Health website http://tis.eh.doe.gov/paa/reports.html.

These persistent electrical safety events underscore the need for continued improvement in human performance. Electrical events typically occur because of equipment failures, unsafe conditions, or unsafe acts. Equipment failures may not be completely preventable, but they can be managed through routine inspection, testing, and preventive maintenance. However, unsafe conditions and unsafe acts, which cause the majority of electrical events, are preventable. Prevention strategies should include thorough planning of electrical work, continuing electrical safety training, effective conduct of operations, communication of management's expectations and enforcement of electrical safety policies, identification of unsafe electrical conditions (housekeeping), and improved configuration control of electrical systems.

KEYWORDS: *Electrical safety, shock, near miss, volt, arc, burn, energized*

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

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