OPERATING EXPERIENCE SUMMARY

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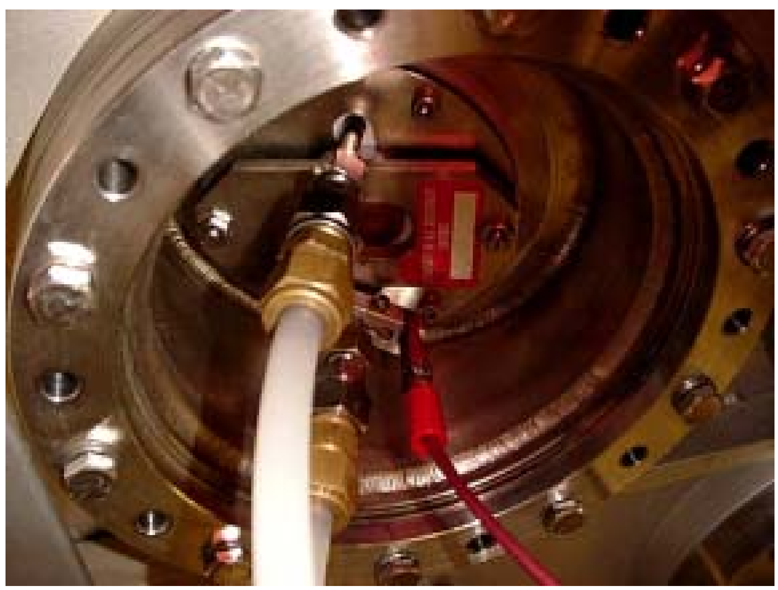

U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2003-10

May 19, 2003

The Office of 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 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.

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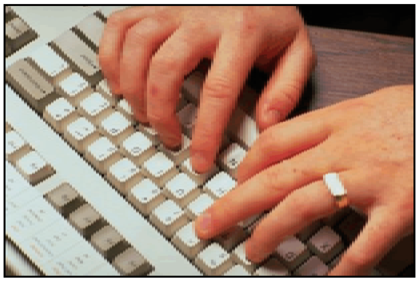

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NOTICE: DEFECTIVE COLLAPSIBLE FUEL TANKS IDENTIFIED

The DOE Quality Assurance Working Group issued a Data Collection Sheet (DCS) on March 17, 2003, concerning suspected defective collapsible fuel tanks manufactured by Reliance Coated Fabrics, Inc., of Mansfield, Texas (database tracking number DCS 428). It is not known if any of these fuel tanks have been purchased or used by DOE or any of its contractors.

Failure of the fuel tanks while in use would create a significant fire safety hazard, and could cause damaging environmental effects. The U.S. Army tested a number of 10,000-gallon tanks at Fort Lee, Virginia, with a 100 percent failure rate.

The national stock numbers and capacities of the tanks are shown in the following table.

Stock Number	Capacity (gal)
5430-01-486-8209	3,000
5430-01-485-8336	10,000
5430-01-486-1034	20,000
5430-01-485-8342	50,000
5430-01-433-6246	210,000

Site management across the DOE complex is requested to (1) determine if these tanks are in use onsite or are in inventory and (2) formally notify procurement personnel about the concern regarding these potentially defective tanks.

If these tanks are in use or in inventory, they should be taken out of service or removed from inventory. A notification report should be filed in the Occurrence Reporting and Processing System under the category "Suspect/Counterfeit Parts." This information should also be reported to Frank Russo, Office of Environment, Safety and Health, Office of Performance Assessment and Analysis, at (301) 903-8008, email frank.russo@eh.doe.gov.

The Defense Criminal Investigation Service is formally investigating this matter, and requests that no additional contact be made with Reliance Coated Fabrics, Inc. at this time. If you have questions regarding collapsible fuel tanks, please contact Rick Green, Office of Environment, Safety, and Health, at (301) 903-7709, email rick.green@eh.doe.gov.

