OPERATING EXPERIENCE SUMMARY

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U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2003-06

March 24, 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.

Operating Experience Summary 2003-06

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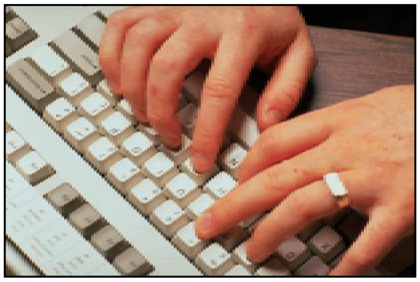

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EVENTS

1. BURIED CONDUIT PARTIALLY SEVERED WHILE CUTTING ASPHALT

On January 7, 2003, at the Lawrence Livermore National Laboratory (LLNL), laborers partially severed an electrical conduit containing a 208/120-volt power line while cutting asphalt with a power saw. A circuit breaker tripped, causing power outages in two buildings. The laborers assumed that conduit was buried at least 18 inches deep, when in fact it was only 4 inches below the surface. No injuries or significant property damage resulted from this event. (ORPS Report OAK--LLNL-LLNL-2003-0001)

Two experienced, certified operators conducted independent underground utility surveys with line-tracing equipment as part of the job planning process. The survey included a depth measurement that indicated the conduit was about 18 inches deep, which was in accordance with the standard LLNL practice of burying conduit 18 to 24 inches deep. The laborers made two passes with the saw, cutting about 2 to 2½ inches deep on each pass. On the second pass, at a depth of approximately 4 inches, they cut the conduit. The damaged circuit was not de-energized and locked out, but the laborers had grounded the saw. The laborers were also protected by personal protective equipment (electrically-rated gloves, face shield, hard hat, ear plugs, and boots).

The run of conduit beneath the asphalt was approximately 20 feet, as shown in Figure 1-1. Manufacturer specifications for the locating equipment used to survey the area stated that "span distances less than 50 feet may not produce accurate depths on buried utilities."

Investigators determined that one of the causal factors for this incident was that the conduit was probably installed nearly 50 years ago. At that time, the current LLNL practice of burying utilities 18 to 24 inches deep was not in effect, so the conduit was much closer to the surface.

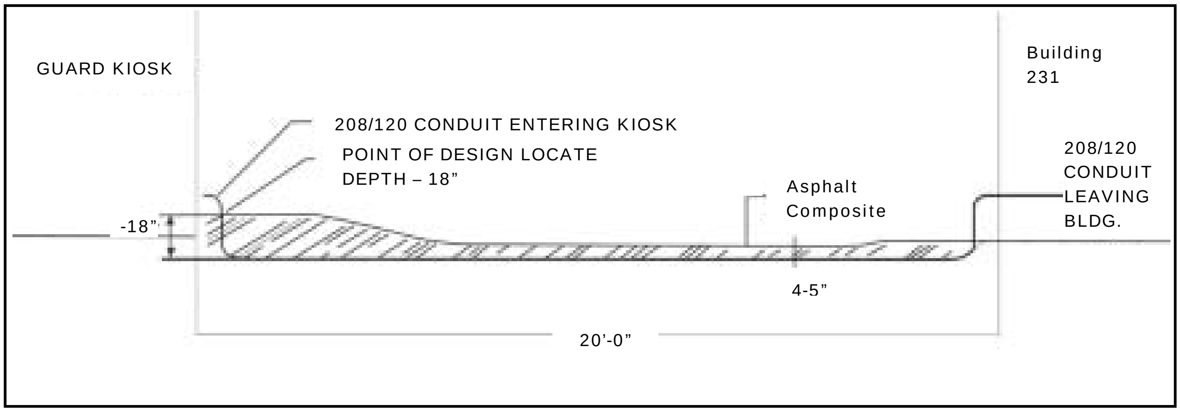

Figure 1-1. Diagram of buried electrical conduit

Corrective actions identified by investigators and construction managers included the following.

- Use ground-penetrating radar to locate buried conduit in cases where the length of conduit is less than 50 feet.
- Re-emphasize the need to install a lockout/tagout of any energy sources located within an excavation area.
- Reinforce the need to use appropriate personal protective equipment when performing excavation or penetration activities near potentially energized conduit to reduce the risk of injury to workers.

