Operating Experience Summary

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Helping the field succeed with safe and reliable operations.

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.

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EVENTS

1. *TRANSFORMER ENERGIZED WITH PROTECTIVE GROUNDS STILL INSTALLED*

On August 22, 2005, at the Idaho National Laboratory, Reactor Technologies Complex, Power Management line crew electricians energized a 138/2.4-kV transformer without removing all of the personnel protective grounds and caused a ground fault. The electricians heard a loud bang, which was immediately followed by the tripping of the circuit breaker to the transformer. There were no injuries and no apparent equipment damage. (ORPS Report ID--BEA-RTC-2005-0006)

The new transformer was being installed as part of an electrical utility upgrade project. The electricians installed three personnel protective ground clusters during installation: one on the transformer primary side; one on the transformer secondary side; and one on the bus work ahead of the main circuit breaker. However, none of the protective grounds was listed on the Clearance lockout/tagout.

When the electricians completed the installation, the Clearance was removed. The electricians verified removal of two sets of personnel protective grounds; however, they overlooked the remaining set of grounds located inside a closed switchgear cabinet. Figure 1-1 shows the inside of the cabinet and the grounding attachment point. Figure 1-2 shows a closeup of the remaining ground, still connected to the "C" phase.

When the incident occurred, the system was configured to energize the transformer with no loads attached, and all personnel had exited the substation before the transformer was energized to avoid potential injury per their safety training. Shortly after the loud bang, smoke detectors in the area activated and firefighters responded. Electricians installed a new Clearance on the transformer before the firefighters entered the substation and determined that there was no fire.

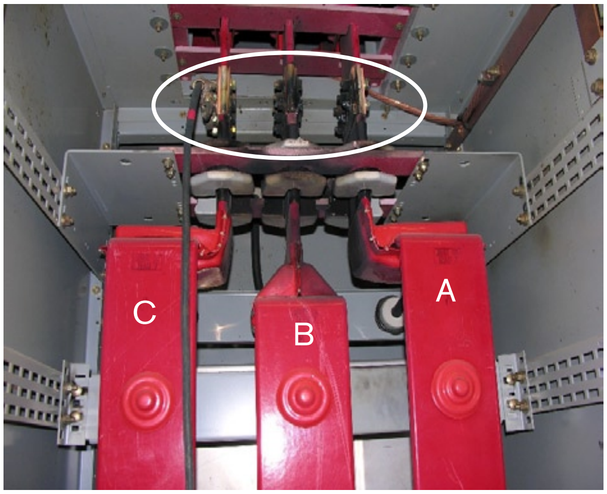

Figure 1-1. Grounding attachment point (circled)

A similar event involving personnel protective grounds occurred at the Reactor Technologies Complex on April 28, 2003. A Primary Authorized Employee had authorized removal of a lockout/tagout on a deep well pump that had been used during an electrical upgrade project. However, the Projects Outage Coordinator saw a grounding cluster still in the pump motor electrical circuit and immediately rescinded the authorization. Investigators determined that subcontractor electricians had installed the grounding cluster as a safety precaution

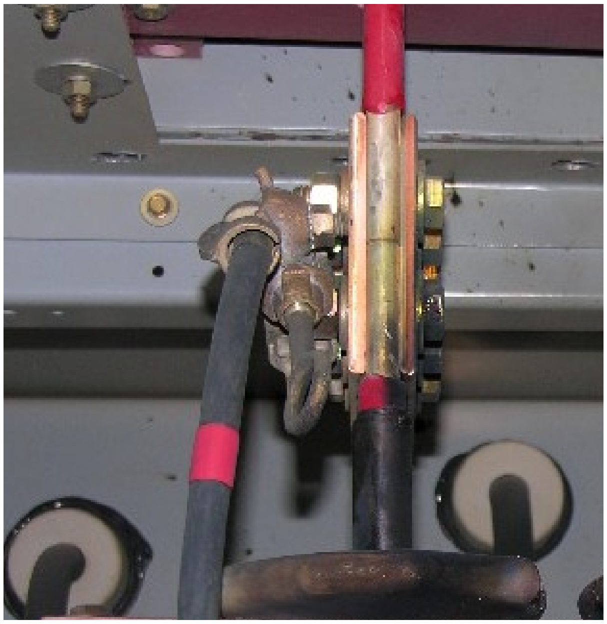

Figure 1-2. Protective ground clamped to phase "C"

