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

OPERATING EXPERIENCE SUMMARY

Office of Environment, Safety and Health

Summary 2001-07

The Environment, Safety and Health (EH) Office of Performance Assessment and Analysis publishes the Operating Experience Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging the exchange of lessons-learned information among DOE facilities.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and, time permitting, conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Frank Russo, 301-903-1845, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction.

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Operating Experience Summary 2001-07

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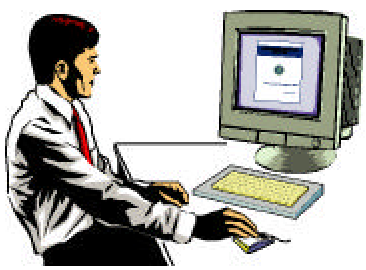

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EVENTS

1. TUBE BUNDLE CATCHES FIRE DURING CONVERTER DISASSEMBLY

On July 25, 2001, in Building K-31 at the East Tennessee Technology Park (ETTP), the nickel barrier tubes inside a gaseous diffusion converter caught fire while the converter was being disassembled using a plasma-arc cutting torch. Workers evacuated the building, and the fire department extinguished the fire with water. No workers were injured, and air sampling indicated no significant release of radioactivity. (ORPS Report ORO--BNFL-K31-2001-0004)

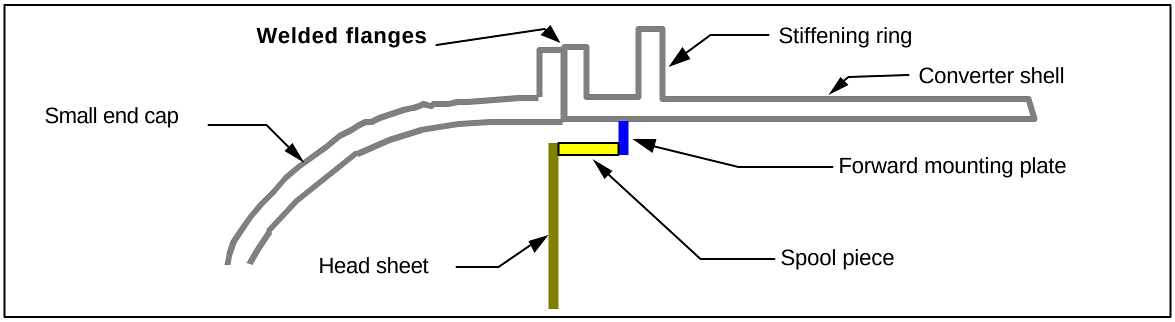

Figure 1. Cross section of converter and internal structures

A first step in disassembling converters is to cut off the small end caps of the converters shown in Figure 1 using plasma-arc torches. This allows access for removing the internal structures that support barrier tube bundles. The barrier tube bundles are located away from the small end caps, on the opposite side of the head sheet, spool piece, and forward mounting plate.

No fires had resulted from the cutting of small end caps for over 400 converters in Building K-33, only some tube end discoloration. One worker cut the small end caps for the first 13 converters being disassembled in Building K-31 without incident.

On July 25, 2001, another worker was cutting the small end cap from the 14th converter when the fire started. The subsequent investigation revealed that, like the first worker, he had used the stiffening ring to guide his torch in making a circumferential cut between the ring and the flanges connecting the converter shell to the small end cap. However, the second worker had held his torch vertically and not angled towards the end cap, as specified in the Enhanced Work Plan (EWP). This resulted in a cut close to the ring that caused hot metal to fall on the wrong side of the forward mounting plate and onto the tube bundle, igniting the tubes. A cut on the other side of the forward mounting plate would have led to hot metal falling onto the spool piece, without touching and igniting the barrier tubes. The investigators concluded that while the worker deviated from the EWP in not angling his cut, the EWP did not specify a precise cut location and did not require verification of the forward mounting plate location, although the equivalent Building K-33 EWP did require such verification. The team that prepared the Building K-31 EWP had failed to recognize the significance of the gap between the external stiffening ring and the internal forward mounting plate. The investigators recommended that the EWP be modified to provide more specific instructions and to require measurement of internal structures and marking of cut locations prior to cutting.

