OPERATING EXPERIENCE SUMMARY

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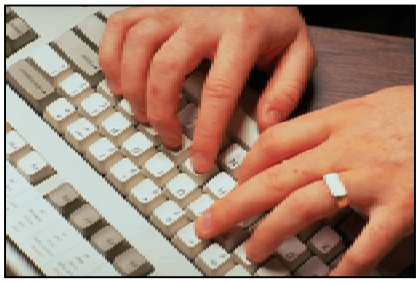

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EVENTS

1. SCREW PENETRATES CABLE CAUSING ELECTRICAL FAULT

On January 30, 2003, at Hanford, electricians unknowingly drove a screw through the insulation of a de-energized 480-volt cable (Figure 1-1) when they replaced a panel cover. When power was restored to the panel, the screw caused a phase-to-ground fault. Workers saw an arc flash, and the 480-volt branch breaker, the main 480-volt panel breaker, and the panel 480-volt feeder breaker opened. The area surrounding the panel door was scorched (Figure 1-2). No one was injured, and there was no damage to plant equipment other than the cable and screw, parts of which were vaporized. (DOE Lessons Learned Identifier 2003-RL-HNF-0014)

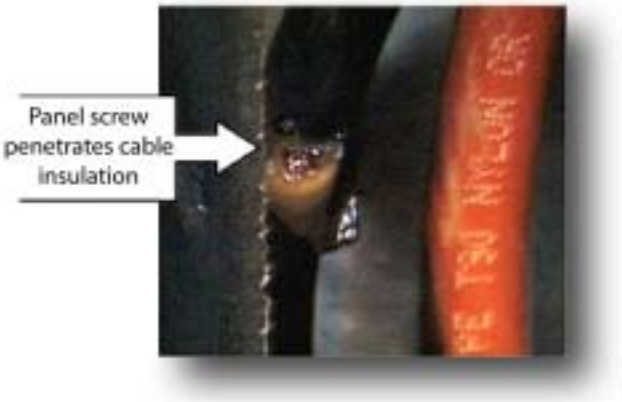

Figure 1-1. The location of the penetration in the cable

Following this occurrence, the plant electrical engineer reviewed and approved a recovery plan, and the electricians shortened and repositioned the cable, then replaced the panel cover screws with shorter ones.

A more thorough inspection of the panel installation might have prevented this event because the electricians would have recognized the hazardous condition created by driving a long screw near to the electrical cable. The lessons-learned submission (http://www.tis.eh.doe.gov/ll) includes the following recommendations to help electricians avoid intrusions when installing and repairing equipment.

Figure 1-2. The panel door after the arc flash

- Exercise extreme care when installing electrical panel covers.
- Verify the proper location of wires and cables before installing screws into panels, especially when replacing missing screws without removing the cover. Removing the panel cover may be necessary in some cases.
- Carefully inspect electrical panels after modifying them and during periodic inspections to ensure bolts and screws that mount panel covers will not contact or penetrate wiring.
- Use screws of an appropriate length in electrical panels.
- Avoid routing electrical cables close to electrical panels.

On August 30, 2002, at Argonne National Laboratory – East, a contractor installing wall-mounted cabinets, in a new facility, inadvertently drilled three screws through the back of a recessed electrical breaker box on the other side of the wall. The screws did not make contact with any of the contents of the breaker box. An electrician found the screws several weeks after the contractor left the site, when he opened the breaker box to begin installing breaker switches. (ORPS Report CH-AA-ANLE-ANLEAPS-2002-0002)

On October 21, 2002, at the Oak Ridge Y-12 Site, a construction worker penetrated an energized electrical wire while drilling into a wall. After the worker cut through the wall, others in the room noticed a strong burning smell and saw the lights flicker. No wire was severed, but

one of three conductors had been partially cut, exposing the energized wire. No one was injured, but several small burn marks were found on the surrounding fiberglass insulation. (ORPS Report ORO--BWXT-Y12SITE-2002-0044)

These events highlight the importance of proper work planning. Before placing screws or drilling, electricians should verify that they cannot penetrate wiring in the area.

KEYWORDS: *Electrical penetration, panel cover screw, ground*

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

2. UNMONITORED CRANE MOVEMENTS CREATE HAZARDS

In two recent events at different DOE facilities, crane operators moved overhead cranes without checking the position of the load hook or monitoring the crane movement, in violation of procedures. Their actions created potential hazards to personnel and caused equipment damage. Although there was potential for serious injury in each of these occurrences, none occurred. The following is a summary of these two incidents.

