OPERATING EXPERIENCE SUMMARY

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Inside This Issue

Preventing Heat-Related Illness

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Now that the warmer months are upon us, it's time to think about the risks associated with working in hot environments, their effects on DOE employees and contractors, and how those risks can be reduced. Heat-related illnesses generally occur when high ambient temperatures, either indoors, outdoors, or within protective clothing, overcome the body's natural ability to dissipate heat, resulting in Heat Stress Disorders.

These heat-related illnesses, range from heat fatigue and heat rash to heat exhaustion and heat stroke. If left untreated, heat illnesses can lead to serious complications, and in the case of heat stroke, even death. According to the Centers for Disease Control between 1999 and 2003 a total of 3,443 deaths occurred in the United States as a result of exposure to extreme heat – an average of 688 deaths per year. The National Institute for Occupational Safety and Health (NIOSH) advises that workers suffering from heat stress are also more prone to make mistakes and suffer other injuries.

In 2006, the State of California's Division of Occupational Safety and Health (Cal/OSHA) performed a detailed analysis of 25 investigations on heat-related illnesses in 2005 that resulted in emergency room visits, hospital stays, or death. The results were to be used, in part, to develop a state-wide heat illness prevention standard. Their findings may be of interest to DOE and its contractors.
(see Cal/OSHA Findings text box)

Most heat-related illnesses (with the exception of heat stroke) can be treated on-site, but can they also be prevented? While there are a number of environmental and human factors that contribute to heat stress, OSHA identifies a number of factors that can be influenced administratively: Acclimatization, Fluid Replacement/Hydration, Clothing, Management Planning and Worker Education.

Cal/OSHA Findings on Heat-Related Illnesses

- Death was the outcome in 54% of the cases
- 38% required 24+ hours of hospitalization
- 84% involved outdoor work exclusively
- 92% involved moderate or strenuous work
- Average temperature was 96 °F
- Average humidity was 29%
- Work was in direct sunlight 76% of the time
- Shade was available in 77% of the cases
- Potable water was present 100% of the time
- 78% showed inadequate fluid consumption

Acclimatization

The data from the Cal/OSHA findings on heat-related illness is enlightening, but it doesn't reflect what may be the most surprising finding of their investigation; the critical importance of gradual acclimatization to hot weather.

Cal/OSHA Findings on Acclimatization

- 80% of the incidents occurred in the first 4 days with 46% occurring the first day on the job
- 34% of the incidents occurred on days 2 - 4 on the job
- 4% of the incidents occurred 5 days - 2 weeks on the job
- 16% of the incidents occurred in weeks 3 - 52 on the job

Over time, the human body adapts to heat exposure through acclimatization. During the first few work days in a hot environment or after returning from an extended absence, a worker's sweat-salt conservation may not be fully developed. After a period of as little as five to ten days, the same level of physical exertion will result in fewer cardiovascular demands on the body. NIOSH recommends that in heat stress environments, workers should increase their exposure at differing rates depending on whether or not they are experienced working in the heat.

NIOSH Recommended Heat Exposure during Acclimatization

Day No.	Experienced Heat Worker	New Worker
1	50%	20%
2	60%	40%
3	80%	60%
4	100%	80%
5	100%	100%

Hydration/Fluid Replacement

A U.S. Army article titled ***"Prevention of Heat Illness,"*** points out that hydration is the most important element in preventing heat illness because it is essential for effective thermoregulatory blood flow and perspiration. It goes on to note that acclimatization, while essential, does not reduce water requirements. However, even when potable water is available, soldiers in hot environments do not voluntarily drink enough water to maintain proper hydration - a phenomenon know as "involuntary dehydration." The article points out that thirst is not stimulated until the body reaches a level that is 1-2 percent dehydrated.

Workers should hydrate before engaging in work in heat stress environments and hydrate regularly during the course of work. Cool water (50°-60°F) or other non-alcoholic beverages should be available at all times to workers in heat stress environments, and OSHA recommends encouraging workers to drink small amounts of liquids frequently at a rate of one cup every 20 minutes. Some studies have shown that workers offered flavored drinks, including electrolyte beverages, were more likely to stay hydrated. Warmer water and poor-tasting water seems to have the opposite effect and may actually discourage fluid replacement.

