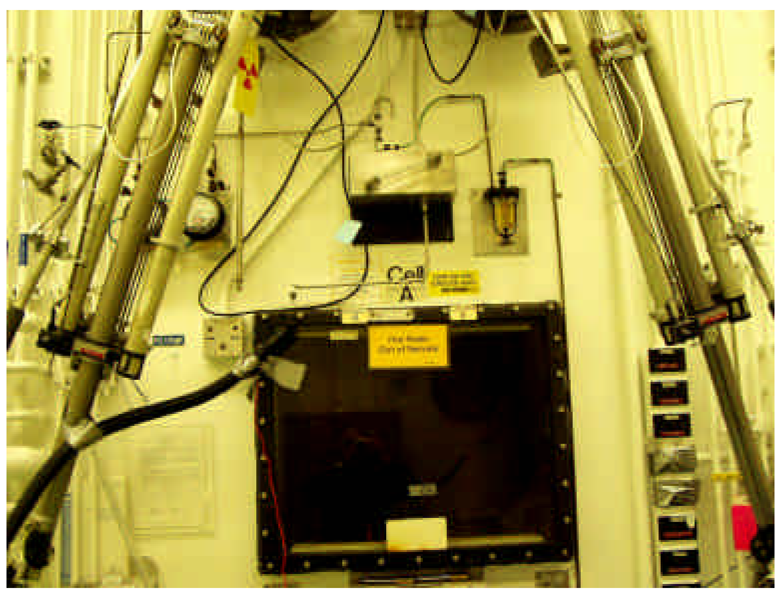
OPERATING EXPERIENCE SUMMARY

Inside This Issue



U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2003-24

December 1, 2003

With the full implementation of the redesigned Occurrence Reporting and Processing System (ORPS) on December 1, 2003, the Occurrence Reporting Binning and Tracking Tool (ORBITT) database has been discontinued. The ORPS database includes HQ Keywords that are equivalent to ORBITT bins to assist users in sorting through events to perform specific searches.

The old ORBITT bins have been crosswalked to the new HQ Keywords to provide data continuity.

Users may direct questions to Bal Mahajan by e-mail at bal.mahajan@eh.doe.gov.

RECEIVE E-MAIL NOTIFICATION FOR NEW OE SUMMARY EDITIONS

The process for receiving e-mail notification when a new edition of the OE Summary is published is simple and fast. New subscribers can sign up at the following URL: http://tis.eh.doe.gov/paa/subscribe.html. If you have any questions or problems signing up for the e-mail notification, please contact Richard Lasky at (301) 903-2916, or e-mail address Richard.Lasky@eh.doe.gov.

Visit Our Web Site

The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy 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, 301-903-8008, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction. If you have difficulty accessing the Summary on the Web (URL http://tis.eh.doe.gov/paa), please contact the ES&H Information Center, (800) 473-4375, for assistance. We would like to hear from you regarding how we can make our products better and more useful. Please forward any comments to Frank.Russo@eh.doe.gov.

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.

EVENTS

1. NEAR MISS: PIPEFITTER CUTS INTO ENERGIZED CONDUCTOR

On June 24, 2003, at Los Alamos National Laboratory (LANL), an apprentice pipefitter cut an energized 120-volt electrical conductor while drilling a hole in a concrete floor. The pipefitter had drilled approximately 2 inches into the floor when he encountered an obstruction. While removing the drill bit from the hole, the apprentice saw a spark and realized he had penetrated a conduit. Inadequate work planning and the lack of a lockout/tagout on nearby circuits contributed to this incident. The pipefitter did not receive an electrical shock. (ORPS Report ALO-LA-LANL-ADOADMIN-2003-0002; final report filed October 9, 2003)

The apprentice and a journeyman pipefitter were installing a ¼-inch copper water pipe. The apprentice planned to drill through the concrete floor to route the line from the second floor to a potable water pipe directly below. He was using a double-insulated Hilti hammer drill with a masonry bit. The drill also had ground-fault, circuit-interrupter protection. Both workers wore personal protective equipment (PPE), including Class 0 dielectric gloves (rated for 1,000 volts) with liners, leather gloves, and rubber boots. When the apprentice cut into the conduit a circuit breaker tripped, interrupting one utility current.