EVENTS

1. ELECTRICAL ARC INDICATES INADEQUATE LOCKOUT/ TAGOUT

On February 21, 2003, at the Pantex Plant, an electrician saw an electrical arc when an unsecured wire hanger came in contact with an energized 120-volt conductor inside a smoke detector. The electrician was removing the cover to the smoke detector to perform a zero-energy check when the wire, which was used to support a suspended ceiling grid near the detector, accidentally swung into the detector. The resulting arc caused the shutdown of a nearby air-handling unit. Subsequent investigation revealed that the energized conductor had not been identified and included in the lockout/tagout (LO/TO) installed for removal of the detector. No injuries or equipment damage resulted from this occurrence. (ORPS Report ALO-AO-BWXP-PANTEX-2003-0008; final report filed April 23, 2003)

The electrician immediately stopped work and traced the energized circuit. He discovered a terminal inside the detector that was not powered from the locked-out fire alarm circuit. He then traced the circuit to an electrical panel in another room that had not been locked/tagged out. This circuit was designed to shut down the air-handling unit when smoke is detected in the air duct. The contractor and subcontractor applied a joint LO/TO to the circuit, then the electrician verified the absence of energy to the terminal and replaced the smoke detector without further incident.

Six weeks before this occurrence, contractor construction management and electrical subcontractor personnel made preparations to replace a fire alarm system and fire suppression system with new systems. They installed a joint LO/TO on the circuit for the fire suppression system and on the fire alarm panel circuit, but failed to perform a thorough check for other sources of energy. Because a LO/TO was in place, the electrician had no reason to consider the suspended ceiling hanger wire a safety hazard and did not attempt to secure the wire before removing the cover on the smoke detector.

Investigators determined that several factors contributed to this occurrence, including (1) the advanced age of the facility being modified; (2) poor work practices used during previous system modifications (e.g., not updating drawings); and (3) a lack of controlled, as-built drawings for both the system and the facility. They also determined that the direct cause of this occurrence was personnel error. The electrician who removed the smoke detector cover did not follow procedures, which required compliance with Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1910.333, *Selection and Use of Work Practices,* (URL http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9910&p_text_version=FALSE) with regard to ensuring conductors are de-energized. Contrary to this requirement, the electrician did not consider that conductors in the smoke detector might be energized until proven otherwise. He also did not consider the potential consequences should the hanger wire come in contact with these energized conductors when the smoke detector cover was removed.

Investigators determined that the root cause of this occurrence was a design problem (drawing, specification, or data errors). The project drawings provided to the subcontractor before construction began did not identify an additional circuit to the existing smoke detector. Subcontractor electricians had previously removed a similar smoke detector that did not have a separate circuit connected to it to shut down an air-handling unit in case of fire.

Corrective actions resulting from this incident included the following.

- Modify existing site specifications on electrical safety to provide detailed instructions for inspecting work areas to identify any obstructions that could present a hazard if they were to come into contact with an energized electrical conductor.
- Issue a lessons-learned document to all subcontractors describing this incident and reminding them that all circuits, even if locked and tagged out, are to be considered energized until verified as de-energized.
- Issue a lessons learned document to all contractor construction project personnel describing this incident, suggesting caution in the use of uncontrolled drawings, and describing the impact that inaccurate drawings can have on the safety of subcontractor personnel.
- Add details to the checklists used to support pre-work walk-downs in the areas of identifying concealed or unusual hazards, potential system dependencies that could affect safety (e.g., the smoke detector tie to the air handling unit), special conditions that may require additional controls, and personnel required to participate in the pre-work walkdowns.

A search of the ORPS database for LO/TO inadequacies revealed several events in the first 3 months of 2003 in which electrical LO/TO processes were deficient. On February 5, 2003, at the Savannah River Site, mechanics performing a balancing operation on a motor discovered that the wrong circuit breaker had been locked out. (ORPS Report SR--WSRC-SUD-2003-0001) On February 1, 2003, at the Strategic Petroleum Reserve Big Hill Site, electricians discovered that a 480-volt lighting circuit they were working on and thought was de-energized was still energized. (ORPS Report HQ--SPR-BH-2003-0001)

These and other LO/TO incidents that occurred in early 2003 are summarized and analyzed in an article entitled "Lockout/Tagout Violations and Lessons Learned" in Issue 2003-06 of the *Operating Experience Summary*, dated March 24, 2003. The article identifies LO/TO traps and pitfalls, such as (1) using inaccurate facility/system design data, (2) assuming that zero energy conditions exist in the absence of verification, (3) working outside the physical boundaries of a lockout, and (4) complacency, inattention to detail, or training deficiencies. Copies of the OE Summary, dating back to July 2001, can be accessed at the following URL: http://tis.eh.doe.gov/paa/oesummary.html.