against induced voltage. Although lockout/tagout procedures require personnel protective grounds to be identified as a separate line entry on the Lockout/Tagout Record Sheet, as well as requiring issuance of a separate Danger Tag, the cluster was not identified on the lockout/tagout or controlled by the subcontractor configuration management process. (ORPS Report ID--BBWI-RTC-2003-0003)

On November 11, 1994, at the Y-12 Plant, electricians energized a 161-kV transformer with the protective grounds still installed, resulting in the loss of normal AC power to the site and subsequent transformer damage. The electricians were re-energizing the transformer, which had been out of service for oil reclamation. The transformer had been locked and tagged on the primary side switch, and the secondary side circuit breaker had been disconnected and tagged. Protective grounding cables had been installed on all three phases of the primary and secondary circuits. Following removal of all locks and tags, the electricians closed the primary switch, creating a ground- fault condition. A check-off error on the High Voltage Tag Order allowed the system to be energized with the two sets of grounds still attached. Investigators determined that there was no clearly defined method for configuration control of personnel protective grounds. (ORPS Report ORO--MMES-Y12SITE-1994-0044)

Guidance on the use of protective grounds for power transmission and distribution can be found in 29 CFR 1926.954, *Grounding for Protection of Employees.* The standard includes guidance for installation and removal of grounds, which is very important in high-voltage transmission line work, as evidenced by an accident involving an apprentice lineman for the Western Area Power Administration. On June 7, 2004, the lineman was electrocuted by induced voltage when he apparently removed his personnel protective ground out of the prescribed sequence while working on a 230-kV powerline.

These events underscore the importance of maintaining positive control over the use of personnel protective grounds. Organizations responsible for installation and maintenance of electrical distribution equipment must ensure that a process is in place for tagging and tracking these grounding devices. Never authorize equipment to be energized unless you can account for every safety ground. Don't allow a safety device to become a safety hazard.

DON'T LET A SAFETY DEVICE BECOME A SAFETY HAZARD. ACCOUNT FOR ALL PROTECTIVE GROUNDS

KEYWORDS: *Protective grounds, ground strap, ground fault, transformer, electrical safety*

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

2. ACCIDENTS DURING CRYOGENIC CONTAINER MOVEMENT

On August 3, 2005, at the Hanford Waste Receiving and Processing Facility, a 220-liter Dewar containing liquid nitrogen tipped onto its side while being transported from a truck to a loading dock (Figure 2-1). There were no injuries, but the relief valve opened for a few minutes and released liquid nitrogen and gas before it reset. (ORPS Report RL--PHMC-WRAP-2005-0005)

Figure 2-1. Truck at loading dock with fallen Dewar

A teamster and an operator were offloading Dewars from the truck to the loading dock using a ramp to accommodate a 2¾-inch difference in height between the vehicle and the dock. The shop-fabricated ramp, made from diamond plate, is 48 inches long and 30 inches wide. The Dewars are 5 feet high and have a wheel base of 24 inches. There are five sets of wheels on the bottom of the cylinder, each of which is 4 inches high and 2 inches wide. The teamster was behind the Dewar, pushing it, while the operator pulled from the front.

Investigators believe that the ramp flexed under the load of the 700-pound Dewar, causing the Dewar to tip to the side, and that once the Dewar started to fall, there was no way to stop it. Fortunately, the Dewar fell in a way that it did not hit anyone. The teamster and operator placed the work area in a safe condition and strapped the Dewar to the truck rail and ramp until a rigging crew could right the cylinder and move it into the facility. Figure 2-2 shows the Dewar strapped in place.