Investigators identified work planning deficiencies in three areas as the cause of this occurrence: (1) work request and work requirements; (2) work package development; and (3) work authorization and release processes.

Work Request/Work Requirements – Investigators determined that the initial work request for this task did not address the need for a penetration permit. When work supervisors decided that a penetration permit would be required, the permit was developed and approved, but no one updated the ES&H Site Hazard and Control Form to reflect the additional requirements associated with the penetration permit.

Work Package Development – Work planners wrote "not applicable" next to a checklist item that required a review of engineering drawings and the de-energization and lockout/tagout of nearby energy sources. Investigators determined that no one reviewed the electrical drawings because the drawings (dated June 5, 1951) had been used on earlier tasks and work planners found that they did not reflect the current wiring configuration. They also determined that supervisors did not de-energize local electrical sources before work began because the contractor had completed earlier blind penetration work without injury. The contractor also required workers to use PPE to compensate for the lack of a lockout/tagout.

Work Authorization and Release Processes – Investigators identified abnormalities in the way ground penetrating radar surveys were performed and how the results were communicated. The survey crew marked the floor areas where they obtained readings and designated areas where survey results were indeterminate (because of limitations of the survey equipment) as "buffer zones." Both the work supervisors and the pipefitters concluded that it was unlikely that electrical conductors would be present in a buffer zone, so they believed they could drill in that area if proper PPE were used. Investigators later cited this conclusion as a "misinterpretation of the term buffer zone."

Corrective actions resulting from this occurrence included the following.

- Facility management personnel will revise their work control procedure to clarify change control and penetration requirements for work planners.
- Contractor managers will revise their work review and approval procedures for penetrations to specify that drilling is not permitted in any area that has not been positively cleared of all hazards (e.g., buffer zones).

- LANL and contractor personnel will review the requirements for performing penetrations to determine if changes are needed.

- Contractor managers will make changes to the processes associated with using survey equipment, including (1) replacing the term buffer zone with the term "unknown zone"; (2) disseminating a standard package for reporting the results of surveys for hidden hazards; and (3) pursuing the use of different types of survey equipment with different operating principles (e.g., electromagnetic devices).

- Contractor health and safety personnel will develop and disseminate a penetration alert/checklist to be included in any work package involving penetration work.

A search of the ORPS database for similar events revealed several electrical intrusions that occurred during the performance of blind penetrations. On September 10, 2003, at the Los Alamos Lujan Neutron Scattering Center, a subcontractor severed an energized 120-volt conductor while cutting through a concrete slab when his gasoline-powered saw cut into a conduit. The conduit supplied power to a nearby wall-mounted receptacle. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-2003-0003)

A survey crew, assigned to perform utility locates for the slab removal work, identified the wall-mounted receptacle and believed the conduit entered the floor and ran parallel to the cut line and an expansion joint (Figure 1-1). However, the conduit entered the floor and immediately angled toward the cut area (Figure 1-2).

Ground penetrating radar surveys did not determine the change in direction of the conduit because of interference from embedded steel reinforcement. The crew did not survey beyond the cut area, and drawings did not indicate the routing of the conduit. Based on the survey markings, supervisors concluded that the area was free of hidden electrical hazards and therefore de-energizing the nearby 120-volt circuit was deemed unnecessary. Survey crews need to consider that concealed utilities do not always follow the path indicated by the visible portion of the line.