These LO/TO incidents illustrate the importance of a thorough, comprehensive approach to planning for the implementation of lockout/tagout applications. Managers, crafts workers, and other operations personnel need to remember that all circuits should be considered energized, even if they are locked and tagged out of service, until they are verified to be de-energized. Problems commonly encountered with inaccurate as-built drawings are likely to be magnified if the drawings are uncontrolled. Effective LO/TO processes include using knowledgeable personnel, conducting thorough research and walkdowns, performing self-checks with independent verification, and ensuring defense-in-depth exemplified by (1) the use of personal protective equipment even when circuits are thought to be de-energized and (2) active emphasis on stop-work authority.

KEYWORDS: *Lockout/tagout, LO/TO, electrical safety, zero-energy checks, control of hazardous energy*

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

2. NEAR MISS WHEN WASTE CONTAINER DROPS FROM HOIST

On February 25, 2003, at the Hanford Site environmental restoration disposal facility, a contractor teamster was offloading a full waste container when it disengaged from the cable, hit the concrete surface, rolled back approximately 10 feet, and struck a container staged behind it (Figure 2-1). The second container was not damaged; the mechanical latch on the tailgate of the rolling container sustained minor damage. (ORPS Report RL--BHI-ERDF-2003-0002; final report filed April 15, 2003)

As the teamster offloaded the container, it rolled backwards until the wheels encountered an obstruction on the concrete pad and stopped. When the container stopped rolling, the teamster continued to elevate the hoist frame of the truck and simultaneously wound out cable from the hoist, creating slack in the cable. The slack in the cable caused the attachment ring on the hoist cable to disconnect from the container

Figure 2-1. The truck and container

hook. With the hoist frame continuing to rise, the wheels came free from the obstruction, allowing the container to slide back. Figure 2-2 shows the locations where the hoist frame rested and where the container touched the ground. The figure also shows an expansion joint in the concrete pad that may have been the obstruction.

Figure 2-2. The container and concrete on which it rested

Along with a causal analysis, a field investigation was conducted to re-create the event. Investigators intentionally introduced slack in a cable to demonstrate the dynamics that can cause it to disengage from a container in the process of offloading. Figure 2-3 illustrates the test. The investigators tested other scenarios to

Figure 2-3. The investigators introduced slack in the hoisting cable

understand how slack can be introduced into a cable. When slack develops in a hoisting cable, longitudinal and rotational forces within the cable cause the cable end to ride up onto the container hook, rotate, and flip off of the hook. This can occur with both eyehooks and D-ring hooks.

The teamster did not stop hoisting and paying out cable when the container became caught up, which allowed slack to accumulate in the cable. Testing revealed that raising the hoist while paying out cable will cause the cable to slacken very rapidly; therefore, the container may have come disengaged before the teamster could stop hoisting.

The investigators identified two root causes: the design of the container hook; and the slack in the cable. The corrective actions for this event are described below.

- Facility management reviewed off-loading procedures with waste transportation drivers and emphasized the importance of avoiding slack in cables and maintaining focus on the container movement during the entire off-loading operation.

- All work crews at site waste disposal work locations were briefed on the event and the dynamics that can result in slacked cables and cable disengagement. In addition, a discussion followed on a proposed container hook modification in which a steel dowel would be welded onto the container hook to prevent the cable from coming disconnected (Figure 2-4).

Figure 2-4. The modified configuration

- The facility contacted the container manufacturer to obtain approval for the proposed modification and distributed sample containers with the dowel welded to the hook to all work sites.

- After obtaining feedback from workers on the effectiveness of the modification and manufacturer approval, the facility began installing modifications on applicable containers. Management documented the modified design to be included in future container procurements.

Hanford has reported six previous events involving similar circumstances: RL--BHI-REMACT-1997-0010, RL--BHI-REMACT-1998-0007, RL--BHI-REMACT-2001-0001, RL--BHI-REMACT-2001-0003, RL--BHI-ERDF-2002-0008, and RL--BHI-REMACT-2002-0009. Each of these events occurred because the containers were not in the fully forward and locked position. When the containers moved, the cables developed slack, the hooks came off, and the containers were free to roll backwards. In all but one event, the container rolled off the back of the rails. Although some corrective actions were taken (e.g., painting locking pins a bright color, refining procedures, retraining, and improving locking mechanisms) following these events, failure to follow procedure led to each of the events.

In the most recent event, all of the improvements from previous events were either in place or did not apply. Therefore, none of the previous corrective actions would have prevented this event. Facility personnel concluded that the most effective way to prevent recurrence is to ensure that drivers continue to receive proper training on container hoisting and transport procedures and insist that they comply with them.

