OPERATING EXPERIENCE SUMMARY

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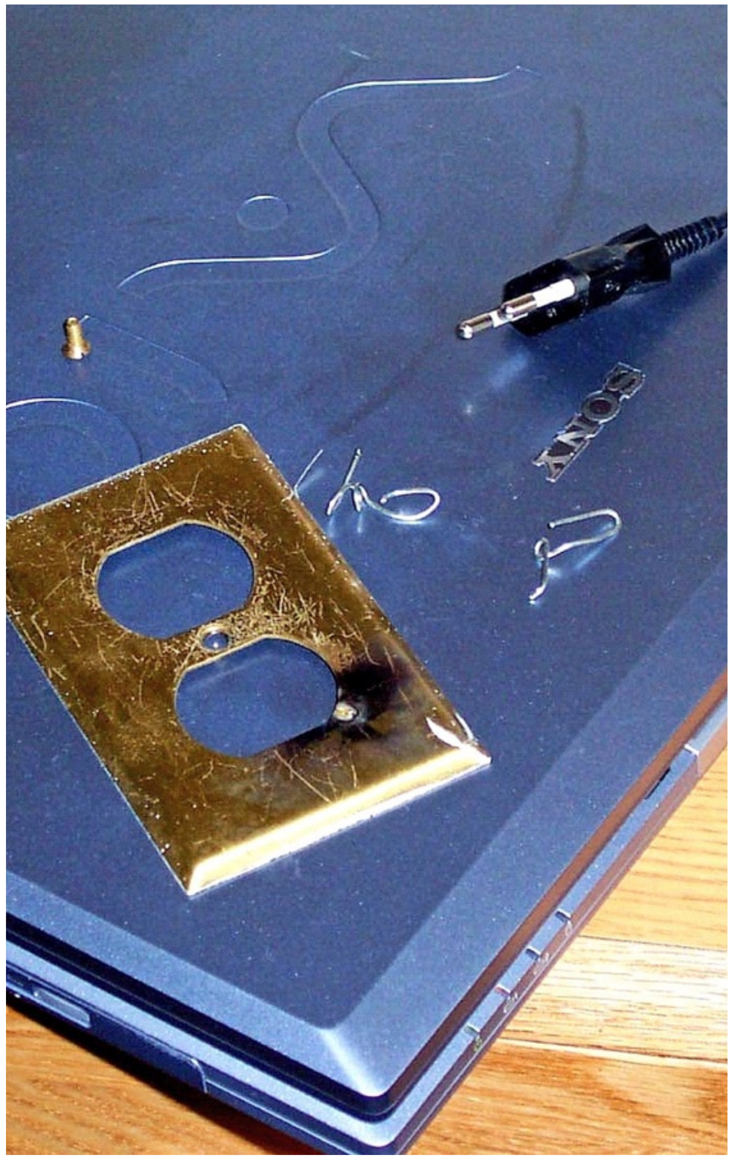

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OE Summary 2005-07

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EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health publishes a series of Just-In-Time reports on its Lessons Learned and Best Practices web site. These reports are targeted to work planners and workers and discuss safety topics relevant to the work they do. Each report presents examples of problems and mistakes encountered in actual reported cases and offers points to consider to avoid similar mistakes in the future.

EH plans to issue more Just-in-Times soon on other safety issues. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

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.

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EVENTS

1. ENGINEERED CONTROLS—IMPORTANT PROTECTION AGAINST EXPOSURE TO HEXAVALENT CHROMIUM

On March 17, 2005, at the Hanford River Protection Project, a laboratory report indicated that a pipefitter was potentially overexposed to hexavalent chromium (CrVI), based on a sample collected during a welding task on March 10. Investigators believe that an altered welding exhaust system was the likely contributor to the welder's high sample readings. The EPA has designated hexavalent chromium as a priority pollutant because it is a potential lung carcinogen and has the ability to cause genetic mutations. (ORPS Report RP--BNRP-RPPWTP-2005-0010; final report filed April 12, 2005)

The pipefitter was part of a work crew performing Shielded Metal Arc Welding (SMAW) on stainless steel and carbon steel in the Pretreatment Facility. SMAW is a welding process in which a consumable electrode (solid metal filler rod with a dry flux coating) is fed to the work piece by the welder. The welding arc vaporizes the filler material, the electrode coating, and some of the base metal, producing the hexavalent chromium. Vaporization of the base metal, which may contain chromium in amounts up to 30 percent, may contribute up to about 10 percent of the total welding fume. All workers were wearing half-face respirators with HEPA filters that had an assigned protection factor (APF) of 10.