Figure 1-1. Electrical receptacle and conduit penetrating the floor and the location of the saw cut

On June 24, 2003, at the DOE North Las Vegas facility, a construction worker installing guardrails on a masonry wall inadvertently cut through an energized 120-volt conductor in a

Figure 1-2. Cut conduit (left) crossing into corner of the cut area

> **PREVENTABLE CONDITIONS THAT CONTRIBUTED TO THIS OCCURRENCE**
>
> - Not using a lock/out tagout and allowing workers to perform the blind penetration wearing personal protective equipment as a substitute for installing a lockout/tagout.
> - Not realizing that those who conducted the hazardous energy survey and those who planned and performed the task would interpret the term "buffer zone" differently.
> - Not reviewing engineering drawings or historical records to identify possible electrical conductors in the area to be drilled.
> - Not updating the ES&H Site Hazard and Control Form to reflect the requirements of the penetration permit.
> - Not using methods other than the results of the ground-penetrating radar surveys to identify hazardous energy obstructions in the area selected for the blind penetration.

lighting circuit, tripping a circuit breaker. Work planners did not identify the conduit because the hidden conductor was beyond the depth capability of the survey instrument used. (ORPS Report NVOO--BN-NLV-2003-0003)

Information on electrical safety practices within DOE can be found in the *Electrical Safety Report,* dated May 21, 1999, and published by the EH Office of Performance Assessment and Analysis. OSHA requirements on design safety standards for electrical systems and on safety-related work practices are presented in 29 CFR Part 1910, *Occupational Safety and Health Standards*, Subpart S, "Electrical." OSHA standards are accessible from the OSHA web site: http://www.osha.gov.

These events underscore the importance of proper planning and taking individual responsibility for working safely in the presence of electrical hazards. In the LANL incident, multiple preventable breakdowns in work planning, work authorization, and work execution occurred. It is unacceptable to rely on personal protective equipment to prevent electrical shock injuries instead of performing comprehensive surveys for hidden electrical conductors or installing appropriate lockout/tagout devices. Supervisors need to be responsible for enforcing electrical safety policies and directives and providing a safe work environment for the workers they supervise.

KEYWORDS: *Electrical penetration, electrical safety, work planning deficiencies, survey for hazardous energy sources, blind penetration*

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

2. FIRE IGNITES IN WASTE DRUM BEING VENTED

On August 13, 2003, at the Idaho National Environmental and Engineering Laboratory, the site emergency coordinator declared an emergency alert when a fire ignited in a bulging waste drum that was being vented. The fire self-extinguished shortly after it ignited. No personnel injuries or personnel contamination resulted from this event. (ORPS Report ID--BNFL-AMWTF-2003-0008; final report issued November 5, 2003)

Facility personnel were retrieving underground transuranic waste drums for inspection. These drums, containing Rocky Flats waste, had been stored for about 30 years, and some were bulging, showing evidence of overpressurization. Bulging drums were vented using a commercially available pneumatic punch with a brass, non-sparking bit. These punches are typically used throughout the DOE complex to relieve gas buildup in drums. The punch is operated remotely using a nitrogen system with a working pressure of 150 psig. Although some damage occurred to the polyethylene drum liners, the waste itself was not affected.

Facility personnel were evacuated from the area, and the drum was monitored remotely using thermal imaging technology. After about an hour, the drum cooled to ambient temperature, and workers re-entered the area and removed the venting device from the drum. The emergency was terminated shortly afterward, and the drum was placed in an overpack container for storage.

An investigation team began collecting data immediately after the emergency was terminated to determine the causes of the event and develop recommendations. The team was unable to pinpoint the ignition source.

The transuranic waste contained in these drums is known to generate flammable gases that could accumulate in the drum headspace. In 1995, Wastren published a report entitled *Idaho National Engineering Laboratory Code Assessment of the Rocky Flats Transuranic Waste.* That report documents headspace gas analyses of 13 waste drums stored at Idaho that demonstrated both hydrogen gas levels well in excess of the 4 percent lower explosive limit (LEL) and elevated levels of oxygen. Other flammable gases, notably hydrocarbons, were present but in concentrations below their respective LELs. Based on the historical headspace data, investigators concluded that the drum headspace could have contained a combustible mixture of hydrogen and oxygen at the time the drum was being vented.

