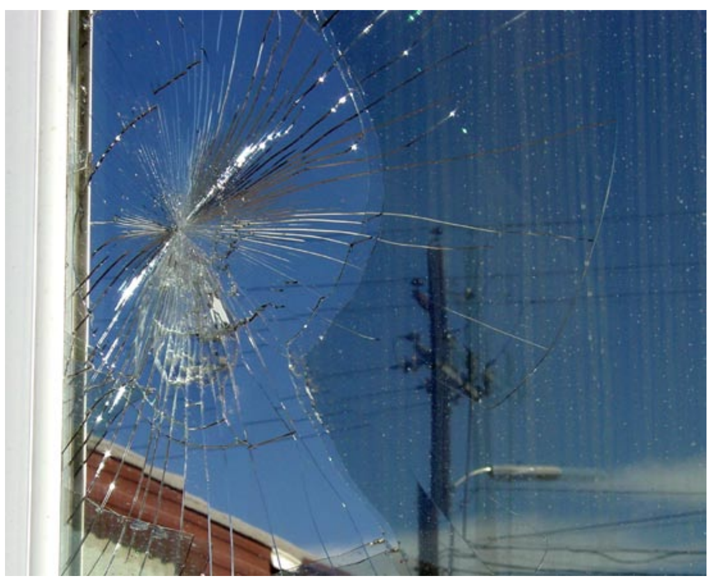
OPERATING EXPERIENCE SUMMARY

Inside This Issue



U.S. Department of Energy

Office of Environment, Safety and Health

OE Summary 2004-16

August 9, 2004

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://www.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 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://www.eh.doe.gov/paa/oesummary/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.

EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health recently began publishing a series of "Just-In-Time" reports. These two-page reports inform work planners and workers about specific safety issues related to work they are about to perform. The format of the Just-In-Time reports was adapted from the highly successful format used by the Institute of Nuclear Power Operations (INPO). Each report presents brief examples of problems and mistakes actually encountered in reported cases, then presents points to consider to help avoid such pitfalls.

1. Deficiencies in identification and control of electrical hazards during excavation have resulted in hazardous working conditions.
2. Deficiencies in work planning and hazards identification have resulted in electrical near misses when performing blind penetrations and core drilling.
3. Working near energized circuits has resulted in electrical near misses.
4. Deficiencies in control and identification of electrical hazards during facility demolition have resulted in hazardous working conditions.
5. Electrical wiring mistakes have resulted in electrical shocks and near misses.
6. Deficiencies in planning and use of spotters contributed to vehicles striking overhead power lines.

The first six Just-in-Time reports were prepared as part of the 2004 Electrical Safety Campaign. In April, the Office of Environment, Safety and Health published a Special Report on Electrical Safety. The purpose of this report is to describe commonly made electrical safety errors and to identify lessons learned and specific actions that should be taken to prevent similar occurrences. This report can be accessed at http://www.eh.doe.gov/paa/reports/Electrical_Safety_Report-Final.pdf.

EH plans to issue more Just-in-Times soon on other safety issues, such as lockout and tagout, fall protection, and freeze protection. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

EVENTS

1. FAILURE TO INSPECT PIPING SYSTEM RESULTS IN FATAL STEAM ACCIDENT IN JAPAN

On August 9, 2004, at the Mihama-3 nuclear power plant in Japan, four workers died from severe burns when a pipe burst, flooding the area they were in with high-pressure steam. Seven other workers were injured, two critically. The pipe that failed had not been inspected in the 27 years since the plant began service in December 1976.

The accident occurred in the turbine building of the pressurized water reactor operated by Kansai Electric Power Company (Figure 1-1). There was no release of radiation because the breached pipe was not part of the reactor primary piping system.

Figure 1-1. Turbine building to the left of the reactor building (center)

Steam at 518°F blew a 2-foot-wide hole in the carbon steel pipe as shown in Figures 1-2 and 1-3. Initial measurements by investigators showed that the section of piping had thinned from its original thickness of 10 millimeters to 1.4 millimeters at the thinnest section. The minimum thickness to maintain proper safety was reportedly 4.7 millimeters. The plant operator had visually inspected the pipe, but never performed ultrasonic tests or radiography to measure the thickness of the pipe. Japan's nuclear and industrial safety agency ordered four other power companies that operate similar reactors to perform ultrasound inspections on plant piping systems.