On April 29, 2003, at the Thomas Jefferson Nuclear Accelerator Facility (TJNAF), a qualified crane operator moved a crane without observing the position of the crane hook, which struck an equipment cabinet and stacked radiation shielding blocks, severed two electrical conduits, and damaged an installed radiation monitor. (ORPS Report ORO--SURA-TJNAF-2003-0001)

The crane operator was working with an assigned safety watch, but the safety watch had moved away from the crane hook and was preparing to load materials. The crane operator began to move the 25-ton bridge crane (Figure 2-1) without checking the position of the crane hook because he assumed it was in the same position as on the previous day. When the crane hook struck the equipment cabinet (Figure 2-2), it severed one conduit containing eight control cables and a second conduit containing a 120-volt, 20-amp control power circuit. The hook continued moving, striking several masonry shielding blocks and knocking over an installed radiation monitor before the crane operator stopped it in response to a shout from the safety watch. Investigators estimated that the crane hook traveled about 20 feet before stopping.

On April 4, 2003, at the Sandia National Laboratories (SNL), a qualified crane operator, using controls in an adjacent room, moved a crane that he did not know was being used to support the front end of a trailer, damaging the trailer and nearby storage crates. (ORPS Report ALO--KO-SNL-5000-2003-0001)

The only qualified crane operator in the building received a phone call informing him that an uncleared contractor had arrived to perform maintenance on the crane and recertify it. When the contractor arrived a few minutes later, the crane operator took him to an alcove

Figure 2-1. 25-ton bridge crane

outside the high bay area because a classified experiment was set up in the high bay. The crane operator believed that no one else was available to perform escort duties and that it might be months before the contractor could come back to recertify the crane. He decided to remove the administrative lock and move the 15-ton bridge crane to an area accessible to the contractor without checking the location of the crane hook.

The bridge crane was connected to two slings being used to stabilize a 1,000-pound front panel on a trailer. When the crane operator moved the crane, the front end of the trailer moved off its supporting jacks and fell to the floor, with its front panel hanging askew from the slings. Two storage crates were also damaged by the falling trailer.

The causal analyses for both incidents produced similar results. In each case, investigators determined that the direct cause was personnel error, inattention to detail. Both crane operators knew that they were to check the location of the crane and its hook before initiating movement, but one operator assumed the crane hook was where he had left it the previous day and the other failed to check the crane because of his security escort responsibilities. In the SNL incident, the crane operator did not follow procedures that required maintaining visual contact with the crane as it moved. Investigators concluded that the root cause of the SNL event was that the facility safe operating procedures did not address either the use of administrative locks and tags or dealing with conflicting responsibilities while operating a crane.

Investigators determined that the root cause of the TJNAF incident was personnel error, inattention to detail, on the part of both the crane operator and the worker assigned the task of safety watch. If either of them had checked the location of the crane hook to ensure that it was in the fully elevated position before moving the crane, the incident would not have occurred. The subcontract requirement for a safety watch was principally written to ensure the proper implementation of personnel fall protection requirements, but laboratory managers and the subcontractor supervisor agreed that the safety watch also should have been aware of the position and movement of the crane.

Although the results of the causal analyses were similar for both incidents, the corrective actions identified by the responsible managers were not. At TJNAF, corrective action focused on retraining of subcontractor personnel involved in the incident in areas related to safe crane operation. Corrective actions resulting from the SNL incident included the following.

Front and rear sides of damaged cabinet

Figure 2-2. Damaged equipment cabinet

- Update the facility Safe Operating Procedures (SOP) to restrict additional duties for personnel operating cranes or other heavy equipment.

- Conduct one-on-one counseling with the crane operator who caused the incident with regard to setting work priorities and complying with the SOP concerning crane operations and administrative locks and tags.

- Conduct a briefing of all facility personnel regarding escorting responsibilities, setting work priorities, complying with the SOP, and the use of administrative locks and tags.

Guidance on the safe operation of overhead cranes is available in the standard, DOE-STD-1090-2001, *Hoisting and Rigging,* which is available at http://tis.eh.doe.gov/techstds/standard. OSHA safety requirements for overhead cranes are detailed in 29 CFR 1910 Subpart N, *Materials Handling and Storage,* section 1910.179, *Overhead and Gantry Cranes,* and can be accessed at http://www.osha.gov.