The emergency response personnel failed to use a Class D extinguishing agent (MET-L-X®) or CO_2, as specified in the EWP. Instead, the fire department extinguished the fire with water. Because the barrier tubes held residues of depleted uranium rather than enriched uranium, the potential for nuclear criticality and radioactive material releases was insignificant. However, the use of water required a major cleanup effort.

On April 4, 2000, a tube bundle fire occurred in Building K-33, which was also ignited by a plasma-arc cutter. This occurred during a later stage of disassembly than that of the July 25, 2001 event, when the tube bundle and its frame had been already removed from the converter. The failure to comprehensively identify fire hazards for the operation and the ineffective use of Class D fire extinguishers to extinguish the fire were among the deficiencies cited in subsequent Price-Anderson actions. (ORPS Report ORO--BNFL-K32-2000-0001, and OE Summaries 2000-08 and 2001-02)

The failure to fully recognize and control the potential ignition of tube bundles by hot weld metal falling through unseen internal gaps led to the July 25, 2001 fire. This event illustrates the importance of fully identifying and addressing hazards in the EWP process.

KEYWORDS: *Tube bundle, converter, fire hazard, Enhanced Work Planning*

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

2. BOLT FAILURE RESULTS IN NEAR MISS WHILE LIFTING AN IRRADIATED TARGET

On August 17, 2001, at the Argonne National Laboratory—East Alpha-Gamma Hot Cell Facility, a lifting mechanism failed causing an irradiated target from the Intense Pulsed Neutron Source to fall approximately one inch into a holding tray. Personnel were transferring the depleted uranium target from a shielded pot to the tray in an air cell in order to move the target into a hot cell for final disassembly. Facility personnel believe stress corrosion or galvanic corrosion probably caused all four bolts in the lifting mechanism to fail. There were no injuries from this event. Managers reported this event as a near miss because had the target fallen four feet to the floor, it would have been extremely difficult to retrieve it remotely, potentially requiring personnel to enter the cell and resulting in unnecessary radiation exposure. (ORPS Report CH-AA-ANLE-ANLEAGHCF-2001-0002)

Galvanic corrosion occurs when two dissimilar metals (e.g., stainless and high-strength alloy steel) are placed in contact with an electrolyte (a conductive solution, such as in water produced by moisture). The damage from corrosion is more severe when metals are simultaneously stressed, such as from welding residual stresses, or, as in this case, from tensile stresses in bolt threads due to tightening. *Over time, stress corrosion cracks* can propagate through corroding and stressed metal components and fail them, as happened to the bolts in this occurrence.