Electrical intrusion events (where saws, drills, backhoes, or other construction equipment damage electrical lines) continue to occur in the DOE complex at an average rate of approximately two per month. This is a slight reduction from the 2.5 per month average rate of occurrence observed in calendar years 2000 and 2001.

In June 2002, the Office of Environment, Safety and Health (EH) issued a special report, *A Review of Electrical Intrusion Events at the Department of Energy: 2000-2001*. This report contains the results of analyses of 63 electrical intrusion events reported in the DOE Occurrence Reporting and Processing System from January 2000 through December 2001. Problems identified in the special report included inaccurate as-built drawings, noncompliance with procedures, lack of zero-energy checks, and inadequate work practices. (This report is located at URL http://tis.eh.doe.gov/paa/reports.html.)

A lessons-learned report on this topic (HQ-EH-2002-01) can be accessed from the Society for Effective Lessons Learned Sharing at the following URL: http://tis.eh.doe.gov/ll/listdb.html.

Information on electrical safety practices within DOE can be found in an EH, Office of Performance Assessment and Analysis, publication, *Electrical Safety Report*, dated May 21, 1999. Information on preventing damage to underground utilities can be found in *Common Ground, Study of One-Call Systems and Damage Prevention Best Practices*, published by the Common Ground Alliance, dated August 1999. This report is available at URL www.commongroundalliance.com. Chapter 4 of the report addresses best practices for locating and marking underground structures.

This event underscores the difficulty of accurately locating the depth of underground utilities, even when the general location of the line is known. The use of scanning and survey equipment has been generally successful in locating buried conduit, but depth indication results are often suspect. This is because locating technologies have limitations that must be understood and compensated for when survey equipment is used. Personal protective equipment and lockout/tagout processes should always be considered when there is a possibility of encountering energized electrical conductors. Determining the precise location and depth of embedded or buried electrical conduit remains an industry-wide problem.

KEYWORDS: *Electrical intrusion, severed conduit, underground utilities, excavation, survey equipment for buried utilities*

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

2. TYPE B INVESTIGATION OF WORKER INJURY IN FALL FROM LADDER

On January 28, 2003, at the Stanford Linear Accelerator Center (SLAC), a systems engineer fell from a ladder, sustaining serious head injuries that required hospitalization. A DOE Type B accident investigation was conducted from February 6 through 24, 2003. (ORPS Report OAK--SU-SLAC-2003-0001)

The systems engineer entered the building to investigate reported nitrogen leaks in radio frequency high-voltage power supplies. It is not known whether he inspected the 12-foot ladder in the area. Working alone, he climbed the ladder to gain access to the top of the older power supply that was to be replaced (Figure 2-1 shows a similar ladder positioned at the scene of the accident). It appears that the engineer stepped sideways off the ladder onto the transformer; he fell to the concrete floor.

Two subcontractor electricians working nearby heard the engineer fall. One stayed at the scene, and the other ran to summon emergency assistance.

The engineer got up on his knees, then lay down again and appeared to momentarily lose consciousness. The engineer was transported to an offsite hospital for treatment. The DOE site office director convened a Type B accident investigation based on the event's meeting the criteria specified in DOE O 225.1A.

The Board's investigation revealed a number of improvements in the work process. Specifi-

Figure 2-1. The accident scene

cally, a pre-work inspection of the ladder would have shown its condition; for example, its non-slip rubber feet were damaged and worn, as can be seen in Figure 2-2. The bent spreaders were a result of the fall.

Other signs of damage and wear existed before the accident, such as longitudinal cracking and a deformed step.
Line management did not perform a hazard analysis before this task began.

The Board noted that in the past 5 years, four ladder accidents had occurred at SLAC, all resulting in worker injuries. The most recent of these are summarized below.

- On August 20, 2002, a SLAC worker dislocated and fractured his right shoulder after he tripped and fell forward into a fixed ladder access opening. His injury required the insertion of a metal plate in his shoulder. (ORPS Report OAK--SU-SLAC-2002-0009; OE Summary 2002-25)
- On June 18, 2002, a subcontractor worker suffered a compound fracture of his left elbow and a right knee hematoma after falling about 6½ feet from an extension ladder to the ground. The worker was transported to Stanford University Medical Center, treated, and released 2 days later. (ORPS Report OAK--SU-SLAC-2002-0004; OE Summary 2002-16)

The Board's report offered a number of Judgments of Need to assist line management in developing corrective actions for maintenance and troubleshooting activities. These are listed below.

