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

OPERATING EXPERIENCE SUMMARY

Office of Environment, Safety and Health

Summary 2002-02
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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.

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

Operating Experience Summary 2002-02

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EVENTS

1. CHLORINE DIOXIDE EXPLOSION AT LABORATORY

On January 8, 2002, at the Los Alamos National Laboratory, a reaction vessel containing chlorine dioxide (ClO_2) exploded inside a chemical hood while chemists were conducting an experiment to develop a method for synthesizing chlorine dioxide in a form that would allow safe storage and transport. Chlorine dioxide is known to be highly reactive and sensitive to multiple types of initiation energies, such as temperature, pressure, static electricity, contaminants and sunlight. One chemist received minor scratches, and the other was uninjured. (ORPS Report ALO-LA-LANL-CHEMLASER-2002-0001)

During the experiment, one of the chemists monitored the pressure and temperature of the pressure vessel (ClO_2 generator), which was certified for 3,000 pounds per square inch. He noticed the temperature rising from the ideal temperature range of 40˚C to 80˚C. At that time, he called to the other chemist and told him to get out of the room. He then stepped out the door next to the chemical hood and isolated the chlorine gas supply line. At that time, the experiment exploded, destroying the vessel and hood, and severely damaging other equipment in close proximity. At that point, the chemists evacuated the building and called 911. They were transported to Occupational Medicine, where they were evaluated and released without restriction. As a precaution, the Emergency Management and Response Incident Command supervised a controlled release of all non-essential personnel from the adjacent operations area.

DOE has directed the Laboratory to conduct an accident investigation. An update of this event and lessons learned will be published in the OE Summary after the final investigation report has been issued.

2. NEAR MISS FROM EXPLOSION IN MICROWAVE OVEN

On October 8, 2001, in a laboratory at the Oak Ridge National Laboratory (ORNL) West Complex, sealed glass tubes containing ferric chloride and hydrochloric acid exploded while being heated inside a microwave oven. The explosion broke the glass turntable in the microwave oven, opened the oven door, and released glassware fragments and chemicals outside the oven. Researchers for the experiment were standing near the oven while this occurred; however, no one was injured or contaminated. The contractor reported this as a near miss occurrence. (ORPS Report ORO--ORNL-X10WEST-2001-0012).

The experiment's principal researcher purchased a household microwave oven from a local department store for the experiment. The conventional oven he had used previously took several hours to heat the chemicals, and he hoped that a microwave oven would reduce the heating time to a few minutes. While the operating manual for the household microwave oven clearly cautioned against heating closed containers and chemicals, the researcher ignored these warnings. In preparing samples to heat in the microwave oven, he placed one-half milliliter of a ferric chloride and hydrochloric acid solution into each of four thin Pyrex® tubes that were four to five inches long and heat-sealed the ends. The researcher believed that the small amount of liquid in the glass tubes would not cause pressures to exceed the 400 to 500 pounds per square inch pressure-retaining capability of the tubes. However, he did not perform a design analysis and failed to enlist the aid of a subject matter expert to verify his assumption. Subsequent calculations showed that he grossly underestimated the air space needed to accommodate the expansion of the solution from a liquid to a gas.

The researcher placed the tubes inside the microwave oven, set the oven at 60 percent power for two minutes, and waited beside the microwave oven while an assistant stood in front. The tubes exploded after about one minute, opening the oven door and splattering liquid chemical about 1 foot, which fortunately was not far enough to hit the researchers. Glass stained with ferric chloride landed near the assistant, but he was not injured. Both researchers were wearing safety glasses.

A subsequent investigation of this occurrence found that not only had the use of a microwave oven in this experiment not been subject to a design review by subject matter experts, but neither had the previous use of a conventional oven. The investigators determined that the root causes of the event were deficient work planning and inadequate hazards analysis.