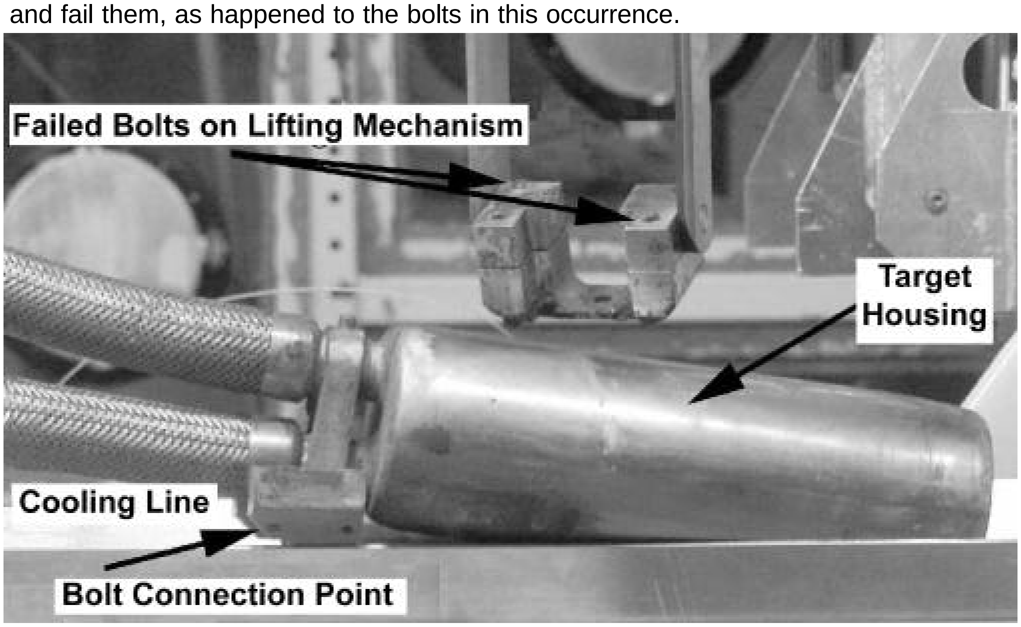

Figure 1. Target housing and part of the lifting mechanism

The target housing and part of the lifting mechanism are shown in Figure 1. The target consists of eight clad depleted uranium pucks, each weighing 3.6 kg (7.92 lbs.). The eight pucks are stacked inside of a nearly cylindrical housing that is welded closed on both ends. Cooling lines attach to one end of the cylindrical housing. Two stainless steel blocks are attached 180 degrees apart at the approximate joint of the housing and the cooling water lines. Each block has two holes tapped into it to allow the attachment of a lifting mechanism. The lifting mechanism is attached to the load by four high-strength alloy steel bolts. An eyebolt protrudes from the stainless steel block, and serves as the lifting point for the target. Normally the cooling lines provide a second fall prevention barrier, but in this case the lines were severed for final target disassembly.

The lifting mechanism is rectangular in shape, consisting of two vertical stainless steel bars connected at the top and bottom with stainless steel blocks held to the bars with high-strength alloy steel bolts.

The target, with a dose rate of 50 rem/hr at 2 inches, had been loaded into a shielded transfer pot at the Neutron Source facility, and the pot was placed into a shielded air cell at the Hot Cell Facility. A shield door equipped with manipulators and the air cell equipped with an overhead manipulator and hoist were being used to remotely transfer the target from the pot to the tray. The target was in the process of being moved from the vertical position to the horizontal position, with the weight of the load resting on the tray at the time of failure.

A visual inspection of the lifting mechanism, which was connected to the target by four 5/16" high-strength alloy steel bolts, revealed that all four bolts had failed. Furthermore, the failed surfaces of the bolts appeared oxidized, indicating that the failures were old.

A staff metallurgist examined the bolts on a scanning electron microscope to investigate the use of high-strength, low alloy steel bolts in a stainless steel assembly. The micrograph of the failed bolt pictured in Figure 2 shows evidence of an intergranular fracture, indicating the cracks proceeded along grain boundaries until the stress was sufficient to fracture the bolt.

Personnel at the Intense Pulsed Neutron Source are conducting a comprehensive review of the bolt failure. To date, experts in metallurgy, corrosion, and chemistry have been consulted. Scanning electron microscopy has been completed, but other tests are yet to be completed. A chemical composition analysis of the bolts has begun. A bolt sample metallographic examination is underway to allow 20X to 700X optical metallography to be completed.

A search of the ORPS reports over the past two years found three occurrences in which corrosion from galvanic coupling of dissimilar metals led to failures. These included an operational restriction on spent fuel movement, leakage of dissolved solids to groundwater from a failed pipe, and dislodging of the plug of a UF_6 cylinder. It is likely that many bolts have failed in the past because of the development of a galvanic cell; however, this event was particularly noteworthy because the bolt failure caused an irradiated target to drop.