Mixtures of hydrogen with air, oxygen, or other oxidizers are highly flammable. Because hydrogen ignites in air at relatively low energy (0.017 milliJoule at 14.7 psi), the discharge of static electricity from a human body, for example, can cause a hydrogen/air mixture to ignite.

The investigators postulated that operating the vacuum exhaust could have produced a static charge on its hose. Because the drum rested on a plastic pallet and was not bonded or grounded, a static charge could have ignited the hydrogen/air mixture being vented from the drum. The flame could have then spread back into the drum headspace. Alternatively, the drum punch, although made of spark-resistant brass, could have produced a friction or impact spark that ignited the gas in the headspace. Also, in sufficient concentrations, hydrogen can self-ignite. The investigation team learned through interviews that information available before the event occurred indicated that all drums of this type have the potential to contain a combustible mixture of hydrogen and oxygen, even if the pressures are low.

Based on the opinions of professional fire protection personnel, the investigative team believes that the potential for ignition of waste drum gases can be reduced, but not eliminated. It may be impractical to try to prevent all drum fires without extensive engineering controls involving elaborate and complicated systems and structures. The investigation team's report recommended controls to improve worker safety and reduce the likelihood of a fire, including revising operating procedures and emergency plans to handle a fire as an expected, but infrequent, event.

The investigation team observed several deficiencies in work planning and change control that contributed to this event.

- The selection process did not include a formal design review or a consultation from a fire protection subject matter expert. As a result, all potential sources of ignition were not evaluated, and the potential for a hydrogen deflagration was not identified.
- Change control procedures did not adequately describe the appropriate method and level of rigor for assessing the potential hazards posed by the change.
- Work control procedures sometimes led the users to implement changes without a sufficient level of review and approval.

The investigation team also found potential contributors to other possible loss scenarios. Further details on these contributors and other aspects of the event can be found in the lessons learned submission, which can be retrieved at the following URL: http://www.eh.doe.gov/ll (Lessons Learned Identifier 2003-ID-AMWTP-0001).

- The documented safety analysis for this facility describes the most likely explosion during venting as a small hydrogen flash with no consequences. However, operational procedures regarded the event as an emergency, which required the assistance of outside agencies and emergency response organizations.

- Drum venting procedures could provide more specific instruction on drum handling, segregation, and venting. Under the current process, operators visually determine if a drum requires venting.

A similar event involving a fire that resulted from static discharge occurred on October 17, 2003, at Argonne National Laboratory–West. A journeyman painter was pouring used solvent from a 5-gallon plastic container through a metal funnel in the top of a 55-gallon drum being used temporarily to store used solvent (Figure 2-1). The painter used a nylon paintbrush to remove the solvent and paint residue, and a static discharge from the plastic bucket to the metal drum ignited the solvent vapors. The painter's gloves and brush caught fire, so the painter dropped the paintbrush, shook off the gloves (Figure 2-2), left the paint storage room, and actuated the nearest fire alarm. The painter and two co-workers estimated the fire in the drum burned for approximately 1 to 3 minutes and self-extinguished. A co-worker entered the paint storage room, removed the paintbrush, and

Figure 2-1. The solvent drum and plastic bucket involved in the fire

Figure 2-2. The burned gloves

HANDLE WASTE DRUMS SAFELY

- If possible, handle the drums remotely or isolate them from personnel.
- Consider the three potential ignition sources (friction or impact sparks, static electricity, and self-ignition) when handling waste drums that could contain explosive concentrations of gases, and ensure that drums are appropriately grounded.
- Identify, where possible, any additional features or controls that could minimize the potential for combustion of flammable gases.
- Always consider the potential for a fire when planning work involving drums that are known to generate flammable gases.
- Make use of all available information across the DOE complex on combustible gases that accumulate in waste drums to determine the appropriate controls to reduce the probability of a fire.
- Analyze the worst-case outcomes of a task to develop the controls necessary to reduce the severity of consequences in the actual case of an adverse event such as a fire or equipment failure.
- Follow the guidance in the DOE fire safety directives when handling waste drums.

doused the area with water. The painter suffered no physical injuries, but her hair was singed. (ORPS Report CH-AA-ANLW-ANLW-2003-0004)