Samples collected from the pipefitter's breathing zone indicated a potential exposure of 0.1934 milligrams per cubic meter (mg/m^3), which is above the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value of 0.05 mg/m3 for soluble CrVI and 0.01 mg/m3 for insoluble CrVI. The pipefitter submitted blood and urine samples, and doctors determined that the results for chromium exposure were in the normal range.

Event investigators determined that someone had removed a bell-mouth exhaust hood (i.e., engineered control), which likely resulted in the high sample results. As a corrective action, engineers evaluated the use of different welding exhaust systems with higher air flow and the use of respirators with a higher APF.

At the same construction site in 2003, an industrial hygienist discovered a welder with a CrVI sample result that was much higher than predicted. The welder, who was conducting SMAW on stainless steel, wore a half-face respirator with a HEPA filter and an APF of 10. The sample result of 0.173 mg/m^3 was 100 times the result from the previous day's activities and from samples taken in the previous 5 months. Analysis of the monitoring data did not indicate the reason for the high sample result, so an exposure to chromium above the regulatory levels was assumed. (ORPS Report RP--BNRP-RPPWTP-2003-0007)

In another event in 2003, a welder at the Hanford site was potentially exposed to CrVI while welding with a high-chromium-content (15 to 32 percent) welding rod. Although the welder wore a welding helmet equipped with a powered air blower, he did not wear a respirator because he was outside and relied on air currents to disperse the fumes. Samples taken from under the welding hood showed a concentration of 0.026 mg/m^3. Even though this level was below the ACGIH limit for soluble CrVI, investigators determined that the powered air blower (and lack of respirator) did not adequately protect the welder from a potential exposure to hexavalent chromium. (ORPS Report RL--BHI-GENAREAS-2003-0002)

On October 4, 2004, OSHA proposed to amend its existing standard for worker exposure to hexavalent chromium because it determined that workers exposed to CrVI below the current permissible exposure limit (PEL) are at increased risk of developing lung cancer. The proposed rule would lower the PEL for all CrVI compounds from 52 to 1 microgram/cubic meter ($\mu g/m^3$) of air as an 8-hour, time-weighted average. The proposed rule also includes preferred methods for controlling exposure, such as using local exhaust ventilation (Figure 1-1), respiratory protection, and protective work clothing and equipment.

Because of this proposed revision to the OSHA PEL, it is important to re-evaluate

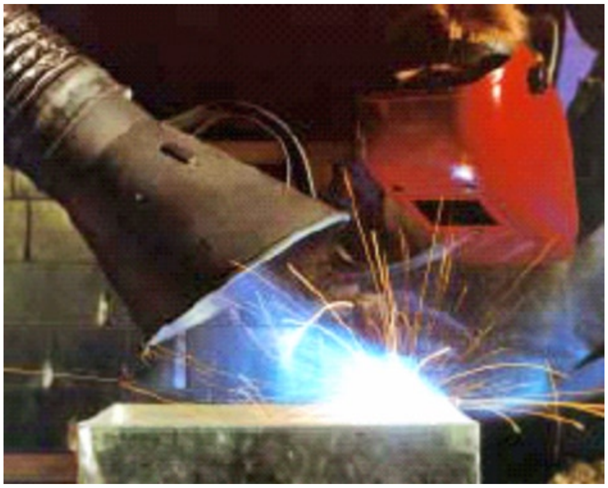

Figure 1-1. Using local exhaust ventilation at the work piece

the effectiveness of engineered controls and the use of adequate respiratory protection for welders. SMAW welding on stainless steel and high-chromium nickel alloys can produce high breathing zone exposures for CrVI. However, properly positioned exhaust ventilation can significantly reduce welder exposure.