- SLAC needs to develop and implement processes for work planning and control that define the scope of work, establish criteria and develop procedures for performing task-specific hazards analyses, authorize work, facilitate the exchange of feedback between management and workers, and ensure management involvement in controlling hazards.
- The Stanford Site Office needs to assess the extent to which SLAC holds line management accountable to ensure that safety requirements are enforced and addressed as part of the work planning process.
- Management needs to develop and implement an effective oversight program to ensure full implementation of the Integrated Safety Management System (ISMS).

***Figure 2-2. The** damaged ladder*

- SLAC needs to develop and implement a process for effectively identifying issues, tracking and trending corrective actions, and reporting results to senior management.

RECENT EVENT: On March 24, 2003, at the Idaho Engineering and Environmental Laboratory, an operator standing on a ladder to check a valve lockout/tagout leaned outside of the ladder's working footprint, falling about 6 feet to the concrete floor and fracturing his pelvis. The operator's injury did not require surgical treatment. (ORPS Report ID--BBWI-ATR-2003-0004)

These events illustrate the importance of developing effective corrective actions to prevent recurrences. The five core functions of the ISMS should be the foundation from which all work processes are built.

KEYWORDS: *Ladder, injury, fall protection*

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

3. UNSECURED SCAFFOLD EXTENSION RESULTS IN NEAR MISS

On February 18, 2003, at the Hanford Site, a worker was standing on an unsecured plywood plank being used as a scaffold extension when it shifted and dropped, causing the worker to fall about 18 inches. The worker and the extension landed on top of two manipulator arm tubes exiting a wall, saving him from a potentially serious 10-foot fall. The extension plank was retrieved before it fell to the floor. No injuries or equipment damage resulted from this event. (ORPS Report RL--PHMC-324FAC-2003-0002)

The scaffold was erected to provide a work platform about 11½ feet above the floor so workers could perform a scabbling operation to clean the ledge of a crane rail. Because of physical constraints within the area, the crew erecting the scaffold had to set it back from the adjacent wall by approximately 1 foot, with its length running parallel to the wall. To allow workers access nearer to the wall, they used a plywood plank as a bridge between the work floor of the scaffold and a crane rail attached to the adjacent wall.

The crew anchored the plywood plank and a spacer underneath it to the scaffold deck with nails. They did not secure the plank on the wall side, and they did nothing to ensure the scaffold could not move. Figure 3-1 shows the erected scaffold, the nearby crane rail on the adjacent wall, and the two manipulator arm tubes exiting the wall of a hot cell. Figure 3-2 is a view from underneath the gap between the edge of the scaffold deck and the crane rail, after the plywood plank that had previously filled this space had fallen.

After it had been erected, the scaffold erection crew placed two tags on the scaffold that were taken from a scaffold erected previously in another part of the facility. One was an "Authorized for Use Inspection" tag; the other was a "Caution" tag. The crew uses "Caution" tags to identify scaffolds that are not in strict compliance with scaffolding requirements but are allowable under specified conditions. The scaffold erection crew did not believe reusing tags from other scaffolding was prohibited by procedure, and they intended to have an inspection performed before releasing the scaffold for use.

The work crew that was scheduled to use the scaffold questioned both the acceptability of re-used tags and whether the scaffolding had been properly inspected and tagged. Technical supervisory personnel were subsequently requested to properly inspect and tag the scaffold. Because he believed that the physical inspection had been completed after the scaffold was erected, a work supervisor performed only a cursory inspection of the scaffold, then affixed the tags.

Investigators identified the preliminary direct cause of this occurrence as a slight movement

Figure 3-2. Gap between the scaffold and the crane rail

of the scaffold away from the wall. This movement allowed the wall-side edge of the plywood plank to slide off the crane rail that supported it and drop, causing the worker on the plank to fall as well. The movement of the scaffold away from the wall may have been caused by the worker leaning into the wall to perform the scabbling operation. Because the footings of the scaffold were on a steel floor, there was minimal resistance to movement in the lateral direction away from the wall.