During 1999, bioassay laboratories at the Savannah River Site experienced three separate explosions of sealed vessels inside microwave ovens. During the most recent explosion, on December 13, 1999, the sealed ceramic container of a fecal sample burst, breaking the glass turntable in the microwave oven and opening the oven door. A subsequent investigation found that an electrical short in the pressure transducer prevented accurate monitoring of the vessel's pressure, and that the vessel's rupture disk had failed to function. The microwave oven was designed for laboratory use and had a safety device that restricted the opening of the door to a few inches. Although glass and other material fell onto the laboratory floor, the restricted door movement kept workers nearby from being injured. (ORPS Report SR--WSRC-LTA-1999-0039, OE Summary 2000-1).

These occurrences show that heating sealed containers or chemicals inside microwave ovens is hazardous. The ORNL occurrence illustrates the importance of hazard analyses and design reviews for laboratory experiments. Personnel selecting and using laboratory equipment should consider the hazards analyzed as well as the manufacturer's recommendations.

KEYWORDS: *Microwave oven, laboratory, explosion*

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

3. SUBCONTRACTOR STRUCK ON HEAD BY PORTABLE FLOODLIGHT

On December 5, 2001, at the Fernald Environmental Management Project (FEMP), two subcontractor equipment operators were positioning and preparing a light tower (portable floodlight) for use when the mast fell, resulting in a head injury to one of the operators. The equipment operator received a glancing blow that knocked him to the ground and resulted in a laceration of the scalp. He did not lose consciousness, and was taken to an offsite hospital for evaluation and treatment. The operator was released by the hospital and returned to finish his shift. Neither equipment operator was wearing a hard hat, which was required by the work plan. The final ORPS Report on this event was filed on January 23, 2002. (ORPS Report OH-FN-FFI-FEMP-2001-0017)

Figure 1. The light tower in the lowered position

The equipment operators were positioning a TEREX® Amida 3-section, telescoping light tower to provide additional lighting for a parking area. This particular model (TX3000) uses a single-winch system to raise and lower the mast vertically and horizontally. A spring-loaded locking device, consisting of a sliding bar that is tapered on one side, can be locked in the engaged position by a locking pin. This allows a single winch to perform two operations: (1) telescoping the mast sections vertically, and (2) raising and lowering the mast sections (in the retracted position) from the horizontal transport position to the vertical position. Figure 1 shows the light tower in the lowered horizontal position, and Figure 2 shows a typical light tower in the fully raised position.

After raising the mast, the equipment operators noticed that one lamp was aimed skyward and required adjustment. One of the operators turned the crank to lower the mast vertically until the sections of the mast were seated. He then inserted the spring-loaded lock pin to secure the mast sections in place and released the vertical lock pin to allow the mast to be lowered horizontally. When the mast was at approximately a 15-degree angle above horizontal, it suddenly fell to the horizontal position and extended approximately 42 inches. The other operator, who was standing outside the expected fall area of the mast, was struck on the top right side of his head and was knocked to the ground. The operator who lowered the mast immediately began to administer first aid to his co-worker, who suffered a scalp laceration approximately three inches in length.

Figure 2. A typical light tower in the fully raised position

The Site Project Safety and Health Manager directed that the position of the fallen light mast not be altered until further details about the incident were known, that the supplier or manufacturer of the light tower be contacted to see if there were any known problems related to the mast, and that all light towers at FEMP be secured immediately.

A site investigation indicated that the direct cause of the injury was failure to follow procedure because the equipment operators were not wearing hard hats when the injury occurred. Although the work area does not require the use of personal protective equipment (PPE), the project-specific safe work plans and safety programs did require the use of proper PPE, including hard hats, when working on equipment.

Additionally, the equipment operator who was struck was standing in front of the lowering mast, although outside the radius of its retracted configuration. The project-specific safe work plan directs personnel to perform work from outside the normal travel range of the part or attachment.

A contributing cause of this occurrence was "inattention to detail" because investigators determined that the sliding bar was not fully engaged and was not locked into the inner sections when the mast was lowered. It was noted that the manufacturer's diagram on the mast does not clearly depict the fully locked bar configuration for the safe lowering of the mast. Also, this was the first time the equipment operator had operated this type (single-winch) of light tower, and he did not consider it necessary to refer to the operator's manual. Figure 3 illustrates the locking mechanism.