These events illustrate the importance of remaining focused when lifting heavy loads (when full, these containers weigh an average of 20 tons) and being prepared to quickly react to unexpected situations. Inattention to detail in this event allowed slack to develop in a cable and caused the cable to disengage, dropping the container and presenting the potential for significant equipment damage or personnel injury.

KEYWORDS: *Near miss, hoisting cable, container, slack, hook, modification*

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

3. FABRICATED SPRAY LANCE RUPTURES WHEN OVERPRESSURIZED

On February 27, 2003, at the Savannah River Site, a fabricated spray lance being used to mine salt from the bottom of a 1.3-million-gallon waste tank ruptured inside the tank. The lance, which had been tested at 3,000 psi, ruptured while being used with a 9,000-psi water supply. There were no injuries or spread of contamination. (ORPS Report SR--WSRC-HTANK-2003-0010; final report filed April 14, 2003)

Operations personnel referred to an existing job hazards analysis for lancing activities and began planning to remove salt that had built up in the bottom of the tank over time. Maintenance personnel had previously built a lance for another application and fabricated a similar lance for the salt-removal operation. The lance consisted of a 40-foot-long, Schedule 40 pipe, 2 inches in diameter, attached to a 6-jet nozzle supplied by the subcontractor. The pipe had been tested at 3,000 psi pressure. The lance that maintenance personnel had fabricated previously consisted of a 1-inch pipe tested at 15,000 psi, but in this case a higher volume of water was desired.

Following a pre-job briefing, subcontractor personnel attempted to mine the salt using a spray ring and water at 600 psi. Apparently the attempt was unsuccessful, and the operation was suspended. They made a second attempt, using the newly fabricated lance with a 9,000-psi water supply, even though the lance had been tested at only 3,000 psi. After 30 minutes, the lance ruptured along the pipe length and failed inside the tank.

Following the event, investigators determined that the root cause of this occurrence was the failure to analyze the hazards of the mining operation before work began. The job hazard analysis the operators used during planning activities addressed lancing in general, but was not specific as to differing pressures or tools. Investigators also determined that the planning process did not include an engineering evaluation to identify the tools that were appropriate for the job or the conditions under which the tools could be used safely.

Facility management determined that the job hazards analysis program is adequate for identifying overall hazards. The program will be integrated with the work package process through an automated system to ensure that work packages undergo engineering evaluations before they are cleared. In addition, the maintenance and engineering divisions will identify appropriate engineering review requirements for vendor-supported work.

This event demonstrates the importance of proper job planning. Job hazard analyses need to consider all potential hazards. Work packages need to clearly define the work that will be done as well as the controls needed to ensure that the work can be done safely. A work package must include an engineering evaluation to define these controls. Workers need to ensure that their equipment is compatible (e.g., rated pressure) with the working pressure of the system.

KEYWORDS: *Waste tank, high pressure, fabricated lance, engineering evaluation*

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

4. RESEARCHER RECEIVES ELECTRICAL SHOCK

On April 25, 2003, at the Pacific Northwest National Laboratory, an experienced researcher performing a routine "sputtering" (electroplating) operation received a substantial electrical shock. The researcher removed a protective guard from the sputtering unit, reached under the vacuum chamber to confirm cooling water flow, and touched a metal cooling water connection attached to a cathode that was operating at 500 volts DC and 0.5 amperes. The researcher stated that his arms/hands were immediately "thrown off" the equipment when the shock occurred, and he had to pace the floor for approximately 10 minutes to "shake off" the effects of the shock. No injuries resulted from this near-miss electrical shock event, but the researcher was fortunate to not have sustained a serious injury. (ORPS Report RL--PNNL-PNNLBOPER-2003-0007)

The researcher was a long-time laboratory employee who had frequently operated the equipment involved in the event. He was also familiar with the design of the cathode assembly, although he had not used the equipment in a few years. Shortly before this event occurred, the researcher had problems establishing cooling water flow on a similar (but not identical) piece of equipment, so he reached under this assembly because he wanted to be sure that he had cooling water flow.

The researcher had installed the cathode assembly in the equipment approximately a week before the incident and had secured all the electrical connections. He knew that when the equipment was energized the entire bottom of the cathode assembly, including the cooling water connections, was energized. He understood immediately after the shock why it had occurred. Figure 4-1 shows the sputtering unit involved in this event; Figure 4-2 shows the underside of the cathode.