Investigators determined that the apparent cause of this event was that neither management nor the work teams considered that the high center of gravity and the design of the wheel base would create a tipping hazard when the Dewar was pushed or pulled on an incline. Contributing factors included flexing of the ramp and using diamond plate, which may have affected the ability to safely steer the Dewar. Also, the truck bed was lower than the dock and was not aligned parallel to the dock edge.

A near-miss event involving the movement of a Dewar occurred at the Pantex Plant on September 23, 2004. A Dewar filled with liquid nitrogen fell over during movement of a transport cart, resulting in a slow leak of nitrogen gas. One of the handlers involved with moving the cart fell and was treated for minor, first-aid-type injuries. (ORPS Report ALO-AO-BWXP-PANTEX-2004-0104)

Two engineering technicians were using a newly approved three-wheeled cart (specifically designed for lifting and transporting this type of Dewar) to move the Dewar from a loading ramp to a gas lab bay. One technician was pushing the Dewar and cart while the other was spotting the move by walking ahead. The accident occurred when the left front wheel on the cart rolled into a ½-inch-deep, unused floor drain,

Figure 2-2. Dewar strapped to truck rail and ramp

which immediately stopped the cart. Forward momentum of the liquid nitrogen shifted the center of gravity of the cylinder outside the stability triangle of the cart, causing the Dewar and cart to tip over and fall to the floor. The technician pushing the cart unsuccessfully attempted to counterbalance the falling Dewar by holding onto the cart handles. As a result, he landed on top of the Dewar when it hit the floor. Industrial Safety and Fire Department personnel righted the cylinder and moved it outside to vent the remaining nitrogen to atmosphere.

Causal factors included the uneven floor surface, which had never been leveled during earlier renovations, and inadequate training on the new cart used to lift and transport the Dewar. The manufacturer's operating instructions for handling cryogenic cylinders recommend lowering the cylinder as close to the floor as practical to reduce the chances of an accident during transport. Training needs for this new equipment were never formalized. Also, an engineering analysis of the stability of the cart was never performed. Figure 2-3 shows a similarly configured three-wheeled cart carrying a Dewar.

On June 30, 2000, at the Fermi National Accelerator Laboratory, a worker crushed his finger while moving a 300-pound Dewar of argon on a four-wheeled cart. Because the Dewar was not properly attached to the cart, it shifted when the worker tilted the cart and Dewar back onto all four wheels. The worker's right index finger was pinched between the cart and the Dewar, and the tip of the bone was crushed sufficiently to require amputation of his finger tip. Investigators learned that workers were never fully instructed on the proper use of the Dewar cart. (ORPS Report CH-BA-FNAL-FERMILAB-2000-0006)

Figure 2-3. Three-wheeled cart and cryogenic cylinder

Good Practices for Handling Large Cryogenic Containers

- Keep hands and fingers clear of any potential pinch points.
- Wear appropriate personal protective equipment (e.g., face shield, safety goggles, loose cryo gloves, apron, high-top shoes, and long trousers without cuffs).
- Keep Dewars upright at all times.
- Do not allow the container to fall on its side or subject it to a sharp impact or severe vibration that can result in a loss of container vacuum or pressurization and release of contents.
- Use carts that are designed specifically for moving Dewars.
- Always consider the movement of liquid inside the container and the container's center of gravity.
- Ensure your route is clear of obstructions and potential hazards.
- Ensure that handlers are properly trained.

These events highlight the importance of ensuring that personnel who handle large cryogenic containers are properly trained on the safe use of carts and the associated hazards of cryogenic liquids. It is important to consider the tipping hazard presented by large, often heavy cylinders with a high center of gravity, especially when moving on inclined surfaces.