A more serious drum fire occurred at Fernald on July 24, 1999, when a 5-gallon can of thorium metal wafers and debris caught fire as it was being vented. The fire spread to another can nearby. The job supervisor attempted unsuccessfully to put out the fire using MET-L-X® extinguishing material before emergency personnel arrived. No personnel exposures or injury resulted from the fire. The venting procedure did not sufficiently describe the manner and location in which the containers should be punched. When the can was punched, the bit disturbed the crust on thorium wafers, which sparked the fire. (ORPS Report OH-FN-FFI-FEMP-1999-0014)

DOE fire safety directives (DOE O 420.1, *Facility Safety*, and DOE G 440.1-5, *Fire Safety Program for use with DOE O 420.1 and DOE O 440.1*) identify the need to analyze all relevant fire hazards in both the facility and job hazards analyses and to provide the appropriate safeguards. These can be accessed at the DOE Directives web site: www.directives.doe.gov. DOE has conducted significant research on drum fire hazards. Questions may be directed to the subject matter expert, Jim Bisker, at 301-903-6542 or e-mail jim.bisker@eh.doe.gov. The accompanying text box contains recommendations for safely handling drums containing potentially flammable gases.

These occurrences illustrate the hazards posed by flammable gases in drums. Personnel working with drums containing flammable gases should implement the appropriate controls to reduce the risk of fire.

KEYWORDS: *Fire, transuranic waste, drum handling, drum venting*

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

3. WORKERS CLEANING HOT CELL WINDOW SPLASHED WITH ACID

On September 29, 2003, at the Oak Ridge National Laboratory, two workers cleaning a hot cell window were splashed with acid on their clothing and skin when an argon sparge gas was introduced into the acid cleaning solution. A pipefitter was splashed on his upper forehead (above his safety glasses). The acid splashed his co-worker over a 4-inch area on the lower neck and shoulder. Both workers wore safety glasses, which protected their eyes, and they immediately used a nearby safety shower to wash the acid off their skin. The workers received first-degree chemical burns. (ORPS Report ORO--ORNL-X10NUCLEAR-2003-0020)

The hot cell window, an old (1960s) design, was being cleaned in place with chemicals instead of removing it from inside the cell (i.e., the "hot" side) to avoid substantial radiological exposures to the workers. The gaskets were deteriorating and leaking, requiring the window to be refilled with progressively heavier mineral oil to reduce leakage into the cell. The high-viscosity mineral oil was difficult to remove from the hot cell windows, and heavy oil and "festoons" (semisolid gel remnants) remained on the window even after the workers flushed it nine times with a cleaning solvent.

The task leader decided to sparge the acetic acid with argon gas to agitate the liquid because he thought it might dislodge the festoons and dissolve the remaining heavy oil. However, no one analyzed the safety implications of using pressurized argon for the sparging operation.

Workers had to remove the expansion tank vent line to protect the window against overpressurization, but the process safety summary prepared for this work did not address removing the tank vent. Removing the expansion tank vent also removed one barrier between the acid and the workers. When the liquid level in the window reached the open vent (see Figure 3-1), about 500 ml of acid sprayed out of the vent onto the workers.

Two causal factors, in addition to the older design of the cell window, are relevant to this