These events illustrate the importance of using engineered controls (forced ventilation) and appropriate personal protective equipment (respiratory protection) to protect welders from exposure to hexavalent chromium and other metals such as beryllium, iron, and manganese. Local exhaust ventilation should be used for all indoor welding and cutting. If stainless steel welding is performed in an enclosed space where local ventilation is impractical, then approved air line respirators should be worn. For stainless steel welding and cutting outside, approved respirators should be used; and again, the use of an airline respirator rather than an air-purifying fume respirator will provide the best level of protection.

KEYWORDS: *Welding, hexavalent chromium, exposure, occupational safety, respirator, ventilation, engineered controls*

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

Minimizing Exposure to Welding Emissions

- Use local exhaust ventilation and fume extraction welding guns to keep the breathing zone clear of particles and fumes.
- Ensure that exhaust-capture nozzles are properly placed and not too far from the workpiece, thus allowing fumes to remain in the breathing zone.
- Use a helmet and position the head to minimize exposure to fumes in the breathing zone.
- Wear appropriate respiratory protection.
- Use special care when welding in a confined space and provide additional ventilation/exhaust as necessary.
- Sample and monitor breathing air zone for concentration of contaminants.
- Read the MSDS for electrodes, and heed any warnings on the electrode container (e.g. electrodes containing chromium and manganese).
- Select materials that minimize chromium.

2. *MODIFYING ELECTRICAL POWER CORDS CAN BE DANGEROUS*

On March 2, 2005, at the Brookhaven National Laboratory, a custodian was changing bed sheets in a residence house room when she saw an electrical spark discharge from an electrical receptacle behind the headboard. The custodian stopped what she was doing and notified her supervisor. An electrician already in the building opened the breaker. Although the spark discharging from the receptacle near combustible materials (the bed sheets and the headboard) posed a significant fire hazard potential, no injury and little property damage resulted from this event. (ORPS Report CH-BH-BNL-BNL-2005-0004; final report filed April 14, 2005)

Investigators noticed that a computer laptop was plugged into the electrical wall receptacle. The laptop's power cord had European-style round pins, each of which had a paper clip twisted around it (Figure 2-1). The paper clips had been inserted into the receptacle to gain conductivity to run the laptop. As the custodian moved the bed while changing the sheets, one of the paper clips contacted the receptacle's grounded metal faceplate, causing a short and electrical spark.

Figure 2-1. Modified plug

Fire and electrical experts examined the receptacle closely and found spark burns and smoke on the receptacle faceplate (Figure 2-2) and soot from the flash on the wooden headboard post. The circuit breaker did not trip, but was tested and found to be properly functioning.

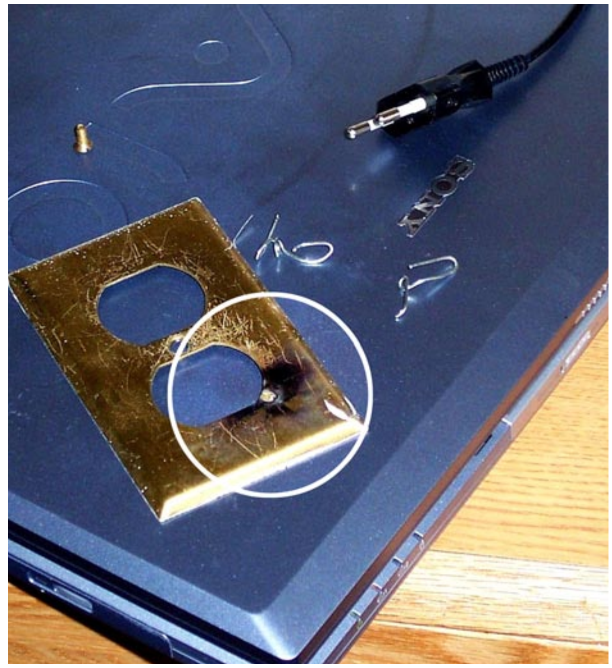

Figure 2-2. Laptop, plug, bent paper clips, and receptacle faceplate with burn marks (circled)

Electrical experts determined that the breaker failed to trip because this was a high-resistance short rather than a direct short. The short condition did not exist for enough time and did not draw enough amps to trip the breaker, but had the power to potentially injure someone and cause property damage.