KEYWORDS: *Dewar, liquid nitrogen, cryogenic, handling, transportation, cart, injury, leak*

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

3. WORKING SAFELY OUTSIDE THE WORKPLACE — PART II: USE THE CORRECT TOOLS AND WEAR PPE

On August 5, 2005, at the Savannah River Site, a mower operator was cutting grass near an occupied office trailer when the mower ejected a rock with enough force to travel 25 feet and break a trailer window in front of an occupied desk. The impact sent shattered glass from the window into another area, where two other workers were sitting, and shards of glass fell onto a desk and the floor. One of the workers in the trailer informed the mower operator about the incident, and he immediately stopped work. (ORPS Report SR--WSRC-SW&I-2005-0023)

This event emphasizes the dangers of motorized yard equipment, as well the distance projectiles can travel. Had the rock hit someone outside the trailer, it could have seriously injured or blinded him or her. Such an event, coming as it does in the middle of home lawn and home project season, is a strong reminder that work safety measures cannot be ignored or left behind when we leave work at the end of the day.

When you work around your house, you are responsible for your own safety and that of your family. However, all the elements that can lead to a work-related accident can be seen outside the workplace, as well: lack of situational awareness, failure to canvass the surrounding area, lack of planning, jumping in to help, or just trying to get the job done as quickly as possible. When we are away from work, it is easy to forget to follow the rules that keep us safe while on the job.

Plan Your Work and Allow Sufficient Time

Don't rush just because a job is on your weekend "to do" list and the kids are clamoring to go to the water park. Allow enough time to plan your work. Gather the correct tools and PPE and check them for operability. Also remember to lock out the breaker/fuse box so no one can turn the power on while you're working on electrical components. Before you begin any work project, make a mental work plan and consider all the hazards (think, "what if"); when you are through working pick up tools or other hazardous items in the work area and put them away. Although it is natural to cut corners when you're in a hurry, statistics show that's when the potential for an accident increases.

The Tool to Engage First: Your Brain

Look Up, Down, and Around

Check for overhead hazards such as power lines, overhanging eaves, gutters, tree limbs, and wasp nests. Also check for hazards underfoot such as loose gravel, uneven pavement, trailing power tool cords, pooled water, hoses, and children's toys and bikes. If you plan to dig, contact a local underground utility locator to check for any digging hazards first. Make sure outdoor electrical outlets are equipped with ground fault circuit interrupters. And remember, it is essential to enforce safety rules with children and pets so they don't wander into the work area and cause or receive an injury.

Wear the Proper PPE

You don't need to dress out in Tyvek anti-Cs to work at home, but you should, at minimum, wear closed-toe boots or shoes; lightweight safety glasses to deflect debris or nails that mower blades turn into projectiles; a hat or visor to protect you from the sun; and full-length pants and a long-sleeved shirt. If you're spray-painting or sanding, do it in an open area (or make sure there is adequate ventilation) and wear a dust mask or appropriate respiratory protection. Wear safety glasses when you use drills or weed whackers, and use protective handwear and a blade guard when you use a power tool with a rotating blade. Wear shoes with grip soles that will protect your feet and provide proper traction whether you're on a ladder or on the roof. And don't forget to use hearing protection when necessary.

On May 4, 2005, at the Sandia National Laboratory, a worker was injured while using a power sander that kicked back and struck him in the knee. Investigators determined that the sander lacked a guard and that although the worker wore safety glasses, he was not wearing a face shield or respirator to protect him from the dust the sander generated. They also determined that the user's manual was unavailable. (ORPS Report ALO-KO-SNL-CAFAC-2005-0002)

In addition to wearing PPE when working at home, be sure to keep user's manuals where you can find (and use) them. Be sure to follow all manufacturer instructions, and store extra parts and attachments together, labeling them for easy retrieval.

Use the Proper Tools and Properly Maintain Them

On June 9, 2004, at Portsmouth, a riding mower lost drive power and ran backward down a hill, coming to rest in a creek. The driver was not injured because he was able to jump off the mower safely. A daily inspection checklist had been completed, but an actual inspection had not been performed in some time, and the hydraulic fluid had leaked out, causing a malfunction. (ORPS Report ORPP-PPPO-BJC-PORTENVRES-2004-0012)

This event serves as a reminder that even minimal, but consistent, maintenance prevents big problems and possible equipment failure. Regular home-tool maintenance should include cleaning tools after use, oiling and servicing all equipment with moving parts on a regular basis, inspecting power tools and their cords for wear and tear, and replacing tools if cords are frayed or cut. Before use, ensure that effective safety guards are in place and that extension cords have adequate capacity for the tools being used.