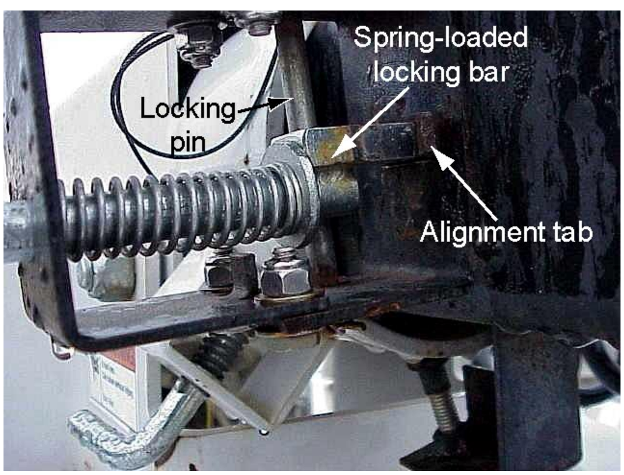

Figure 3. The locking mechanism

Investigators determined the root cause of this occurrence was "inadequate or defective design." A manufacturer's design engineer met with subcontractor and Fluor Fernald personnel to evaluate the incident. A replication of the sequence of events, as described by both equipment operators, resulted in a duplication of the occurrence. The design engineer could not confirm the designed configuration of an alignment tab, but did acknowledge that the tab appeared to have been bent and that the function of the safety pin and retaining washer could easily be defeated. He added that he believed that the mast spring-loaded locking device design was not intended to allow as much freedom of movement as could be seen with this sliding bar. The light tower involved in this incident, as well as five other light towers by the same manufacturer that were on site, allowed the spring-loaded locking bar to be disengaged and turned 90 degrees, even with the locking pin inserted behind the retaining washer on the spring-loaded locking bar.

As a result of the investigation, all single-winch light towers were removed from service at FEMP, and will be replaced with double-winch units from a different manufacturer. The two-winch units are considered to be safer than single-winch light towers. Safety precautions were also developed for all Fernald personnel involved in using light towers. Additionally, hardhat requirement labels will be affixed to all light towers site-wide. It is suggested that personnel at DOE facilities review the use of single-winch light towers in service at their sites to ensure that similar accidents do not occur.

KEYWORDS: *Light tower, portable floodlights, injury, defective design, procedure, inattention to detail*

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

4. 480-VOLT WIRES EXPOSED DURING DEMOLITION PROJECT

On November 12, 2001 at the Rocky Flats Environmental Technology Site, a demolition crew destroyed a guard tower using an explosive device. The tower fell immediately, and debris rolled onto a 480-volt junction box containing wiring that fed the Perimeter Security Zone lighting system. The wiring inside the junction box was controlled by a photoelectric sensor that was designed to de-energize the lights during daylight hours. A final ORPS report for this event was filed on December 21, 2001. (ORPS Report RFO--KHLL-FACOPS-2001-0006)

Shortly after detonation, a front-end loader was used to move the tower rubble so that the excavation crew could visually observe the scene and ensure that all explosive charges had been detonated. The junction box, which protruded slightly above ground level, was damaged during the clearing operation, causing the conductors to become exposed. Several days later, a team of excavation specialists preparing for removal of the tower foundation discovered that the junction box had been damaged, and observed several exposed wires. The specialists checked the sites where two other towers had been demolished on the same day, and no other damaged electrical equipment was found.

The 480-volt wires were exposed from about noon on Saturday until Monday morning, when the condition was discovered. A photoelectric sensor, designed to de-energize the lights during daylight hours, controlled the wiring inside the junction box. Because of the remote location of the tower and the time of day that the demolition took place, the potential for electric shock was low. However, the photoelectric sensor represented the only remaining barrier to an electric shock event after other barriers had been compromised.

The direct cause of this event was personnel error – inattention to detail. The junction box containing wiring for the perimeter lighting system was originally determined to be out of the way of the designated fall path and at a sufficient distance away from the structure that it would not pose a hazard when the tower fell. Therefore, the electrical hazard was not addressed in the activity hazard analysis. Project management did not anticipate or make allowances for a subsequent field change in the work plan (described below) that caused the junction box to be in the fall path of the tower debris.