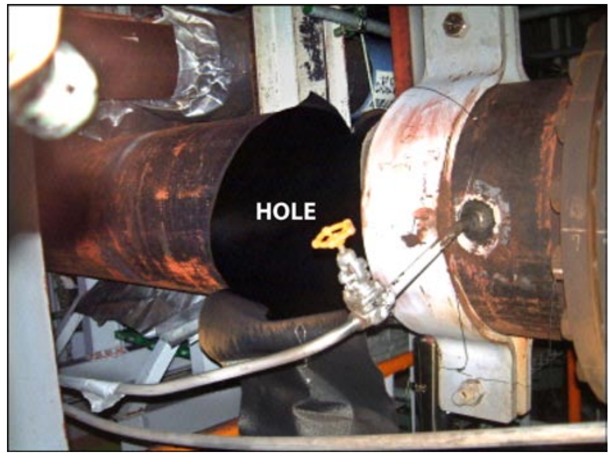


Figure 1-2. Breached large-diameter pipe

Figure 1-3. Close-up of pipe break

The issue of thinning carbon steel piping in light water reactors was raised in the United States as a result of a catastrophic rupture of an 18-inch main feedwater pump suction pipe on December 9, 1986, at the Surry Power Station in Virginia. The rupture resulted in fatal injuries to four workers. Ultrasonic measurements indicated that the pipe wall had thinned from a nominal thickness of 0.5 inch to 0.05 inch. A similar pipe rupture occurred at the Trojan Nuclear Plant in Oregon on March 9, 1985, where a 14-inch heater drain pump discharge pipe failed. One worker received second-degree burns. After 9 years of operation, the pipe wall had thinned from a minimum wall thickness of 0.375 inch to 0.1 inch.

In both events, wall thinning was caused by erosion/corrosion. Before the Surry event, single-phase carbon steel piping runs were not generally inspected for potential wall thinning because they were not thought to be susceptible to thinning from erosion/corrosion.

Another event occurred on July 22, 1992, at the Maine Yankee nuclear plant, where a steam line ruptured on a moisture separator reheater, resulting in a plant shutdown. There were no injuries. Wall thinning from erosion/corrosion was the cause. (NRC Event No. 23926)

Following the Surry event, the Nuclear Regulatory Commission staff issued Bulletin No. 87-01, *Thinning of Pipe Walls in Nuclear Power Plants.* The bulletin requested licensees to submit information that described their inspection programs for monitoring the thickness of pipe walls in high-energy, single-phase and two-phase carbon steel piping systems.

A search of the ORPS database for events involving piping system failures caused by wall thinning found a 1992 event at Savannah River K-Area, where operators discovered a hole in the discharge line of a pump. Ultrasonic testing revealed circumferential wall thinning from corrosion. As a corrective action, managers increased the ultrasonic testing frequency from 5-year to 2-year intervals. (ORPS Report SR--WSRC-KAREA-1992-0141)

Events involving personnel injury from steam leaks, including worker fatalities, have also occurred at DOE facilities. These events are few in number and resulted primarily from conduct of operation failures that caused water hammer, equipment failure, and inadequate energy isolation.

The disastrous event in Japan underscores the importance of periodically assessing the integrity of piping systems to reduce the potential for injury and damage to equipment caused by erosion/corrosion.

KEYWORDS*: Steam leak, pipe failure, fatality, injury, inspection, erosion, corrosion, wall thinning*

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

2. ELECTRICAL ARC RESULTS IN MINOR FLASH BURNS

On May 10, 2004, at the Pantex Plant, a warranty service technician received minor flash burns to his eyes from an electrical arc that occurred when his screwdriver came in contact with 460-volt terminal connections after he made repairs to a new chiller system. The technician was not wearing personal protective equipment and had not used a lockout/tagout. Fortunately, the technician did not incur permanent eye damage. (ORPS Report ALO-AO-BWXP-PANTEX-2004-0046; final report filed August 13, 2004)

The service technician had opened the 460-volt main circuit breaker to the chiller to replace a damaged contactor for two fan motors. After replacing the contactor, he closed the circuit breaker, and the chiller unit went through a delayed startup process. While waiting for startup, the technician decided to use a screwdriver to verify tightness of the 460-volt terminal connections on the contactor. His screwdriver slipped off a screw and made contact with two phases on the contactor, resulting in the electrical arc and in loss of power to the building.