A preliminary determination of contributing causes to the event included procedural issues related to (1) improper installation of an extension to the scaffold as a working surface, and (2) inadequate inspection and tagging processes. Also, using an unsecured, unguarded bridge plank as a working surface may have violated OSHA requirements, such as those contained in 29 CFR 1910.28, *Safety Requirements for Scaffolding*. OSHA standards are accessible at http://www.osha.gov.

The following corrective and compensatory actions are expected to result from this event.

- Suspension of the use of similar scaffolds at the facility until they have been inspected to ensure that they can perform their intended function safely.
- Inspection of all scaffolds site-wide.
- Resolution of the issues involved in this event by the contractor's Scaffolding Technical Authority organization.
- Evaluation of the need for refresher training for scaffold erectors, inspectors, and users.
- Clarification of the responsibilities assigned to scaffold inspectors and erectors in site requirements documents.
- Completion of an independent safety investigation of the event to provide recommendations for long-term improvements.

A search of the ORPS database for events related to the erection and use of scaffolds revealed several occurrences, including the following. On September 13, 2002, at the Oak Ridge Y-12 Site, workers were installing safety rails on a 13-foot high scaffold when one of the workers climbed over the railing of an adjacent catwalk and stepped across an open span onto the scaffold platform. The span that the worker stepped across was approximately 25 inches wide, and fall protection was not provided. (ORPS Report ORO--BWXT-Y12SITE-2002-0040)

On August 28, 2000, at the Savannah River Site Tritium Facility, carpenters were installing toe boards on the working platform of an 18-foot high scaffold when one of the toe boards fell, striking an electrician who was standing on the floor. The electrician was treated for a contusion of the elbow. (ORPS Report SR--WSRC-TRIT-2000-0009)

The February 2003 event at the Hanford Site underscores the importance of performing an engineering evaluation when modifications are made to scaffolds before any proposed changes are implemented. Particular attention should be focused on ensuring adequate overlap and securing working surfaces to ensure that they remain stable throughout the proposed work evolutions. This is especially true for modifications to working surfaces in the form of extensions of the surfaces. In addition to the engineering evaluation, a detailed inspection by a certified inspector should be performed before the scaffold is used.

KEYWORDS: *Scaffold, fall protection, scaffold inspection, scaffold modification*

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

4. LOCKOUT/TAGOUT VIOLATIONS AND LESSONS LEARNED

There have been a number of lockout/tagout (LOTO) events since the beginning of calendar year (CY) 2003 that involved a near-miss to hazardous energy. The purpose of this article is to notify the DOE complex of the characteristics and frequency of these continuing LOTO events and provide lessons learned.

The following eight events are typical of the many types of LOTO failures occurring across the DOE complex.

- On March 13, 2003, at Savannah River, maintenance personnel working on a fan discovered a LOTO applied to the wrong component. (ORPS Report SR--WSRC-FBLINE-2003-0002)

- On March 5, 2003, at Savannah River, subcontract technician failed to install a proper LOTO while replacing light fixture ballast. (ORPS Report SR--WSRC-BMSDGEN-2003-0003)

- On February 18, 2003, at Idaho, maintenance personnel working on an air-handling unit discovered that two condensate valves had not been identified or closed under the LOTO. (ORPS Report ID--BBWI-LANDLORD-2003-0002)

- On February 5, 2003, at Savannah River, while balancing a motor, mechanics noticed 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 believed a 480-volt lighting circuit they were working on was de-energized and locked out under another task when it was not. (ORPS Report HQ--SPR-BH-2003-0001)

- On January 30, 2003, at Sandia National Laboratories, multiple LOTO issues resulted in a Sandia-wide stand-down and reauthorization of LOTO qualifications. (ORPS Report ALO-KO-SNL-NMSITE-2003-0001)

- On January 24, 2003, at Pantex, a subcontract electrician failed to perform a zero energy check, resulting in an electrical arc when a wire was cut. (ORPS Report ALO-AO-BWXP-PANTEX-2003-0005)

- On January 15, 2003, at Idaho, an engineer used an improvised metal tool in close proximity to an energized source without installing a LOTO while trying to free a stuck part in a piece of equipment. (ORPS Report ID--BBWI-SMC-2003-0001)

It is important to point out that the results of the stand-down at Sandia for LOTO issues have produced positive results. Workers attended a new LOTO training module as part of their reauthorization to perform lockouts and tagouts. In addition, supervisors conducted independent observations of workers performing lockouts and tagouts to validate the effectiveness of the reauthorization process. The observations will continue over the next few years to monitor for progress or decline.