Tools Checklist

Before you start working, check hand tools to prevent injury.

- Use the right tool for the job.
- Select tools with comfortable handles and secure grips.
- Ensure that handles are tightly wedged into tool heads and securely bolted or screwed on.
- Sharpen edges so cutting tools move smoothly.
- Carry tools in a tool belt to leave hands free.
- Ensure that guards are in place on grinders, saws, etc.
- Ensure that electrical tools are grounded or double-insulated, and that cords and plugs are not frayed/worn.
- Use a stable work surface in a well-lighted area.
- When the job is complete, clean the tools, inspect them for wear, and store them in such a way that sharp edges won't interfere with passersby and that they are out of children's reach.

— Electronic Library of Construction Occupational Safety and Health

Be Cautious When Using Ladders

If you're pounding a nail, it's common sense to use a hammer, not the butt end of another tool. But when people need to reach a height, they don't always use common sense. A ladder should be the right one for the job — for example, do you need a properly braced stepladder or a securely locked extension ladder? Make sure the side spreader locking devices on the ladder work, that rungs aren't cracked or broken, and that the feet are intact. Set the ladder on a flat, dry, firm surface, never place it on a table or other raised surface. Go no higher than instructions on the ladder indicate. Don't over-reach or make sudden movements, and remember to balance as you carry loads, leaving one hand free to hold and climb. Don't be distracted by other activities, and keep the area clear of children and pets. If you're working on the roof, use a ladder 3 feet longer than the point of support. If you're working near electrical lines or equipment, use a wood or fiberglass ladder and have someone "spot" for you. Don't place a ladder in front of a door that may unexpectedly open or near birds' or wasps' nests.

Know When to Issue a Stop-Work Order — Your Own

Stopping work when you have doubts about safety is a responsibility all DOE workers share. But do you know when to stop work before you get hurt at home? When things aren't going right — if the power cord is too short; the ladder won't reach; the screws are the wrong size; or you're hot, tired, distracted — **stop work**. Take time to drink a glass of water, a soft drink, or a cup of coffee; take some deep breaths; and just "chill" for awhile. Don't attempt to work "just a little longer" or use a workaround. If you are not familiar with a process or have work that involves electrical wiring and heights, hire a professional to do the work. Remember, your safety and that of your family are worth the cost involved in hiring someone to do work you are not qualified to perform.

A new tool or ladder will always cost less than medical care for a tool-related injury.

Home projects should be performed with the same thorough planning, careful selection of PPE, and thoughtful, step-by-step execution used at DOE work sites. There, programs are in place to help workers go home each night in the same safe condition they arrived. Workers owe it to themselves, their families, and their employers to work safely at all times and in all places.

KEYWORDS: *PPE, mower, mowing, ladder, power tools*

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

4. OPERATOR ERRORS AND DESIGN FLAWS CITED FOR LEAK AT BRITISH REPROCESSING PLANT

On April 20, 2005, at the Thermal Oxide Reprocessing Plant (THORP) in northwestern England, a camera inspection of a feed clarification cell revealed that 83,000 liters of dissolver solution had leaked from a broken pipe into the cell sump. The dissolver solution consisted of nitric acid containing approximately 20 metric tons of uranium and plutonium. No personnel were injured as a result of this incident, and the leaked highly radioactive material was contained within the cell, which acts as a secondary containment. British

Figure 4-1. Thermal Oxide Reprocessing Plant

Nuclear Fuels Limited (BNFL) operates THORP, which is located on the Sellafield nuclear site (Figure 4-1).

Since THORP opened in March 1994, operators have chemically separated elements of spent fuel rods, extracting 97 percent of the uranium and plutonium for further use as nuclear fuel. This operation is similar to the separation processes conducted at DOE facilities. After the uranium, plutonium, and fission products are dissolved in nitric acid and the remnants of steel fuel rods are removed, the solution must be centrifuged to remove any remaining shards of steel or tailings. This stage, called clarification, is the point in the process where the leak occurred.