Investigators learned that the technician failed to follow his company's lockout/tagout procedures. In addition, he was not wearing the personal protective equipment his employer required, which included safety glasses and leather/insulated gloves. Investigators determined that the direct cause of the event was that the technician failed to follow the energized work procedures required by 29 CFR 1910.333, *Selection and Use of Work Practices.* They also determined that the root cause of the incident was that sufficient controls were not in place to perform warranty work. Procedural changes were implemented to require the use of lockout/tagouts for warranty work.

A similar event occurred at the Hanford Cold Test Facility, where a subcontractor electrician received minor flash burns to his left forearm and his neck when an electrical arc occurred while he was installing a circuit breaker in a distribution panel. The 480-volt panel was energized, and neither a lockout/tagout nor an energized work permit was in place. (ORPS Report RP--CHG-TANKFARM-2002-0075)

Figure 2-1 shows the screwdriver after it accidentally made contact between the breaker C-phase, line-side lug and the grounded mounting plate as the electrician attempted to install the lower mounting screw for the circuit breaker. The resulting arc flash burned the electrician and caused him to jump back from the work area.

Figure 2-1. Burned and damaged screwdriver

In another event, at Sandia National Laboratory–New Mexico, a maintenance electrician caused a short circuit and received electrical flash burns to his left hand (Figure 2-2) and one finger on his right hand while troubleshooting an energized 120/208-volt power strip. The electrician used a generic work order that did not require a lockout/tagout of the power strip. (ORPS Report ALO-KO-SNL-NMFAC-1999-0002)

Figure 2-2. Flash burns to electrician's hand

At the Kansas City Plant, an electrician received third-degree burns that required skin grafts to his face, neck, arms, and hand from an electrical flash. Figure 2-3 shows the electrician's scorched

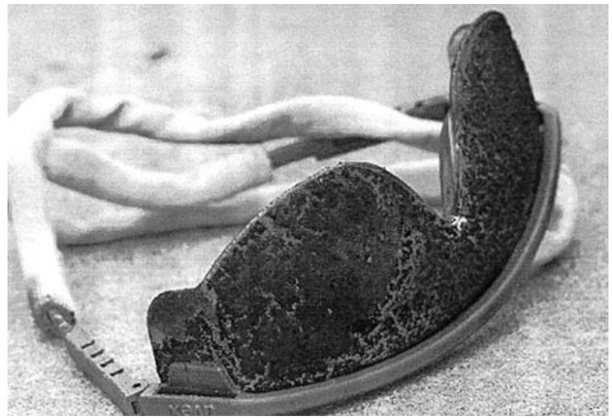


Figure 2-3. Electrician's safety glasses

safety glasses. The electrician was performing preventive maintenance inside a 13.8-kV switchgear cabinet in a substation. He was cleaning out the cabinet with a paintbrush and did not know that surrounding equipment was energized. A Type B Accident Investigation Board was unable to determine the exact event scenario, but they believe that either debris falling onto energized components or the electrician's shirt sleeve contacting energized equipment caused an electrical fault. (ORPS Report ALO-KC-AS-KCP-1998-0010)

The requirements in OSHA 29 CFR 1910.333(c)(2), "Work on Energized Equipment," state: "…only qualified persons may work on electrical circuit parts or equipment that has not been de-energized under the procedures of paragraph (b) of this section. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools."

These events illustrate the dangers associated with an electrical arc flash caused by unsafe acts near energized equipment. Safety and health hazard analyses must be included in the work control process to prevent worker injury. The hazard analysis process should include provision for lockouts/tagouts, job specific walk-downs, integration of work activities, and personal protective equipment. Pre-job briefings, facility procedures, and training programs should emphasize the dangers that can occur when things go wrong while working on or near energized equipment (e.g., electrical shock, arc flash, and arc blast).

ELECTRICAL HAZARDS FROM ENERGIZED CIRCUITS

- **Electrical Shock and Burns** – Contact with electrical energy can result in nerve and tissue damage, severe burns, and electrocution as current flows through the body.
- **Arc Flash Burns** – An arc flash can heat the air to temperatures as high as 35,000°F, vaporizing metal, and can cause severe skin burns from direct heat exposure and by igniting clothing.
- **Arc Blast** – The heating of air and vaporizing of metal create a pressure wave that can damage hearing, cause a concussion, and produce other injuries from flying or falling metal and parts.