The contributing cause was determined to be inadequate administrative control. The demolition contractor requested a change to the plan that would cause the tower to fall at a location 90 degrees different than originally proposed due to irregularities in the structure of the tower. Following a document review conducted in the field, the project manager approved the change, and work commenced to detonate the tower. The change in work activities presented another opportunity to perform a more thorough review and analyze the previously unrecognized hazard.

The root cause of the event was determined to be a deficiency in work organization and planning related to the failure to include the junction box in the recognized set of hazards during pre-job planning. Work planners need to ensure that adequate controls are in place and require a thorough review of all work activities and anticipated hazards.

Work planning documents and proposed job activities must be carefully evaluated for hazards that may be introduced when a level of uncertainty exists. Because demolition work using explosives had not previously been performed at the site, the increased level of uncertainty should have led to a more thorough job review. Failure to perform adequate pre-job planning in a rapidly evolving environment can result in unsafe conditions. Work should not commence until there is a thorough understanding of the hazards involved and corresponding controls have been implemented.

KEYWORDS: *Energized circuit, electrical, junction box*

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

5. SUBCONTRACTOR OBSERVED WORKING WITHOUT FALL PROTECTION

On November 5, 2001 at the Portsmouth Gaseous Diffusion Plant, a safety inspector observed two subcontractor workers performing overhead activities from an elevation of about 10 to 12 feet without fall protection. One worker had used a ladder to access a pipe chase, stepped from the ladder onto the piping, and was not tied off or wearing a safety harness. The inspectors terminated the work and initiated an investigation into the noncompliance. No one was injured in this event. (ORPS Report ORO--BJC-PORTENVRES-2001-0017)

Two subcontractor workers were installing an electrical connection in an existing facility without engineering drawings to specify location and configuration. The work package contained a scope of work description and an activity hazard analysis. A pre-job safety briefing was held. The hazard analysis did not address the need for fall protection, as the workers had a lift platform available from which to perform overhead activities. During the course of the work, the lift broke down. The workers were temporarily sent away to complete other jobs and subsequently returned to the work site. Their supervisor was working with another crew in a different building at the time, and also had jobs and crews in other buildings.

Because the workers were left to rely on skill-of-the-craft (instead of engineering drawings) to perform the work, they decided to use a ladder to reach the pipe chase and then roll from the ladder onto the piping. There wasn't enough space to stand above the pipes, nor was there an approved tie-off point for a lanyard. The worker who climbed onto the pipe chase chose to lie on his back to make the electrical connection. The worker commented that it had been common practice (without fall protection) to work in such a fashion while working for the United States Enrichment Corporation, where both workers had received fall protection training.

After the incident, both subcontractor employees were given a remedial course in fall protection (Lesson Plan # 11915, based on BJC-EH-2003, Rev. 0, *Elevated Working Surfaces and Fall Protection,* and Wastren's procedure SH-A-2003, *Elevated Work/ Fall Prevention*, Rev. 0). The lesson plan notes that a harness and lanyard should be used when working at elevations greater than 15½ feet. This height appears to be inconsistent with the height requirement stated in the Occupational Safety and Health Administration (OSHA) standards, 29 Code of Federal Regulations (CFR). For example, 29 CFR 1926.501, *Duty to Have Fall Protection*, requires employers to determine that walking/working surfaces have the strength and structural integrity to safely support their employees. The regulation further states, that each employee on a walking/working surface with an unprotected side or edge that is 6 feet or more above a lower level must be protected from falling by a guardrail system, a safety net system, or a personal fall-arrest system.

The workers claimed that the type of fall protection available to them would have allowed them to hit the floor had they used it because they were 12 feet above the floor. The comment was made in the event critique that they could have wrapped the lanyard around the pipes to take out some of the slack, however that was not an approved tie-off for this job. In fact there were no approved tie-off points.

Skill-of-the-craft latitude should not be given if the required safety equipment specified in the work package becomes unavailable during the work activity, as this could significantly impact the safety precautions required during the performance of the work. The activity hazard analysis was insufficient for the scope of work. In addition, the supervisor was overseeing work in five different buildings at the same time, and could not adequately advise the workers.