Encouraging hydration, coupled with worker education on the importance of fluid replacement is the key to avoiding heat-related illnesses. An Australian study of 2,000 mine workers under continual heat stress reported in ***"Occupational and Environmental Medicine"*** found that "involuntary dehydration did not occur in well-informed workers."

Clothing Selection

The standard description of hot weather clothing is "lightweight, light-colored and loose-fitting," and 100% cotton clothing has been shown to help prevent heat rash. While this is a good guideline for most outdoor work, in many cases that description does not meet the requirements for DOE work. The most important clothing factors are reflective ability and permeability. Much of DOE work typically requires varying levels of protection up to and including multi-layered Personal Protective Equipment (PPE) which, while blocking most of the radiant heat, adds weight, increases energy consumption, and may not allow for evaporative cooling (Figure 1-1).

Figure 1-1. Working outside in the sun while wearing PPE

Section 534 of DOE-STD-1098-99, *Radiological Control*, discusses heat stress as it applies to radiological work. The Standard recommends addressing heat stress when planning work in hot environments, setting appropriate work time limits, using clothing that wicks perspiration away from the body, using body cooling devices, and relaxing protective clothing requirements. It also points out that heat stress has occurred at ambient temperatures less than 70 °F when multiple sets of anti-contamination clothing (anti-C's) or plastic suits were worn or when strenuous work was required.

For this reason DOE's Office of Health, Safety and Security follows the guidelines recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for physiological monitoring of fit and acclimatized workers wearing semi-permeable and impermeable encapsulating clothing.

Suggested Frequency of Physiological Monitoring (work time)		
Adjusted Temperature (degrees F)	**Normal Work Clothing**	**Impermeable Clothing**
90 or above	Every 45 minutes	Every 15 minutes
87.5 - 90	Every 60 minutes	Every 30 minutes
82.5 - 87.5	Every 90 minutes	Every 60 minutes
77.5 - 82.5	Every 120 minutes	Every 90 minutes
72.5 - 77.5	Every 150 minutes	Every 120 minutes

NIOSH has developed factors for four common clothing ensembles to assist in making temperature adjustments to cover a wide range of work demands and environments.

NIOSH Recommended Temperature Adjustments for Clothing	
Normal work clothes and cloth coveralls	Add 0.0°C / 0.0°F
Polyethylene-based particle-barrier coveralls	Add 0.5°C / 0.9°F
Water-barrier, vapor-permeable film laminate coveralls	Add 2.0°C / 3.6°F
Limited-use vapor-barrier coveralls	Add 10°C / 18°F

Environmental Factors

"It's 95 °F in the shade!" We've all heard that but what does it really mean? Meteorologists refer to that as "dry-bulb" temperature. Once humidity is integrated, the "feels like" temperature can change drastically because the amount of water in the ambient air affects the body's ability to cool itself through evaporation. This "Heat Index" or "Humiture" can be helpful in determining how workers will tolerate their environment. Wind speed, on the other hand, is a double-edged sword; in hot weather, wind speed has a positive impact by helping in the evaporation process, while in cold weather it has the opposite effect by adding a "wind chill" factor.

The temperature adjustment deemed most useful in calculating heat stress is the Wet-bulb Globe Temperature Index (WBGT) which considers not only the dry-bulb temperature, wind, and humidity, but also the effects of solar radiation. A variety of stationary, portable, and hand-held WBGT site-monitoring instruments are commercially available.

Management Activities

There are a number of steps management can take to try and minimize the danger of heat-related illnesses.

Evaluate Risks – Identify the operational characteristics of the environment and perform work-load assessments (light, medium or heavy). Identify a temperature sampling methodology (preferably WBGT) and develop a work/rest regimen. Ensure cool potable water/beverages are available at all times. Identify individual worker risks (age, weight, conditioning, acclimatization) and monitor those workers at risk for heat stress.

Develop Written Plans/Programs – Increase awareness and preventionby developing programs such as an Injury and Illness Prevention Programthat incorporates heat-related illnesses.

Below is a Work/Rest/Water Consumption Table developed by the U.S. Army for a heat injury prevention program on fluid replacement guidelines for warm weather training.