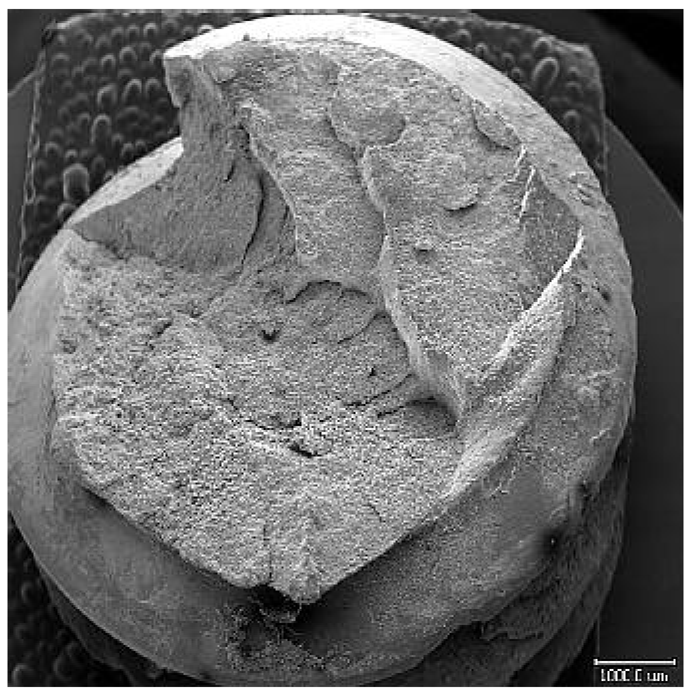

Figure 2. Scanning electron micrograph of the fracture surface of one of the failed bolts

This occurrence illustrates the importance of periodic inspection and load testing of the stressed components; particularly weight-bearing components made of dissimilar metals. When inspections are not operationally feasible, the design should include defense-in-depth features, so that a common-mode-failure would not cause a significant problem to occur.

KEYWORDS: *Bolt failure, dissimilar metals, stress corrosion, galvanic corrosion*

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

3. FREEZE PROTECTION REMINDER

Personnel at DOE facilities are reminded to review and implement their freeze protection plans with the onset of the cold weather season. Burst pipes, frozen water lines, and cracked fire protection sprinkler heads are typical of the reported problems during cold weather. Other reported problems include collapsed roofs from the weight of snow and ice, flooding from melting snow, and electrical malfunctions from water leakage into buildings. Cold weather damage can be costly to clean up or repair, and can adversely affect facility operations. Comprehensive freeze protection programs help minimize or avoid events related to cold weather system vulnerabilities.

Several actions may be taken to establish freeze protection for facility systems and equipment. These actions, together with contingency plans for severe weather, should be incorporated into written procedures and periodically reviewed for adequacy. The following list identifies some typical measures that should be included in freeze protection plans.

- Clean, service, and functionally test facility heating systems and ensure that power and temperature controls are protected against inadvertent deactivation by unauthorized personnel.
- Check antifreeze used in cooling systems, and replace as necessary.
- Secure all air intakes, windows, doors, and other access areas that could provide abnormal inflows of cold air.
- Develop plans for alerting personnel and providing increased surveillance of vulnerable systems in periods of extreme, unusual, or extended cold. Operations and maintenance personnel should be on call to respond to any events.
- Install temperature alarms or automatic backup heat sources on vulnerable systems that require special protection because of hazards or costs associated with freeze damage.
- Inspect outside storage pads and unheated storage areas to ensure that no stored materials are susceptible to freeze damage.
- Ensure cold weather gear is readily available for emergency, maintenance, and operations personnel.
- Review wet-pipe sprinkler systems for areas susceptible to freezing and develop provisions for preventive or compensatory actions such as activating auxiliary heat, draining, and posting fire watches.
- A task team should be established to provide for the development and implementation of severe weather protection plans. Plans should ensure that preparatory actions and requirements imposed to provide seasonal weather protection, particularly those that could affect safety system functions, are reviewed by facility operations and safety personnel before implementation. The following list identifies some typical additional measures included in cold weather protection plans.
- Inspect for heat tracing tape degradation.