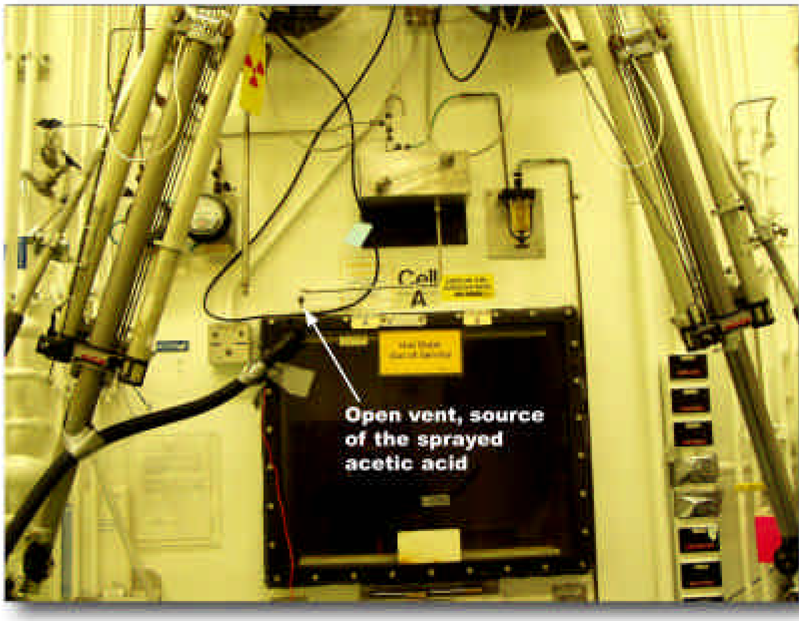


Figure 3-1. The hot cell window and vent

occurrence. The leaking window gaskets required heavier mineral oil to be added to reduce leakage, which required the workers to use a more aggressive agitation source (pressurized argon gas) to clean the windows. Also, disconnecting the cell window expansion tank vent line led directly to the discharge of acetic acid into the workspace and onto the workers.

Corrective and compensatory actions resulting from this occurrence included the following.

- Discontinue sparging with pressurized argon gas until the safety implications of the technique can be analyzed.
- Repair the leaking gaskets around the hot cell window so normal-weight mineral oil can be used.
- Evaluate new cleaning processes, agitation techniques, and different configurations during work planning.
- Identify and implement controls (e.g., lower liquid level in the window, contained venting capability, personal protective equipment) for sparging should it be used again.
- Use a finer metering valve for supplying argon gas to the liquid should sparging be used again.

Occurrences involving hot cells are reported relatively infrequently in ORPS. On October 9, 2002, at Argonne National Laboratory East (ANL–E), a hot cell facility operator reported that shielding solution was leaking from a hot cell window. The leak at the older vintage ANL–E hot cell was traced to a combination of a corrosion problem and a defective weld. The hot cell window, considered a safety significant component in the facility safety analysis report, was

GOOD PRACTICES FOR WORK PLANNING AND EXECUTION

- Analyze all the identifiable hazards associated with planned work evolutions and techniques.
- Involve operations and crafts personnel in the hazards analysis and the detailed work planning process.
- Proceduralize techniques and evolutions to help ensure that appropriate hazards analyses are performed.
- Establish controls in the form of engineered systems/components (where practicable) or administrative requirements to mitigate the consequences of accident sequences associated with the analyzed hazards.
- Accommodate the design features and operational idiosyncrasies of older equipment into the work planning process.
- Stop work for additional analysis if new or seldom-used techniques are being considered for performing the task.
- Thoroughly investigate the safety implications of any design or configuration changes being considered.
- Reinforce workers' authority and responsibility to stop work if unsafe conditions are encountered or suspected.

successfully repaired. (ORPS Report CH-AA-ANLE-ANLEAGHCF-2002-0004)

As was the case in the incident at Oak Ridge National Laboratory, inadequate procedures were identified as a contributor to an October 1, 1997, hot cell incident at Los Alamos National Laboratory. Maintenance and operations procedures related to operation of the hot cell doors were not in compliance with laboratory policies. Procedural problems were identified in a pre-job review of proposed maintenance activities on the hydraulic systems for several hot cell doors. (ORPS Report ALO-LA-LANL-CMR-1997-0018)

The ORNL incident illustrates the potential risks introduced by relying on "skill-of-the-craft" work controls. Although the gas-sparging technique of agitating the cleaning solution had been used successfully during earlier window cleaning tasks, it had not been proceduralized. Therefore, it was not analyzed for its effects on other system parameters and for worker safety implications. Thus, the "law of unintended consequences" was not considered in the planning process when the expansion tank vent connection was removed, creating the possibility for expelling acid from the hot cell window. The designs and operational characteristics of older vintage equipment (such as hot cell windows) need to be carefully accommodated in work planning and execution to provide safety assurance for workers.