KEYWORDS: *Fall protection, work packages*

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

6. DOE CITES FLUOR FERNALD, INC. FOR NUCLEAR SAFETY VIOLATIONS

On January 4, 2002, DOE issued a Preliminary Notice of Violation (PNOV) against Fluor Fernald, Inc., contractor of the Fernald Environmental Management Project (FEMP). This action is a result of a series of procedural nuclear safety violations of the Occupational Radiation Protection Rule (10 CFR 835) (NTS Reports NTS-OH-FN-FFI-FEMP-2000-0005 & -0006) and the Quality Assurance Rule (10 CFR 830.120) (NTS Reports NTS-OH-FN-FFI-FEMP-2001-0003 & -0004) at the Fernald Waste Pits Remedial Action Project (WPRAP). The deficiencies were brought to light from DOE's evaluation of several problems and events occurring during calendar years 2000 and 2001 and from a recent DOE-FEMP review.

Section I of the PNOV relates to the elevated airborne radioactivity levels at the WPRAP T321 trailer. The violation includes multiple radiological program deficiencies associated with the event; namely, the lack of appropriate air monitoring and the failure to maintain worker exposures As Low As Reasonably Achievable (ALARA). Subsequent to the startup of thermal dryer operations at WPRAP, no effective design features or administrative controls were instituted to limit radiation exposure from the inhalation of thorium-230 by personnel in the trailer. As a result of these deficiencies, 23 personnel received unplanned and unmonitored exposures ranging from approximately 30 to 330 millirem for the period December 1999 through August 2000. These violations constituted a Severity Level II problem with a civil penalty of $27,500.

Section II of the PNOV contains a violation describing deficiencies in the quality improvement area. Specifically, examples were noted in which Fluor Fernald processes were not effective in controlling and resolving identified deficiencies in a timely manner. These examples include (1) the failure to ensure that issues identified in the Conduct of Operations Monitor Reports were placed in an appropriate corrective action process; (2) the failure to correct deficiencies initially identified by Fluor Fernald relating to the operator training program; and (3) the failure to take sufficient corrective actions following an earlier WPRAP airborne radioactivity event to preclude or correct in a more timely fashion the subsequent T321 problem. These violations constituted a Severity Level II problem with a civil penalty of $27,500.

No monetary mitigation in these civil penalties for timely self-identification was provided to Fluor Fernald because the violations were either long-standing in nature or identified by DOE. However, DOE recognized that Fluor Fernald promptly entered the deficiencies into DOE's Noncompliance Tracking System (NTS) once they were identified. DOE also recognized that Fluor Fernald had proactively reported roll-up Conduct of Operations and Radiological Control programmatic issues at WPRAP into the NTS earlier during 2001, and was undertaking corrective actions for those issues. Both fines were therefore reduced by 50 percent mitigation in recognition of Fluor Fernald's comprehensive and timely corrective actions relative to the subject events once they were identified, and in light of Fluor Fernald's historically strong Price-Anderson Amendments Act (PAAA) performance with respect to the self-identification and correction of regulatory issues.

These violations illustrate several lessons learned from a management perspective with potentially significant impact on PAAA enforcement, including:

- The need for timely and aggressive action in addressing identified deficiencies and precursor conditions, and
- The need to ensure that short-term compensatory or "workaround" measures instituted during startup are followed up with appropriate longer-term measures.

Additionally, ALARA principles should be considered in the preliminary design stage of facility modifications.

The Price-Anderson Amendments Act of 1988 requires the Energy Department to undertake regulatory enforcement actions against contractors for violations of its nuclear safety requirements. The program is implemented by the Office of Price-Anderson Enforcement. This action was taken with the support and participation of DOE-FEMP, which will ensure that the corrective actions are fully implemented. Additional details can be found on the Internet at http://tis.eh.doe.gov/enforce.

KEYWORDS: *Enforcement, Price-Anderson Amendments Act, radiation monitoring, training, corrective actions*

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