These events underscore the need to consistently follow safety procedures when operating overhead cranes. When operating cranes, workers need to avoid other duties such as security escorting or related work preparations that distract them from their principal responsibility of safely operating the crane. When work requirements seem to conflict, workers should not hesitate to stop what they are doing and seek assistance in resolving the conflict to ensure that the work is performed safely.

KEYWORDS: *crane operation, visual monitoring of crane movement, crane accident, equipment damage, conflicting responsibilities*

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

3. *NEAR MISS TO SEVERE INJURY WHEN TOWER CRANE RIGGING STRIKES WORKER*

On May 1, 2003, at the River Protection Project Waste Treatment Plant construction site, a tower crane operator was swinging the boom of a crane in a congested area, under the direction of a spotter, and struck a nearby laborer in the shoulder and on the side of his hard hat. The spotter directed the crane operator to swing the boom to the left as he was lowering the load block. As the block came down, the slings suspended from it struck the laborer. (ORPS Report RP--BNRP-RPPWTP-2003-0005; final report filed May 30, 2003)

Construction personnel were preparing to pour two concrete walls for a building in an area congested with equipment and people (Figure 3-1). A shackle and two, 20-foot slings were suspended from the crane's load hook (Figure 3-2). The spotter intended to change the rigging configuration and signaled the crane operator by radio to swing left to the area where he had placed the additional rigging. The spotter did not clear the area of personnel or prepare the area for dropping a crane block to ground level. Several workers were standing and working in the area where the new rigging was to be attached.

Figure 3-1. The congested construction site

Figure 3-2. The tower crane with its rigging

The spotter directed the crane operator to lower the block and swing the boom, then he realized that the suspended slings were too close to personnel. He directed the crane operator to stop, but the sling struck the laborer. The slings continued swinging, so the spotter grabbed them and pulled them out of the way of other workers.

All crane operations were suspended and the spotter's certification was revoked. To prevent future occurrences, crane spotters attended a meeting in which their primary responsibilities were reinforced. The following corrective actions were taken.

1. The work area must be cleared of personnel and equipment before, during, and after a lift.

2. The work area must be kept clear from the travel path of cranes and rigging equipment.

3. If personnel must remain in the area, stage the rigging equipment outside the building.

4. Blow the whistle to alert personnel of approaching rigging equipment when rigged to the load hook.

Management also directed all tower crane spotters to perform no other duties while they are spotting. Management verified that all tower crane spotters have been appropriately trained and that they understand their roles and responsibilities in assisting crane operators when maneuvering around work sites and moving loads. Finally, because of the congestion in the work area, the rigging equipment was moved to a lay-down area outside the building to preclude the need for attaching the rigging in a congested area.

There have been a number of events reported in ORPS involving the movement of heavy equipment in congested construction or decontamination and decommissioning areas. On January 9, 2003, at the Rocky Flats Environmental Technology Site, for example, an operator working in a congested tent was maneuvering a forklift loaded with an empty intermodal container and nearly struck a waste technician. A health and safety specialist saw the forklift and pushed the technician out of its path. (ORPS Report RFO--KHLL-ENVOPS-2003-0001; OE Summary 2003-03)

Another recent event occurred at the Oak Ridge Y-12 Site on April 30, 2003. A construction worker was using a forklift to move construction material. The location inside the building was only a short distance from the dock, but the area was very congested. A spotter assisted the forklift operator as he moved the load. After the load was placed, the spotter left and the operator began to back the forklift out of the area with about 12 inches of clearance. The forklift operator needed to raise the forks to clear the top of several containers and continued to back out of the area with the lift mast raised. He struck a 480-volt bus line box located approximately 9 feet above the floor. He stopped and got off the forklift to determine if he had caused any damage, but saw none. The next day, the forklift operator noticed that the bus line box was slightly tilted, but was otherwise undamaged. There were no personnel injuries. (ORPS Report ORO--BWXT-Y12SITE-2003-0020; update/final report issued June 4, 2003)

These occurrences illustrate the difficulty of operating industrial equipment in congested work areas. Spotters should assist equipment operators in maneuvering to and from the work site as well as assisting them with lifting and placing a load safely. Hazard control measures for crane movement should be in place whether or not the crane is carrying a load.