KEYWORDS: *Acid burns on skin, hot cell, cleaning hot cell window, work planning deficiencies, gas sparging*

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

4. EMPLOYEE INJURIES COST U.S. BUSINESSES NEARLY $1 BILLION PER WEEK

The Liberty Mutual Research Institute for Safety recently published its latest Workplace Safety Index, which reports that while American workplaces are becoming safer, the cost of on-the-job injuries continues to rise.

The Workplace Safety Index ranks the leading causes of serious on-the-job injuries, which Liberty Mutual defines as those resulting in an employee missing 6 or more days from work, based on direct costs (payments to injured employees and their medical care providers). The Liberty Mutual Research Institute compiles and publishes the Safety Index to help companies focus their safety efforts by highlighting the causes of the most expensive workplace injuries.

"Managing the significant and growing cost of workplace injuries is a critical challenge facing all companies, regardless of size, industry, and location," notes Brian Melas, a senior vice president of commercial insurance at Liberty Mutual. "Improving workplace safety is key to managing this nearly $1 billion per week impact – prevent the injury, avoid the associated costs. For example, Hard Rock Café's U.S. operation saved almost $400,000 in 2001 and 2002 by reducing workplace injuries at a faster rate than the restaurant industry as a whole." Significant findings from the latest Workplace Safety Index include the following.

- The financial burden of serious work-related injuries and illnesses grew to $45.8 billion in 2001 from $44.2 billion in 2000.

- This cost grew 13.5 percent between 1998 and 2001, or 4 percent after adjusting for inflation in medical and wage benefits.

The top 10 causes of workplace injuries in 2001 are listed in Figure 4-1. Costs of the top three injury causes (Overexertion, Falls on Same Level, and Bodily Reaction[1]) grew faster than inflation between 1998 and 2001. Figure 4-2 displays the costs of the top 10 causes as a percentage of the total.

These three causes represented 50.1 percent of the total costs of serious workplace injuries in 2001, costing about $23 billion a year or $450 million a week.

[1] Bodily Reaction is defined as injuries from bending, climbing, slipping, or tripping without falling.