Although the number of reported LOTO events has decreased over the past three years, and is down by almost 50 percent since CY 2000, these events continue to occur and represent a potential safety hazard to workers. This is particularly true for those events involving electrical energy.

A search of the ORPS database indicated that the number of LOTO events involving electrical systems actually increased during the period from January 2002 through February of 2003, while LOTO events involving other hazards decreased (Figure 4-1). During this period, electrical LOTO events were three times the number of those involving other hazards.

The foremost consequence of an improper lockout is the threat of injury from stored energy, uncontrolled hazards, or hazardous materials. This may include voltage from unexpected sources, hazards from rotating equipment, pressurized systems, and elevated temperatures. The most effective barrier against electrical sources is to de-energize the source and apply a LOTO.

The principal components of a lockout are planning the work, establishing the lockout, performing the work, and removing the lockout. A review of direct causes for lockout problems reported in ORPS reveals that the majority of lockout events are related to conduct of operations issues and work planning. Planners and lockout installers should understand and avoid lockout traps and pitfalls.

Improperly established lockouts and tagouts can evoke a false sense of security. A worker who approaches equipment that has been locked out is apt to place a great deal of trust in the lockout. A work planner may relax requirements for personal protective equipment or special precautions based on confidence in the lockout. An inadequate lockout can expose workers to unexpected hazards for which no other protection many have been provided. Aged or broken equipment, inadequate design documentation, or undiscovered energy sources can undermine an otherwise perfectly executed lockout.

Guidance on LOTO issues can be found in OSHA standard 29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*, and other OSHA fact sheets and booklets. These documents can be accessed at www.osha-slc.gov/SLTC/control-hazardousenergy. Other guidance can be found in DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, which is available at http://tis.eh.doe.gov/techstds/standard/std1030/std1030.pdf.

LOCKOUT TRAPS AND PITFALLS

- Inaccurate facility design data can lead to inadequate lockouts.
- Missing or conflicting component labeling can cause errors.
- Assuming a zero-energy condition exists without verification can result in injuries.
- Working outside the physical boundaries of a lockout can introduce unanalyzed hazards.
- Failing to independently verify correct component and required position can result in unidentified lockout errors.
- Departure from standard lockout points or practices can produce incorrect lockouts.
- Inadequate control of multiple lockouts on the same system or component can expose workers to unexpected hazards.
- Complacency, inattention to detail, reliance on skill-of-the-craft, or inadequate training can lead to inadequacies in any stage of the lockout process.
- Pressure to meet schedules or deadlines can compromise safety by increasing the likelihood of errors.