KEYWORDS: *Electrical safety, arc, flash, burn, electrical safety, lockout/tagout, energized*

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

3. EXCAVATION WORKERS BREACH WATER PIPE WITH HEAVY EQUIPMENT

On June 4, 2004, at the Hanford Site, a backhoe operator accidentally broke off a 12-inch-long pipe stub attached to a large water main that was pressurized to 100 psig. The broken stub formed a water jet that discharged some 60,000 gallons of water 60 feet into the air, spraying nearby trailers with water and debris. Construction workers had exposed the 10-inch water main by hand-digging and were using the backhoe to slope out the trench. When the event occurred, the backhoe was digging over an unexposed section of pipe, and the equipment operator did not know there was a stub on the pipe section. (ORPS Report RL--PHMC-PFP-2004-0012; final report filed August 20, 2004)

The scope of the excavation work was to expose the water main and measure it for a saddle so a tap could be installed the following day. An excavation permit was in place that required hand-digging within 5 feet of the buried utility. No one was providing oversight for the work because the scope was simply to expose and verify the size and type of pipe. The drawing used when planning the water tap did not show the short length of 2-inch-diameter pipe, which was one of many saddle stubs used to inject chlorine into the pipeline during its construction. Figure 3-1 shows the excavation site.

Figure 3-1. Excavation trench

The excavation crew consisted of two construction workers and a radiological control technician (RCT). When the backhoe operator breached the pipe, the two construction workers (one in the backhoe) were near the trench, and the RCT was over 100 feet away. During the initial stage of the water jetting, the building emergency director determined that two people inside one of the trailers were safe and did not need to evacuate. However, about halfway through the event, the backhoe operator lowered the bucket over the water jet, which changed the direction of the water flow causing rocks in the trench bank to become projectiles. The flying debris broke a window in a trailer (Figure 3-2) that was 120 feet from the leak, and rocks fell onto the roof of the occupied trailer.

A water utilities operator shut off the water after about 50 minutes. One of the factors that delayed isolation of the leak was that the operator had to get a calibrated air sampler because the isolation was located in a confined space.

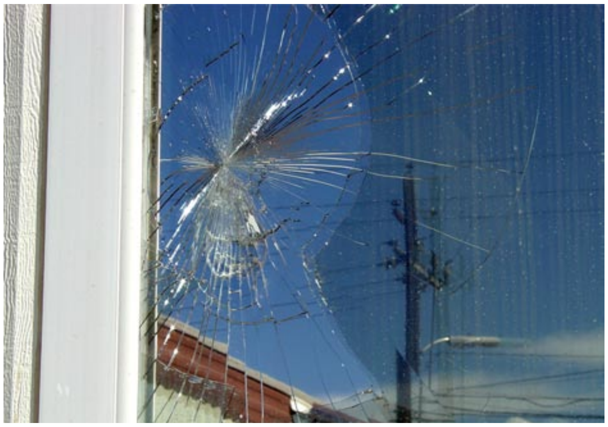


Figure 3-2. Shattered window on trailer

Investigators learned that the chlorination stubs, which are common on water mains at the Hanford site, intentionally were not shown on drawings because there are so many of them. Water utilities personnel knew about the stubs, but the excavation crew did not know they were in the area they were excavating.

The intended principal barrier to this event would have been the excavation permit. The permit stated that once the water main was exposed, the excavators had to obtain a waiver allowing use of a backhoe to clean out the trench. The excavation crew did not request or obtain the waiver, which probably would have been granted. A discussion of the chlorination stubs (Figure 3-3) during the waiver process might have prevented this event.

Figure 3-3. Chlorination stub attached to water main

The Hanford procedure for excavation, trenching, and shoring will be revised. The new excavation permit form will include special instructions stating that when water utilities are involved, there may be chlorination stubs in the area, even if they are not shown on the drawings.

A similar event occurred on August 17, 2004, at the Fernald Closure Project, where an operator of a front-end loader inadvertently struck and punctured an active outfall line. As the operator attempted to scrape dirt away from the already-exposed 28-inch-diameter pipe, the edge of the loader bucket cut a 2-inch by 4-inch hole that released approximately 1,000 gallons of treated waste water into the excavation. Investigators determined that the front-end loader was not the best choice of equipment to perform the work near the pipeline. (ORPS Report OH-FN-FFI-FEMP-2004-0024)