Figure 4-1. The sputtering unit

Investigators identified several inadequacies in the hazard control and conduct of operations processes associated with the work the researcher was performing. For example, neither the researcher nor his (acting) supervisor knew that, when the researcher removed the protective guard while the power supply was energized, the changed conditions mandated use of an energized work permit and associated personal protective equipment to perform the work. Neither the researcher nor the (acting) supervisor knew that laboratory procedures require an immediate medical evaluation for anyone who receives an electrical shock. Also, the procedures being used to perform the work were nearly 10 years old, and event reportability criteria were not clear to the personnel responsible

Figure 4-2. Underside of cathode

for reporting occurrences. As a result, the incident was not reported to the Occurrence Reporting and Processing System until 6 days after it occurred.

A preliminary causal analysis indicated that a broad array of issues may have played a role in the event, including inadequate training, incomplete hazards identification, insufficient work controls, obsolete procedures, inadequate implementation of hazard controls, and improper conduct of operations practices.

Corrective actions resulting from this event are expected to include the following.

- Evaluate all other sputtering chambers to identify any similar hazards.
- Evaluate other electrical equipment at the laboratory to identify any similar hazards.
- Develop and establish a safe operating mode for all sputtering equipment (detailing the function of the protective guard) with the concurrence of the Electrical Safety Committee, the building manager, and line management, before allowing operation of the equipment to resume.

A search of the Occurrence Reporting and Processing System database revealed two other electrical shock events at PNNL in the last 12 months. On July 29, 2002, a student researcher received an electrical shock from a faulty cartridge heater. The shock occurred when the researcher touched the metal edge of a fume hood with one hand while holding a stainless steel inspection mirror, in contact with the faulty cartridge heater, in the other. (ORPS Report RL--PNNL-PNNLBOPER-2002-0011; Operating Experience Summary 2002-20) On May 16, 2002, a researcher received a mild electrical shock while attaching a sensor to a radar unit he was testing. Investigators tested and evaluated the electrical receptacle and equipment involved in the incident, and concluded that the cause was an improperly grounded receptacle. (ORPS Report RL-PNNL-PNNLBOPER-2002-0005; Operating Experience Summary 2002-14)

The National Fire Protection Association Standard 70, *National Electrical Code*®, provides safety standards for electrical circuits and systems. A copy of the 2002 edition of the code can be obtained by calling the NFPA at 1-800-344-3555 or from the NFPA website at http://www.nfpa.org/codes.

These events underscore the need for workers to be constantly aware of the hazards associated with the work being performed, and of the limitations on the controls instituted to limit exposure to these hazards. In the April 2003 event, the researcher removed a protective guard on the front of the equipment specifically installed to protect users from electrical shock hazards. Removal of this guard created a condition where an energized work permit and personal protective equipment were required to use the equipment, and neither the researcher nor his supervisor was aware that these new requirements applied. The absence of the physical protection provided by the guard, the absence of the discipline and hazard awareness provided by the permit process, and the absence of personal protective equipment resulted in a condition where the researcher was directly exposed to the electrical hazard and could have been seriously injured.

KEYWORDS: *Electric shock, cathode, DC power source, research equipment, laboratory researcher*

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

5. ELECTRICAL CIRCUIT BREAKER LOCKING DEVICE PROBLEMS

On May 5, 2003, at the East Tennessee Technology Park Closure Project, a locking device two subcontractor electricians had used on a 200-amp circuit breaker fell off because it was not adequately affixed to the circuit breaker handle. The electricians had used electrical tape to help hold the device in place. (ORPS Report ORO--BJC-K25GENLAN-2003-0007)

The electricians were installing a new circuit for a power outlet. They had used double circuit breaker protection and verified the absence of voltage with a meter. A safety advocate checking electrical isolation for the work opened the circuit breaker panel door to check the locking device, and the device fell to the floor. The safety advocate immediately stopped the job. The electricians tried to reinstall the locking device, but after several attempts determined that the device was inadequate for this application because it kept falling off. Work was completed after stationing one of the electricians at the circuit breaker to ensure it remained open.

During a critique of the event, critique members learned that the electricians applied electrical tape to shim the handle in an attempt to get the locking device to remain in place and prevent operation of the circuit breaker. Figure 5-1 shows the locking device, which uses a thumbscrew to hold the device in place.