The clarification cell is a stainless-steel-lined space measuring 60 meters long, 20 meters wide, and 20 meters high. The camera inspection was initiated because of calculated discrepancies in the nuclear material balance and indications of leakage into one of the sumps within the cell. Investigators determined that the dissolver solution had been leaking into the cell for many months, possibly since July 2004. It is believed the pipe, which provides feed to an accountancy vessel (tank), suffered a major break on or around January 15, 2005, based on a rapid increase in sump level and rising temperature. Figure 4-2 shows the failed feed pipe to the accountancy vessel.

A Board of Inquiry was charged with identifying the cause of the incident. The Board of Inquiry report identified a culture of operational

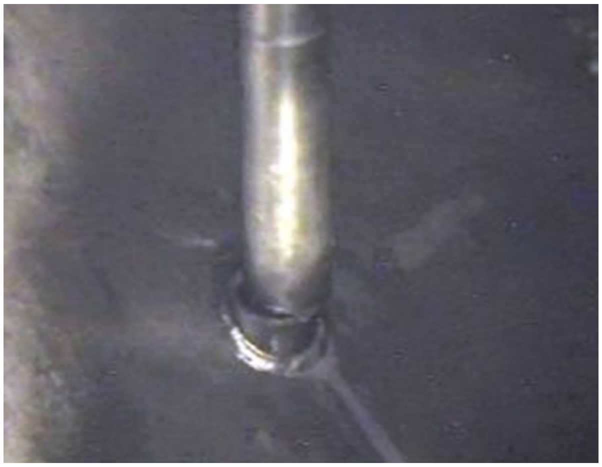

Figure 4-2. Failed pipe nozzle on tank head

complacency for failing to identify a leak that had been ongoing for 9 months. The Board also identified design flaws associated with the accountancy vessels that led to fatigue failure of the feed pipe. The findings from the report are summarized below.

Conduct of Operations Issues

The loss of significant quantities of solution should have been averted by earlier detection of leakage into the cell. Operators failed to act appropriately to off-normal conditions of increased sump level, results from sump sampling, and discrepancies in nuclear material balances.

From July 2004 to August 2004, there was a slight deviation in nuclear material accountancy. A "Shipper/Receiver" difference was outside the normal expected tolerance, but was not considered a concern by safeguards personnel. Hindsight, however, suggests that this could have been an indication of a developing issue. The first clear indication of a significant discrepancy in the material balance occurred in March 2005. However, because of the complexity of the calculations, safeguards personnel believed it was simply a calculation error. A subsequent calculation in April 2005 confirmed that 19 tons of uranium had been lost from the primary system over the course of three separation campaigns.

There are two sumps in the clarification cell that are sampled automatically and remotely. In November 2004 and in February 2005, two samples showed positive for uranium. Investigators found no evidence that either of these sample results were ever acted upon at the time of discovery.

The sump level is monitored by a pneumatic liquid level indicator, which is safety-related for criticality safety and warns operators of a leak. The level indicator has a history of erratic operation, with over 100 cases of spurious Lo or Lo-Lo alarms from July 2004 through March 2005. Operators investigated only two of these alarm conditions, and there is no evidence that corrective actions were performed on the instrument.

The level indicator was reading normal level when the camera inspection showed significant quantities of dissolver solution in the cell sump. Investigators later discovered that air flow to the instrument was not set properly, causing the instrument to read much lower than actual levels. They believe that previous maintenance work inadvertently resulted in the low air flow.

Equipment Design Issues

The accountancy vessels are suspended from the cell roof to allow weighing of the vessel and contents and determining material balance. To achieve this, the vessels are supported by four rods that pass through the roof to a weigh mechanism. The vessels are normally operated suspended, except for brief periods to establish a datum or for calibration, at which time they are lowered to rest on a steel frame in the cell (Figure 4-3).