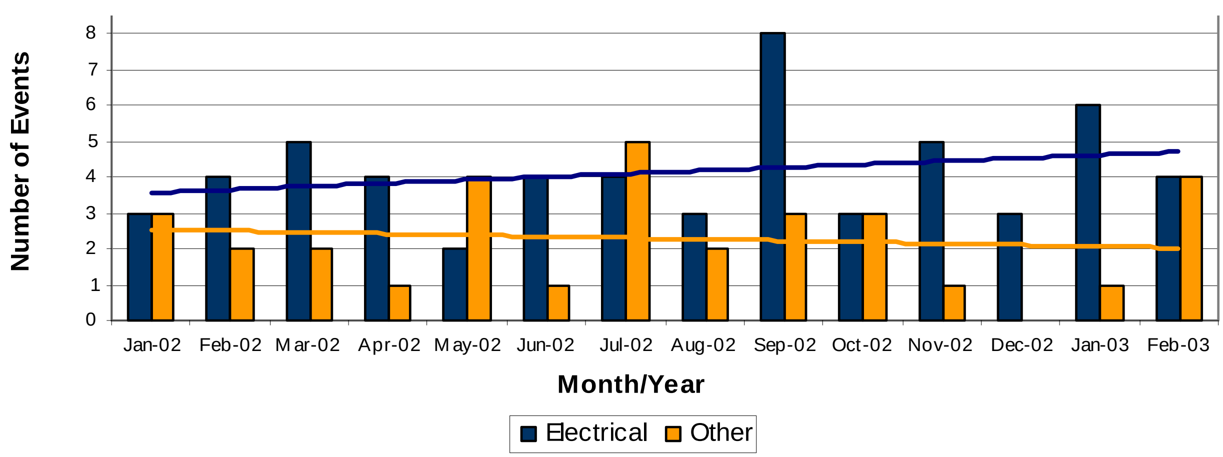

Figure 4-1. Lockout/tagout events by type

LESSONS LEARNED

- Work planners should include enough detail in work plans to allow positive identification of work scope and requirements for lockout protection.
- Lockout planners should thoroughly research and walk down (where practical) each lockout, particularly if the accuracy of the design documentation is questionable.
- Work planners should apply defense-in-depth to lockout requirements proportional to the hazards involved (e.g., added PPE or special work methods).
- Lockout installers, independent verifiers, and lockout owners should practice self-checking to ensure correct components are locked and tagged, are in the correct position or condition, and provide adequate protection.
- Each worker who signs on to a LOTO should independently perform a walk-down of the lockout and verify a safe-to-work energy check was performed.
- Stop-work responsibility and authority should be exercised when the adequacy of a LOTO is in doubt.

The lockout/tagout program is a critical part of each site's integrated safety management program. It is an administrative program that can work only as well as the degree of discipline and attention to detail given to its implementation.

Facility staff should investigate adverse lockout/tagout occurrences promptly and communicate lessons learned to work groups and apply these lessons to training programs and procedures. Managers should require periodic walk downs of active lockouts to ensure that they are properly applied and controlled.

KEYWORDS: *Lockout/Tagout, LOTO, safety, lessons learned, control of hazardous energy*

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

5. *SAFETY ALERT INVOLVING TRANSPORTATION OF COMPRESSED GAS CYLINDERS*

The U.S. Army Medical Research and Materiel Command recently reported an incident that occurred at an Air Force installation at Fort Huachuca, AZ. A driver was transporting unsecured compressed-gas cylinders in the back of a pickup truck when he had to stop suddenly, forcing two cylinders forward through the rear windshield. One of the cylinders was propelled through the front windshield on the passenger side of the vehicle (Figure 5-1). The driver was uninjured, and there was no passenger.

Figure 5-1. The cylinders shifted in the truck bed

The safety alert identified several issues that contributed to this incident. The bottles were stacked too high and were not secured in the truck bed. The driver was also speeding, so he had to brake suddenly and hard. Fortunately, the cylinders' valve stems were covered, which may have averted a missile hazard. The truck driver drove 2 miles back to the shop in a significantly damaged, unsafe vehicle (Figure 5-2).

Title 49 of the Code of Federal Regulations, section 177, *Carriage by Public Highway*, (URL http://www.access.gpo.gov/nara/cfr/waisidx02/49cfr17702.html), addresses the handling and transportation of compressed gas cylinders. Specifically, subpart 840 states that cylinders "must be securely restrained in

Figure 5-2. One cylinder burst through the windshield

an upright position, loaded in racks, or packed in boxes or crates and securely attached to the motor vehicle to prevent the cylinders from being shifted, overturned, or ejected from the vehicle under normal transportation conditions."

A search of the Occurrence Reporting and Processing System database revealed two similar events involving unsecured loads in pickup trucks.

- At the Paducah Gaseous Diffusion Plant, two operators were transporting a small tilt dumpster to a storage area in the bed of a pickup truck. When the driver of the pickup truck stopped at a stop sign, the dumpster shifted and rolled forward into the rear of the pickup truck cab, shattering the rear glass and damaging the roof of the vehicle. There were no injuries to personnel. (ORPS Report ORO--BJC-PGDPENVRES-2001-0023)
- At the Idaho Power Burst Facility Area, the driver of a pickup truck transporting three empty 71-gallon steel drums applied the brakes too hard when approaching a stop sign, causing the unsecured drums to slide forward and shatter the window of the cab. The driver had bound the drums to each other with duct tape, but did not think to secure the load to the bed of the truck to prevent them from sliding. (ORPS Report ID--LITC-PBF-1997-0005)

When transporting items and materials, personnel should follow all applicable procedural requirements to ensure materials are properly secured to each other and to the vehicle. Inadequate or makeshift methods of securing materials can result in shifting loads and damage to the materials being transported or to the transportation equipment.

KEYWORDS: *Unsecured load, shifted load, transportation, truck bed*

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