Figure 5-1. Locking device that fell off the circuit breaker handle

The design of the circuit breaker handle did not permit ready and secure attachment of the locking device because it was tapered (Figure 5-2). Figure 5-3 shows a reenactment of the lockout device installed using electrical tape.

Other events in which locking devices have fallen off include the following.

- On July 31, 2002, at the Thomas Jefferson National Accelerator facility, a lockout device installed by a subcontractor electrician to provide electrical isolation fell off. The device, designed for use on a double circuit breaker, had been installed to block two adjacent circuit breakers. The device slipped off because it did not provide a proper fit with the equipment being locked out. After the locking device fell off, someone noticed there was no locking device in place and closed the circuit breakers, in violation of the lockout. (ORPS Report ORO--SURA-TJNAF-2002-0005)

Figure 5-2. 200-amp circuit breakers showing thick tapered actuation handle

- On May 3, 1999, at the Savannah River Soil Groundwater Closure Project, operations personnel discovered that a locking device for a circuit breaker had broken and fallen to the floor. The plastic device separated because it was not designed for the circuit breaker. The weight of the hasp and lock contributed to the failure because the device was only designed to support the weight of a tag. (ORPS Report SR--WSRC-SGCP-1999-0011)

Figure 5-3. Reenactment showing lockout device installed with electrical tape (orange) applied to circuit breaker handle

It is important that lockout devices are used properly and remain in place to provide the protection intended. OSHA 29 CFR 1910.147, *Control of Hazardous Energy (Lockout/Tagout)*, Section 1910.147(c)(5)(ii)(C)(1), "Lockout Devices," states that lockout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters or other metal cutting tools.

A report by B. Miller Engineering contains an evaluation of the effectiveness of several lockout devices intended for use on single and multi-pole circuit breakers. The report, which includes test results and photos on lockout devices manufactured by North Safety Products, Brady USA, Inc., and Panduit, can be accessed at http://www.bmillerengineering.com/lockout.htm.

In addition to locking devices falling off, a lessons-learned report from Hanford identified a problem where a certain type of locking device caused damage to the circuit breaker handle. (SELLS Identifier 2002-RL-HNF-0017)

Figure 5-4 shows damage to the center pole operating handle of a circuit breaker caused by excessive and repeated tightening of the locking device set screw. The setscrew crushed the hollow part of the handle (shown between the arrows). This damage also allowed the center pole to remain closed when the breaker switch was placed in the open position.

Figure 5-5 shows the set-screw-type locking device manufactured by Panduit (Model PSL-CB) installed on a multi-pole circuit breaker.

Figure 5-4. Damaged circuit breaker handle

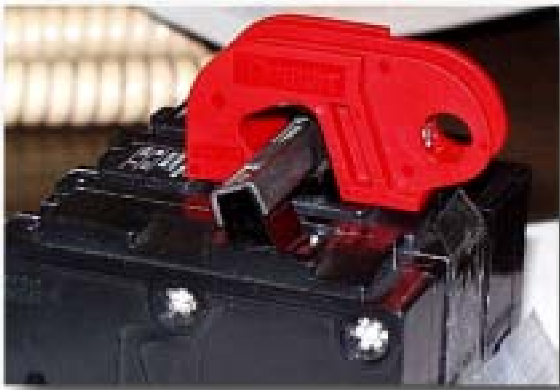

Figure 5-5. Circuit breaker locking device that uses a setscrew

To avoid recurrences, facility electrical engineers researched available multi-pole locking devices for circuit breakers with a tie-bar. Figure 5-6 shows a model manufactured by Brady (Item 5578) that uses a thumbscrew, which securely locks out the breaker without causing damage.

Figure 5-6. Thumbscrew-type locking device for multi-pole circuit breakers

A copy of the Hanford lessons-learned report can be accessed from the SELLS website at http://tis.eh.doe.gov/ll/listdb.html.

These events underscore the importance of selecting a lockout device that is designed for the particular application to ensure that it does not cause any damage and that once installed; it prevents operation of the equipment being locked out. Circuit breaker device styles vary based on the manufacturer of the breaker and the size and configuration of the breaker. This also applies to locking devices used for valves in piping systems. A simple chain and lock may work for some *valve designs, while others may require lockable devices that encapsulate the valve handle or the entire valve.*

KEYWORDS: *Lockout/tagout, locking device, circuit breaker*

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