KEYWORDS: *Tower crane, rigging, near miss*

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

4. NEAR MISS - PIECE OF CONNECTION STEEL FALLS FROM ROOF

On May 21, 2003, at a Hanford Site building being prepared for safe storage, a worker snagged his fall protection lanyard on an 80-pound piece of connection steel called a "spider column," causing it to fall through a roof opening and land on a concrete floor 20 feet below. The spider column was staged in a skiff box on the partially disassembled roof near the roof opening. The column narrowly missed an oxy-acetylene torch cart when it hit the floor. No workers were in the immediate area when this near miss occurred, and there was no equipment damage. (ORPS Report RL--BHI-DND-2003-0003)

Figure 4-1 shows a spider column similar to the one that fell. A gouge where the column hit the concrete floor indicated that it missed the oxy-acetylene torch cart by only 18 inches. The skiff box, which contained five spider columns, was similar to that shown in Figure 4-2. Workers had hoisted it to the building roof earlier in the day of the incident, as directed by the ironworkers who would be installing the columns. Normally the spider columns are hoisted one at a time to the location where they will be welded in place. Using a skiff box to stage five columns on the roof was expected to save time. This was the first time that individual pieces of connection steel had been lifted as a group and staged on the roof.

Figure 4-1. Example spider column (with ballpoint pen to show scale)

Figure 4-2. Example skiff box

Workers placed the skiff box on the roof with the open end immediately adjacent to an 8-foot-wide opening in the roof. Figure 4-3 shows the roof opening that the spider column fell through. The lanyard strap that provided fall protection for the worker was attached to a column above and behind the skiff box. The worker stated that he did not feel the lanyard strap snag on the spider column before it fell. The ironworkers installing the spider columns thought that staging the columns on the roof and moving individual columns across a roof I-beam for installation was a safe work practice.

Following the incident, workers moved the oxyacetylene torch cart from under the roof opening to the edge of the room. The subcontractor ironworker foreman also directed workers to lower the skiff box containing the other four spider column assemblies to the ground.

A preliminary analysis of causal factors for this incident indicated that the potential hazards asso-

Figure 4-3. Roof opening near the skiff box

ciated with the innovation of staging spider columns on the roof were not sufficiently evaluated. The possibility of the fall protection lanyard snagging on a staged spider column and causing it to fall was not considered, and the skiff box should not have been placed with the open face immediately adjacent to an opening in the roof.

In addition to moving equipment out from under roof openings and installing barriers beneath overhead work, the following compensatory and corrective actions resulted from this incident.

- A crane hoist will be used to set the remaining spider columns in place, one at a time.
- Structural steel components will not be stored or staged on the roof.
- Tools, bolts, connection plates, and other incidental construction materials will be stored away from roof openings, preferably in containers.
- Workers must remain aware of the locations of their lanyards so that they do not snag on materials or equipment in the immediate work area.
- General work areas in the building beneath overhead work will be demarcated with caution tape and "overhead work" signs.

A search of the ORPS database for other events involving falling items that endangered workers revealed several other incidents in recent years. On March 20, 2003, at a Sandia National Laboratory building construction site, two workers sustained injuries when an unsecured steel beam, being used with a chainfall to lift a metal stairway, slipped sideways and fell. One worker received a serious crushing injury to his foot, and the second worker received a laceration to his leg. This accident was the subject of a DOE Type B Accident Investigation that was completed in April 2003. (ORPS Report ALO-KO-SNL-NMFAC-2003-0005; Operating Experience Summary 2003-11)

At the Lawrence Livermore National Laboratory National Ignition Facility construction site, three construction workers were struck by falling items within one 24-hour period in June 2002. A falling ratchet wrench struck a worker on his hard hat, causing a contusion and requiring first aid; a 10-foot piece of tubing fell, bounced on the floor, and struck a worker in the face resulting in a chipped tooth that required medical treatment; and a screwdriver fell approximately 20 feet and hit a worker on his hard hat, but did not injure him. (ORPS Report OAK--LLNL-LLNL-2002-0014)

These events underscore the need to carefully evaluate falling hazards at construction sites and implement controls on the hazards identified. Hazards analysis and hazard control implementation are especially important for construction process innovations, such as the staging of construction steel elements on the building roof in the Hanford incident or the use of an unsecured, improvised hoist in the Sandia accident. Falling objects continue to endanger and injure workers at DOE sites, and increased vigilance is needed to provide higher levels of safety assurance for workers, especially at construction sites.

KEYWORDS: *Falling objects, construction safety, hazards analysis, innovative construction processes*

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