Another event occurred at the Idaho Nuclear Technology and Engineering Center, where construction subcontractors inadvertently hit and ruptured a potable water line with the bucket of a trackhoe, dumping water into the excavation. Four underground lines (fire water, raw water, potable water, and steam) had been identified in the area using subsurface surveys and area drawings. The potable water line (shown on the drawings) did not show up on the subsurface survey because the line was fiberglass. The excavation crew had located three of the lines by hand-digging, but never completely uncovered all the lines across the excavation area. They made an assumption about how the lines ran and did not check the drawings for verification. The crew violated procedures when they decided to use the trackhoe to taper the sides of the excavation within inches of the identified lines. The procedure requires hand digging only, unless the area director and facility manager grant an exception. (ORPS Report ID--BBWI-LANDLORD-2002-0012)

These events illustrate that even when a utility has been located and exposed, damage can still occur if operators are not careful while using heavy equipment in the vicinity of the utility. Excavation crews and utility owners need to plan ahead and be prepared should an accident occur.

SAFETY CONSIDERATIONS FOR EXCAVATION NEAR UTILITIES

- Has the utility owner been notified of the excavation work?
- Has the utility been identified (e.g., water, gas, oil, electrical)?
- Has the utility been located or exposed?
- Has the correct equipment been selected for the excavation?
- Can the equipment be operated safely in proximity to the utility?
- Can the utility be isolated before excavation begins (i.e., lockout/tagout)?
- Have isolation points been identified and are their locations known if the utility is breached?
- Has the response time been considered if a breach occurs, including special conditions (e.g., confined space entry) that could impact isolation time?
- Is someone immediately available or on-call to respond to a problem?
- Are all tools and equipment available to isolate the utility in case of a breach?

KEYWORDS: *Excavation, pipe break, backhoe, trackhoe, loader, digging, leak*

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

4. CUT POWER CORDS CAN RESULT IN SEVERE ELECTRICAL SHOCKS

Several recent events across the Complex involved workers inadvertently cutting into power cords. Although no injuries resulted from any of these events, power cords that are pinched, nicked, or cut pose an electrical shock hazard. To avoid this type of damage, and the potential for an electrical shock, power cords should be kept out of the way when using cutting equipment.

On August 23, 2004, at the Fernald Closure Project, a laborer using a portable bandsaw to cut previously de-energized cables and cords on the floor inadvertently grabbed the power cord for the bandsaw and cut it. The power cord was similar in size and color to the cables. The laborer was not injured. (ORPS Report OH-FN-FFI-FEMP-2004-0026)

Demolition work was being performed in a former computer room, which has a false floor containing hundreds of cables and wires that had been disconnected and abandoned in place. The laborer was using a double-insulated bandsaw powered from an electrical distribution panel equipped with a GFCI circuit breaker to size-reduce the cabling. The laborer would hold the bandsaw with one hand and grab a handful of wires from the floor and pass them across the blade to cut them. He inadvertently grabbed the black power cord along with other black wires and cut them with the saw. As soon as the saw stopped running and the lights went out (the circuit breaker tripped), the laborer realized what he had done.

Tool choice was found to be an issue in this event, not only because the power cord was cut, but also because the laborer's hands were in close proximity to the blade. The use of non-electric tools, such as side cutters, will be considered for future work of this type. Also, power cords for electric tools will be marked with "barber pole" tape for easier recognition.

On July 21, 2004, at Oak Ridge X-10, a subcontractor technical representative invoked a safety pause when she observed unsafe work practices. One of the incidents that led to the pause involved a cut power cord. In this case, a subcontractor laborer switched off the power to a portable band saw but did not stop the still-moving blade from coming in contact with the power cord. The blade nicked and frayed the electrical insulation, causing a short circuit and tripping a ground-fault circuit interrupter (GFCI). The laborer was not injured. (ORPS Report ORO--BJC-X10WSTEMRA-2004-0005)

To address this incident, the contractor revised the activity hazard analysis to include additional information on power tool safety. The contractor also conducted a training session on power tool safety and presented a cutting demonstration in which the operator pointed the saw away when cutting and allowed the saw blade to come to a complete stop before moving on to another task.

Four near-miss events occurred at Rocky Flats in the last 3 months involving energized electrical power cords that were inadvertently damaged during work activities. A worker received an electrical shock in only one of these events, but the potential for a severe shock existed in all four events.