While investigators were still in the room, its occupant, a recently hired scientist who had visited Brookhaven before, returned. After the investigators explained what had happened, the scientist apologized and explained that he tried to obtain an adapter (Figure 2-3) but was unable to find one in local stores.

At the critique the next day, the event was discussed in detail. The custodian and other support personnel were commended for their quick and appropriate responses. The scientist was counseled on electrical safety and received additional electrical safety training.

Figure 2-3. A European-to-U.S. adapter

The organization responsible for residence housing inspected all residence buildings for evidence of altered power cords or receptacles. The Laboratory issued a memorandum to all onsite residents informing them that power cords and receptacles are not to be modified. It also provided locations where approved adapters could be purchased. The memorandum will be included in welcome packets for onsite visitors as well.

This event illustrates the importance of using an appropriate adapter when using electrical cords and receptacles with differing voltages or configurations. Not only is it an important consideration when using foreign equipment with U.S. power supplies, it applies to using plugs with a grounding prong with an ungrounded socket. Never attempt to modify electrical equipment or power cords to gain access to a power supply.

GOOD PRACTICE

Sites that host foreign visitors should consider purchasing a supply of electrical adapters and making them available to visitors who need them when they arrive onsite.

KEYWORDS: *Power cord, modification, near miss, electrical*

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

3. WORK PLAN DEVIATION RESULTS IN PRESSURE VESSEL FAILURE

On February 22, 2005, at the Sandia National Laboratory Geomechanics Lab, a technologist pressurized a pressure vessel used for geophysics research above the conditions specified in the work plan, damaging it. The technologist was not injured; and, although some components were damaged, the vessel did not rupture. (ORPS Report ALO-KO-SNL-6000-2005-0001)

The steel pressure vessel stands about 30-inches tall, is 15 inches in diameter, was proof-tested to 71,000 psi and has a maximum allowable working pressure of 91,000 psi. The vessel consists of a shell, upper plate, and lower plate. During operation (sample testing), the upper and lower plates are clamped to the shell by 10 bolted tie rods. Sample material is placed inside the vessel shell (filled with hydraulic oil) and is pressurized by an intensifier. The sample can also be loaded in the vertical (axial) direction, using a loading piston that passes through the top of the pressure vessel and transferring vertical force from the reaction frame to the sample. Figure 3-1 is a diagram of the properly configured pressure vessel.

When the incident occurred, the technologist was evaluating a problem associated with the calibration of a load cell that measures axial

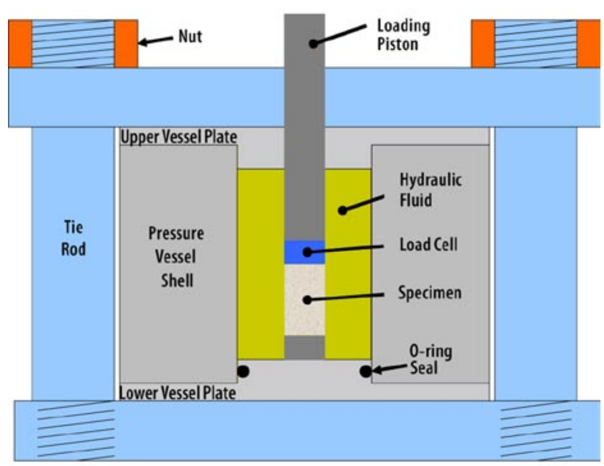

Figure 3-1. Diagram of pressure vessel in normal configuration for sample testing

force inside the vessel. The cell was placed inside the pressure vessel, and the assembly was then placed into the test frame so that the axial load could be applied by the loading piston. The technologist's work plan only allowed for troubleshooting the load cell at ambient pressure conditions. Figure 3-2 shows the pressure vessel in the loading frame and the location of the operator's panel and computer terminal.