Investigators believe the pipe failed because of fatigue stresses induced by excessive movement of the vessel. Operators had seen problems with vessel vibration as evidenced in their shift logs and video footage showing significant movement of the vessel during agitation and emptying cycles.

The original design of the accountancy vessels provided for seismic restraints to prevent lateral movement and induced stresses from pumping devices. However, the installed configuration was modified and did not include the restraint blocks. The Board of Inquiry has no evidence that the design was reviewed to consider fatigue stresses following modification that eliminated the restraints.

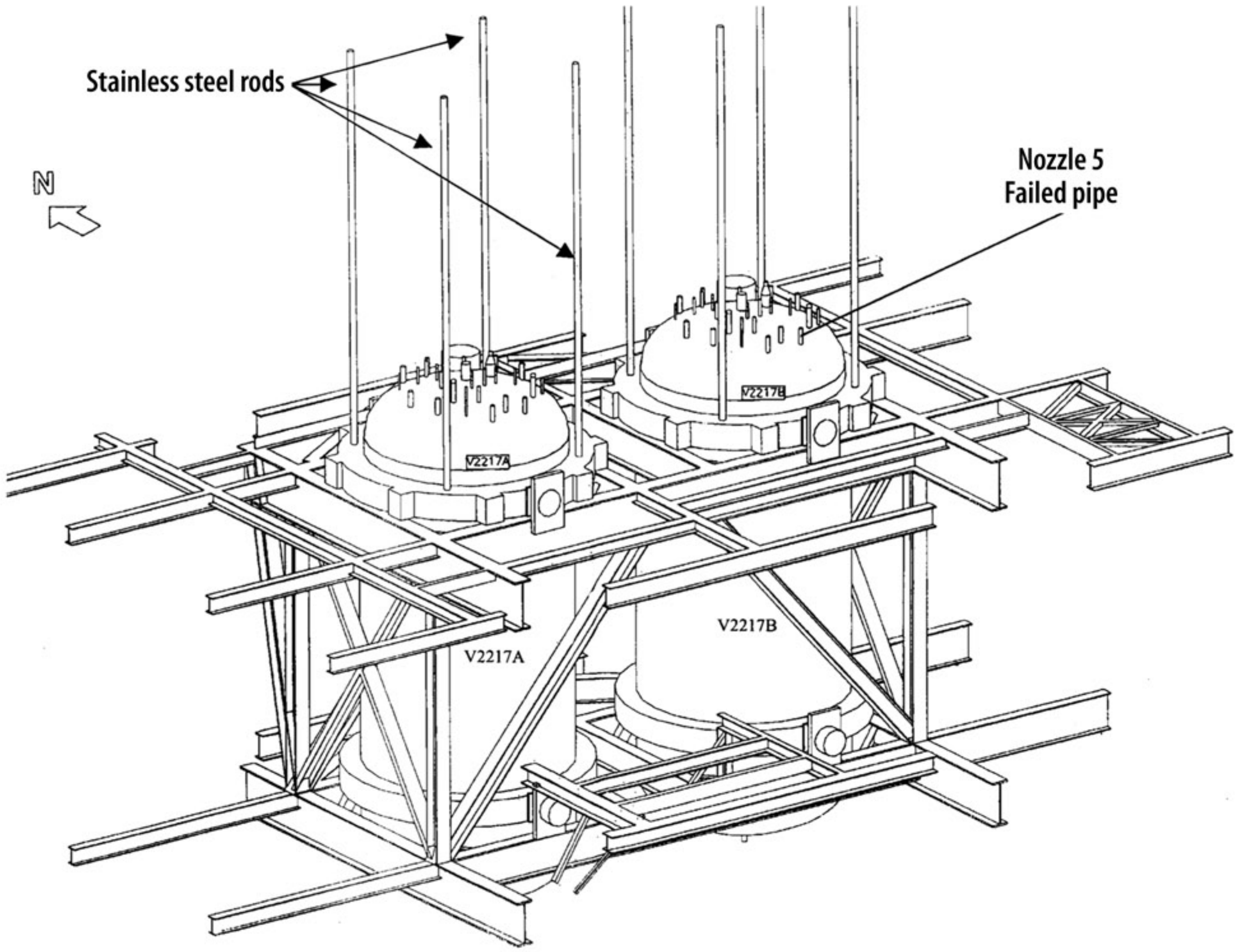

Figure 4-3. Accountancy vessel showing suspension rods and support frame

Cultural Issues

Operators, safeguards personnel, team leaders, and managers believed that material losses of this magnitude could not have occurred and that it had to be an error in paperwork. Their belief was that THORP was a "new plant," built to the highest standards, and therefore leakproof. Because the vessels and piping were all welded construction and fabricated to high standards, a major leak onto the cell floor was regarded as unlikely. However, the assumption was that if such an event were to occur, operators would be alerted by the sump alarm. Unfortunately, the sump alarms did not result in appropriate operator response. The "new plant" culture pervades all levels within the THORP organization, and this culture has continued despite previous operating experience that demonstrates leaks can and do happen. The following examples are relevant.

- In February 2005, three workers were grossly contaminated while changing out a thermocouple in a dissolver because dissolver solution had leaked through the primary boundary into the thermowell pocket.

- In 1998, erosion of an outlet pipe in the dissolver cell resulted in the leak of highly radioactive solution into the secondary containment. This leak went unnoticed for years despite sump level indication, sump sampling, and contaminated radiological probes that suggested a problem.

The Board of Inquiry's view is that plant workers had not fully learned the lessons from these previous events and continued to maintain an attitude that a loss of containment was not credible. The operational culture at THORP was, therefore, complacent with regard to detecting losses from the primary containment.