On June 24, 2004, a subcontractor D&D worker on a scissor lift was using a reciprocating saw to cut hangers and brackets from the ceiling when the saw bound up and kicked back. The worker was unable to control the saw's downward momentum, and the blade nicked a 120-volt extension cord 3 feet below that powered a portable room continuous air monitor. (ORPS Report RFO--KHLL-371OPS-2004-0015)

The supervisor immediately stopped work. An electrician investigated and reported that the ground wire had been nicked. Investigators learned that before the job started, the work crew walked-down the area and concluded that the extension cord was far enough away from the work area. The worker wore appropriate personal protective equipment and was operating the saw with both hands. Facility management decided to take the following corrective actions to prevent recurrence.

- Find a tool for cutting brackets and hangers that is easier to control.
- Determine which brackets and hangers must be cut flush with the ceiling.
- Brief work crews on this event with an emphasis on keeping electrical cords out of the way when using cutting equipment.

Two weeks earlier, a subcontractor D&D worker received an electrical shock when he attempted to free a cart loaded with ductwork that was hung up on a toolbox. A 120-volt power cord plugged into the electrical outlet behind the toolbox was pinched between the box and the wall and had apparently energized the cart. Workers noticed arcing from the cord, but no injuries resulted from the incident. (ORPS Report RFO--KHLL-371OPS-2004-0014)

On May 13, 2004, a subcontractor worker operating a floor-shaving unit inadvertently ran over the unit's 480-volt power cord. Personnel in the area heard a loud popping sound, realized that the power cord had been run over, and hit the emergency stop button.

The operator had finished shaving part of the floor, but stopped to let an RCT decontaminate a hot spot on the floor. The operator backed the unit up to make another pass on the floor, checked for obstacles behind him, and pulled the unit back. A tender was nearby, but he was taping a vacuum hose to a handle and talking to the RCT Foreman, so was unaware that the operator was moving the unit. There were no injuries or electrical arcing, but the power cord was damaged. (ORPS Report RFO--KHLL-371OPS-2004-0013)

On May 5, 2004, a subcontractor D&D worker using a 30,000-psi hydrolancing tool to remove contamination from a building column hit a 480-volt power cord that was wrapped around the bottom of the column. He cut through two layers of cord insulation to the bare wire. He saw a spark and immediately stopped work. The worker was not injured. (ORPS Report RFO--KHLL-771OPS-2004-0004)

Investigators determined that the worker knew that energized electrical cables were in the work area, but thought he could work around them. Pre-job briefings did not clearly state the standard operating procedure, which prohibits hydrolasing within 10 feet of any energized electrical cable, and the worker stated that he was unaware of the 10-foot rule.

It is important to take precautions to avoid nicking or cutting power cords when working with powered tools such as saws or hydrolances, but it is also essential to check power cords for any sign of damage or breaks in the insulation before using them. Figures 4-1 and 4-2 are examples of damaged cords that should be replaced.

These events illustrate the importance of paying attention and taking appropriate precautions when using cutting equipment near a power cord. Cords that are pinched, nicked, or cut can pose electrical shock hazards. Imprecise tools such as reciprocating saws and hydrolances can be very *difficult to control and should not be used near electrical cables or high-pressure piping. Nearby equipment should be locked and tagged out or alternative methods should be used. Workers should also inspect power cords for damage before using them.*

Figure 4-1. Worn cord and damaged grounding prong

Figure 4-2. Cord with damaged insulation

KEYWORDS: *Electrical cord, power cord, near miss, D&D, hazard analysis, work planning*

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

POWER CORD SAFETY CONSIDERATIONS

- Ensure power cords are kept clear of the work area and are never used in a position where they can be damaged by power tools.
- Visually inspect the cord for damaged and exposed conductors. If the cord is damaged, do not use it.
- Ensure that the ground prong is in good condition.
- Never drag cords over rough surfaces or use them to lift or pull materials.
- Disconnect cords at the receptacle, using the plug and not by jerking on the cord.
- Do not string electrical cords through water, oil, or grease.
- Do not hammer nails or staples into cords.
- Unplug, coil, and store power cords that are not in use.

Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
INPO	Institute for Nuclear Power Operations
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
SELLS	Society for Effective Lessons Learned

Units of Measure	
AC	alternating current
DC	direct current
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
NOV	Notice of Violation
SAR	Safety Analysis Report
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question

Regulations/Acts	
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
RCRA	Resource Conservation and Recovery Act
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement

Miscellaneous	
ALARA	As low as reasonably achievable
HVAC	Heating, Ventilation, and Air Conditioning
ISM	Integrated Safety Management
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control