Figure 3-2. Assembled pressure vessel (circled) in the loading frame

Because the work plan specified ambient pressure only, the technologist engaged only 2 of the 10 tie rods to ensure proper alignment of all pressure vessel components. Encouraged by the results of his successful troubleshooting, the technologist decided to check the load cell at elevated pressure and began to pressurize the hydraulic oil, thus deviating from the work plan. At approximately 45,000 psi the threads stripped on one of the two tie rods, allowing the upper plate and upper vessel plate to separate from the vessel shell, damaging the threads on other tie rods (Figure 3-3) and causing a rapid depressurization of the oil.

When the upper vessel plate lifted off the shell, it rotated and broke a piece of metal free from the o-ring seal groove at the inner bore near the top of the shell (Figure 3-4).

The technologist, who was sitting 10 feet away at the control station, immediately shut down the hydraulic pump. No other workers were in the area of the loading frame but an employee in another room did hear the vessel fail. There was no shrapnel; however, the metal fragment and a

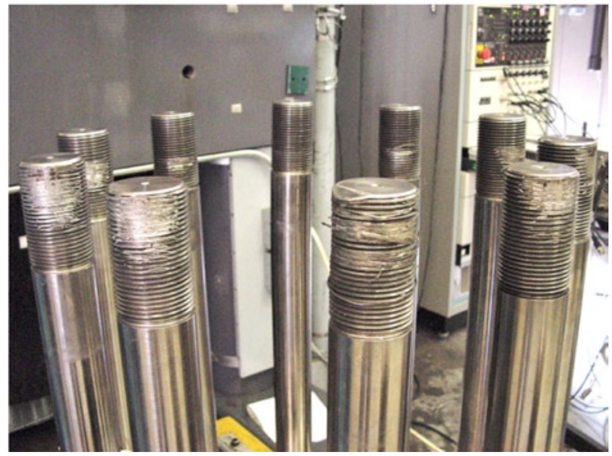

Figure 3-3. Stripped threads on tie rod ends

nut from one of the tie rods did come off in the immediate area. There was no barrier around the loading frame at the time of the incident to contain parts or exclude personnel.

The calibration testing on the load cell was not covered under a formal test procedure. This lack of formalization contributed to the occurrence and resulted in a stop-work order by the facility manager until additional process controls are established (e.g., a procedure for conducting calibrations and a pre-pressurization checklist).

The importance of ensuring pressure vessel integrity prior to pressurization is illustrated in an event that occurred at Argonne National Laboratory–East in 1999. A researcher and technician were pressurizing a stainless steel pressure vessel used to examine the characteristics of diesel fuel aerosols when one of three glass viewing ports (Figure 3-5) failed at 800 psi. (ORPS Report CH-AA-ANLE-ANLEES-1999-0001)

Figure 3-4. Metal fragment from o-ring groove

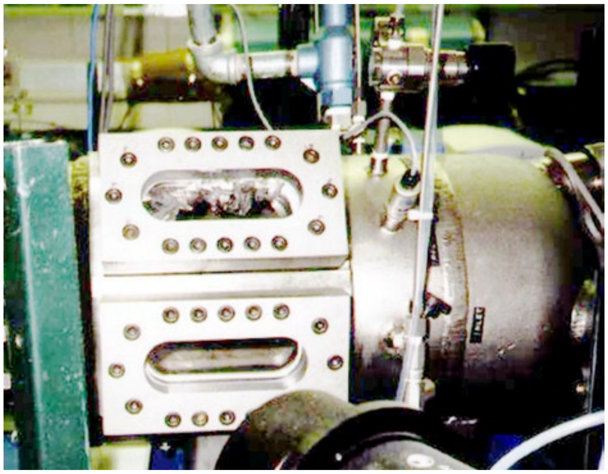

Figure 3-5. Vessel and failed upper viewing port

When the viewing port failed, projectiles of glass chipped a masonry-block wall, shattered fluorescent lamps, severely damaged an overhead ventilation duct, and injured the technician.