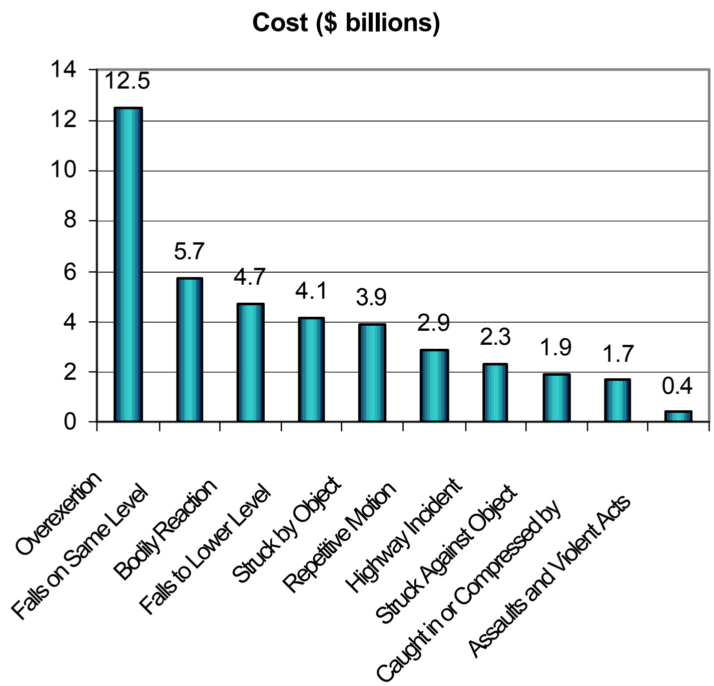


Figure 4-1. Top 10 causes of workplace injuries by cost, 2001

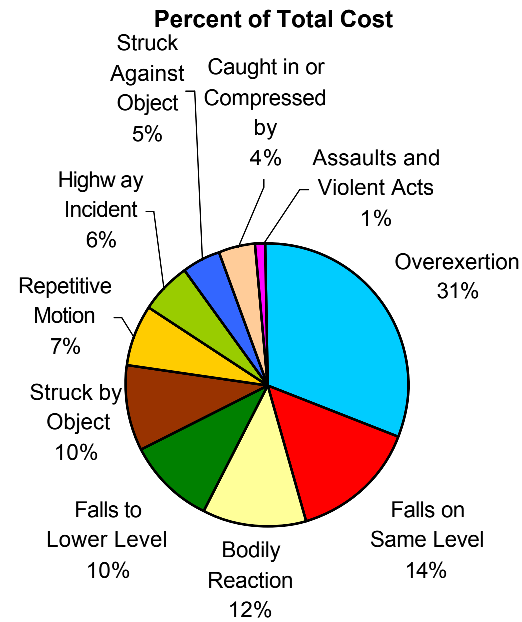


Figure 4-2. Cost of top 10 injury causes, as a percentage of total

The frequency of serious work-related injuries fell 6 percent between 2000 and 2001, the largest single decline in the 4 years the Workplace Safety Index has been compiled. There were fewer, but more expensive, serious work-related injuries in 2001: one reason the total cost of injuries did not decline despite the 6 percent drop in frequency.

"The latest Index findings tell employers to expand their efforts to address the fastest growing causes of work-related injuries – Overexertion, Falls on Same Level, and Bodily Reaction," notes Karl Jacobson, a senior vice president of loss prevention with Liberty Mutual. "This is where there is real potential to get at the benefits of a safer workplace – protecting employees and avoiding the financial impact of on-the-job injuries."

For practical suggestions on reducing workplace injuries, see Table 4-1. This table is provided courtesy of Liberty Mutual Research Institute for Safety.

More information on the latest Workplace Safety Index findings, tips on how employers can prevent the leading causes of workplace injuries, and case studies showing how companies benefited from improved safety are available at http://www.libertymutual.com.

KEYWORDS: *Workplace injuries*

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

Table 4-1. Tips for reducing workplace injuries

	GUIDELINES
Overexertion	• Evaluate production, storage, and display methods to preclude excessive reaching, bending, pushing, pulling, lifting, loading, and unloading • Use mechanical lifting aids such as hoists or adjustable lift tables, to reduce the need to bend, reach, and twist. Use carts, tables, or other devices to move and position heavy objects • Design jobs to allow sufficient rest pauses
Falls on Same Level	• Keep floors free of holes, water, grease, and other potential fall hazards • Provide footwear with the tread pattern and soling necessary to prevent slips • Provide adequate lighting for all interior and exterior walking surfaces • Highlight transitions in floor height • Remove snow and ice in parking lots and on sidewalks • Use appropriate non-slip floor surfaces, cleaners, and waxes
Bodily Reaction	• See Overexertion, Falls on Same Level, and Falls to Lower Level
Falls to Lower Level	• Use appropriate ladders capable of comfortably reaching work or storage heights • Use mechanized material handling devices to access higher levels • Regularly inspect and repair all ladders and lifting equipment • Provide railing protection for areas with abrupt floor level changes (i.e. loading dock) • Avoid storage of heavy or awkward items above the reach of most workers • Provide handrails and slip-resistant treads for all stairs. Avoid storage of any kind on stair treads and walkways • Install nets when other types of fall protection cannot be used
Struck by Object	• Aisles should be clearly marked and unobstructed, with adequate clearance • Train and supervise lift truck operators • Enforce speed controls and install mirrors at blind spots to enhance visibility • Stabilize overhead storage • Avoid storing or displaying products or equipment in areas where people travel • Restrict access underneath work areas • Use equipment and power tools only with the manufacturers' guards in place • Maintain all equipment and tools by following the manufacturers' guidelines • When approaching mobile equipment, workers should always make eye contact with the driver