- Inspect dry-pipe fire protection systems to verify that all water is drained.
- Review prioritization of outstanding work packages to ensure that freeze protection equipment is returned to service as soon as possible.
- Review procedures to ensure compensatory measures are available in the event power is lost to heat tracing tape or other freeze protection equipment.
- Review administrative controls governing temporary equipment to ensure availability of freeze protection provisions when needed.
- Review administrative controls governing design changes to ensure that freeze protection considerations are addressed (e.g., adding drains when changing a wet-pipe fire protection system to a dry-pipe).
- Review the configuration of shutdown facilities to determine if freeze protection is required.
- Develop a program to look at long-range weather projections and determine necessary actions to prevent systems from freezing in facilities where cold weather is typically not expected, but may occur infrequently.

Managers should review their systems and equipment maintenance histories, policies, procedures, and work planning processes, and should walk down systems to identify potential cold weather problems.

Section 4.18 of DOE G 433.1-1, *Seasonal/Severe Weather and Adverse Environmental Conditions Maintenance*, provides guidance to assist facility maintenance organizations in the review of existing methods (and the development of new methods) for establishing a seasonal maintenance program. Section 4.18.3.2 of the Guide includes cold weather preparation information; Section 4.18.3.7 provides an example of a cold weather checklist. This guidance also contains, in addition to information on cold weather protection, guidance for hurricanes, tornadoes, flash floods, and other natural disasters.

DOE/EH-0213, *Cold Weather Protection*, October 1991, Safety and Health Bulletin 91-4, provides insights, corrective actions, and recommendations applicable to sites susceptible to cold weather. This bulletin and others can be found at URL http://tis.eh.doe.gov/docs/bull/links.html.

KEYWORDS: *Freeze protection, maintenance*

ISM CORE FUNCTION: *Develop and Implement Hazard Controls*

4. OVERHEAD CRANE NEAR MISS

On September 20, 2001, at the Lawrence Livermore National Laboratory (LLNL), a subcontractor worker, who was working on the roof of a temporary clean room, had to take evasive action to avoid being struck by an overhead crane. The worker was on top of the clean room in the west end of Laser Bay 2 when he observed the overhead bridge crane moving towards him. He called out to the crane operator, who could not hear or see him. The worker then lay down in the prone position to make certain that the crane would not hit him as it passed over him. There were no injuries resulting from this occurrence. (ORPS Report OAK--LLNL-LLNL-2001-0038)

The subcontractor worker was wearing fall protection and used a ladder to access the 40-foot-high roof. The ladder extended above the roof by three feet. While he was on the roof, a second work crew started moving the overhead bridge crane. The crane operator was standing on the ground level and moved the crane by remote control. While the crane was in motion, part of its structure hit the extended part of the ladder, causing the ladder to break. The crane operator immediately stopped the crane when it struck the ladder. The worker on the roof accessed the platform of the stopped crane and used the crane access ladder to descend to the deck of the bay. The only property damage was to the ladder.

The crane spotters on the floor level were unable to see the top of the clean room. In addition, the coordination between the crew responsible for roof work and the work crew conducting overhead crane operations was inadequate. The two Safe Plans of Action did not consider the hazards of one work activity on the other activity.

The subcontractor took immediate appropriate disciplinary action and began an investigation. The subcontractor also changed their work procedures to require lockout and tagout of the overhead crane whenever elevated work is being performed in any area underneath the path of the crane until the final investigation is complete. This procedure change has been communicated to the entire workforce. As an additional measure, subcontractor management is investigating the use of crane rail stops to limit crane travel.

Adequate immediate actions have been taken. Senior management has appointed a team to conduct further analysis and develop recommendations. LLNL safety personnel are closely monitoring the subcontractor's adherence to their modified work procedures.

This occurrence illustrates the importance of proper work coordination among different work crews, particularly if there is a potential for interference by equipment used by either work crew.

KEYWORDS: *Near miss, overhead crane*

ISM CORE FUNCTIONS: *Define the Scope of Work, Analyze the Hazards*