Responding promptly to alarm conditions is very important. On November 25, 2000, at the Savannah River Site H-Canyon, an operator noticed an unexpected level decrease in a uranium storage tank. An inspection of the piping identified a failed spool piece, which was leaking uranium solution into the tank containment sump. The operator closed a valve and isolated the leak. Investigators determined that a lack of an alarm response procedure for the sump was a contributing cause. Two sump alarms had been received before the operator discovered the leaking flange while performing schedule rounds. If alarm response procedures had been implemented, the source of the leakage might have been identified sooner. As a corrective action, alarm response procedures were developed for the sump alarms in the uranium sumps. (ORPS Report SR--WSRC-HCAN-2000-0051)

The Department of Energy Action Plan on lessons learned from the Columbia Space Shuttle Accident and the Davis-Besse Reactor Pressure-Vessel Head Corrosion Event revealed the same type of cultural issues, complacency, and lack of technical inquisitiveness as major causes of both accidents. The Department's Action Plan was published June 2005 and can be accessed at http://www.eh.doe.gov/ll/Columbia-DavisBesse_DOE_ACTIONPLAN.pdf.

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter I, "Operations Organization and Administration," states that a high level of performance is achieved in DOE operations by establishing high standards, by ensuring that personnel are well trained and by holding workers and their supervisors accountable for their performance in conducting activities. The Order also states that it is the responsibility of the shift operating crew to operate the facility safely by adhering to operating procedures and operational safety requirements and by using sound operating practices. Chapter II, "Shift Routines and Operating Practices," describes professional watch-standing practices for all operating personnel. Section 6, "Response to Indications," states that operators should treat instrument readings as valid unless they can prove otherwise. When operators are in doubt, safety should always be placed above production.

The incident at THORP underscores the importance of operator vigilance and strong conduct of operations. The failure to promptly recognize anomalous plant indications, coupled with operators who did not consider the loss of containment to be credible, resulted in a nuclear mishap and significant cleanup effort. Operators must believe their indications, maintain a questioning attitude, and thoroughly investigate abnormal conditions. The disasters involving the space shuttles Columbia and Challenger, the reactor accidents at Three Mile Island and Chernobyl, and even the sinking of the Titanic, all come to mind. If you don't believe it can happen, then you may not be prepared when it does.

KEYWORDS: *Leak, pipe break, uranium, plutonium, reprocessing, conduct of operations, design, vibration, fatigue, culture, sump, alarm*

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