The technician and researcher had just reinstalled the viewing port (quartz window) and were pressurizing the vessel to 900 psi with nitrogen when the incident occurred. Investigators determined that the technician and researcher were both aware of a readily visible flaw (1-inch crack) in the viewing port glass at the time of installation, but proceeded with the pressurization.

These events illustrate the dangers associated with improperly operated or maintained pressure vessels. Vessel failures occur without warning and are often catastrophic, resulting in serious injuries and equipment and facility damage. Maintenance, testing, and operation of pressure vessels and supporting systems should be performed in accordance with approved procedures, checklists, and work plans. Facility managers should ensure that personnel adhere to procedural steps and do not deviate from work plan requirements and safety instructions.

KEYWORDS: *Pressure vessel, over pressurized, damage, work plan, near miss, procedures*

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

4. DILUTE SULFURIC ACID OVERFLOW RESULTS IN OPERATIONAL EMERGENCY

On February 2, 2005, at the Oak Ridge National Laboratory, utility operators on their hourly rounds at the steam plant smelled a strong odor and saw a haze near a tank containing 10 percent dilute sulfuric acid. They immediately began ventilating the area and told a painter working nearby to leave the building. The laboratory shift superintendent ordered facility personnel to evacuate the building. (ORPS Report ORO--ORNL-X10UTILITY-2005-0001; update/final report filed March 16, 2005)

The utility operators notified their project leader, who assessed the situation and concluded that he could safely approach the tank. As he did so, he noticed 2 gallons of liquid in the secondary containment and left the building to notify the laboratory shift superintendent. Emergency response and hazardous materials teams entered the building and neutralized the acid in the secondary containment (Figure 4-1). Facility management terminated the emergency within 2 hours. There was no release to the environment or worker exposure.

Investigators determined that the direct cause of this event was a plugged ventilation line. They believe that the root cause was most likely acid crystals that formed in the line and plugged it, causing acid to siphon from the bulk acid

Figure 4-1. Secondary containment with neutralization results

storage tank to the dilute sulfuric acid mix tank and eventually overflow into the secondary containment. Although there are no preventive maintenance records for the ventilation line, it has been in service for about 18 years without a failure.

In addition to the lack of preventive maintenance, investigators identified the following contributing causes.

- The tank's fill line was incorrectly marked at 29 inches instead of 27 inches, which would allow the tank to be overfilled by as much as 9 gallons.

- The utility operators were not familiar with the building's airflow patterns or the potential source of the leak.

Corrective actions included cleaning out the vent line, establishing a 6-month preventive maintenance schedule for the line, marking the tank at the correct level of 27 inches, and evaluating the ventilation in the area of the tank.

A search of the ORPS database identified other events where material inadvertently siphoned between tanks. On September 24, 2004, at the Idaho Nuclear Technology and Engineering Center, for example, sulfuric acid was found leaking from a reverse osmosis unit. Investigators believe that inlet valves were left open during maintenance activities, causing the acid to be siphoned from an acid storage tank. No one was injured, and there was no release to the environment. (ORPS Report ID--BBWI-LANDLORD-2004-0014)

On September 10, 2003, at the Savannah River H-tank farm, operators draining a waste tank noticed that the liquid level in the drain tank was rising higher than expected. The operators isolated the flow path and flushed the line. One of two possible causes postulated by investigators was that salt deposits plugged the transfer lines, creating a siphon effect. (ORPS Report SR--WSRC-HTANK-2003-0037)

The Oak Ridge event illustrates the necessity for personnel to possess a thorough knowledge of a facility's configuration and demonstrates that assumptions about the robustness of a system should never be made. For tanks with smaller vent lines, the possibility exists for materials to plug the lines; therefore, checking the lines periodically is essential. In the event of an inadvertent leak or spill, facility managers should ensure that personnel know what to do, whom to contact, and how to conduct emergency procedures.

KEYWORDS: *Sulfuric acid, overfill, leak, secondary containment, preventive maintenance, siphon*

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

Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CPSC	Consumer Product Safety Commission
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
MSDS	Material Safety Data Sheet
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control