Work/Rest/Water Consumption Table

		Easy Work		Moderate Work		Hard Work	
Heat Category	WBGT Index (F°)	Work/Rest (min)	Water Intake (Qt/hr)	Work/Rest (min)	Water Intake (Qt/hr)	Work/Rest (min)	Water Intake (Qt/hr)
1	78-81.9	NL	½	NL	¾	40/20	¾
2 (Green)	82-84.9	NL	½	50/10	¾	30/30	1
3 (Yellow)	85-87.9	NL	¾	40/20	¾	30/30	1
4 (Red)	88-89.9	NL	¾	30/30	¾	20/40	1
5 (Black)	>90	NL	1	20/40	1	10/50	1

Heat Illness Prevention Training Program for Workers and Supervisors – Emphasize the importance of hydration; recognize the need for acclimatization; and provide tools for recognizing the early signs of heat stress. OSHA offers free cards in English and in Spanish on the subject of heat stress that can be downloaded and printed.

Emergency Response Plan – Maintain current procedures for: contacting emergency medical services; transporting employees to a point where they can be reached by an emergency medical service provider; and providing clear and precise directions to the work site(s).

As a result of the Cal/OSHA study, in June, 2006 California became the first state in the country to adopt heat stress illness prevention regulation that requires the availability of water at all times, access to a shaded area, and the education of supervisors and employees on preventing heat-related illness and what to do if they occur.

A recent event involving heat-related illness occurred on June 7, 2007, at Los Alamos National Laboratory where two workers suffered potential heat exhaustion while supporting a tank replacement operation in a tank room. The job required several entries of 90 minutes each and the workers wore anti-C's, paper coveralls, an acid suit, and a respirator. Both workers reported feeling shaky, nauseous, and overly hot. They were given oxygen and administered fluids via an intravenous line and transported to an emergency room where they were monitored for approximately 2 hours, after which they reported feeling better. (ORPS Report NA--LASO-LANL-TA55-2007-0020)

On June 15, 2006, at the DOE Central Training Academy, a participant in the 2006 DOE Security Protection Officer Training Competition suffered heat injury during a strenuous team competition with ambient temperatures of 90 °F and 21 % humidity. The participant was hospitalized for 8 days before being released. (ORPS Report SO--CTAW-CTA-2006-0001)

On May 2, 2005, a worker at the Kansas City Plant Kirtland Operations facility became lightheaded and fainted in a paint booth after spray painting for 2 hours in 94 °F temperature. He wore Tyvek® clothing and an air line respirator to protect from the chemical hazards. Heat stress training was less than adequate because it didn't address the different types of clothing that may contribute to raising body temperature. (ORPS Report NA--KCSO-AS-FMTNM-2005-0003)

These events underscore the importance of understanding how serious heat stress can be and what actions to take if it occurs. The immediate health effects from heat stress or heat stroke pose a far greater risk to workers wearing anti-C's, chemical suits, or heavy firefighters' equipment than those of other job-related hazards. Workers should be adequately trained in the prevention of heat-related illness and should also be vigilant and aware of the signs of heat stress, both theirs and their co-workers. If a coworker wearing anti-C's exhibits symptoms of heat stress while in a contaminated area, you must act quickly to get the person out to the step-off pad as soon as possible. If that is not possible, you should loosen the PPE (taped wrists, hood, etc.) to allow air to circulate and cool the victim. Having the victim lie on a concrete floor can help in cooling, as can applying a cooling vest or ice pack.

KEYWORDS: *Heat, heat stress, heat-related illness, hydration, dehydration, heat stroke, acclimatization, temperature, hot weather*

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

Poor Job Planning Results In Electrical Worker Fatality

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On April 30, 2007, at the Bangor Naval Submarine Base, an apprentice lineman was electrocuted when he touched a line truck that had become energized when the truck boom came in contact with an overhead power line. The victim was part of a line crew that was attempting to set a communication pole near 12,470-volt power lines. (IBEW Local 77 Accident Investigation Report)

A line crew from a Navy subcontractor was on the base to re-route 10 spans of 3-phase primary overhead conductors to an underground service and remove the overhead lines. Because of scheduling problems with the Navy, the subcontractor was unable to provide all the materials needed to dead-end the overhead wire. As a result, the subcontractor's general foreman borrowed the material from the Navy's High Voltage Department in exchange for replacing a 30-foot-tall communications pole.

Figure 2-1. Work area showing the pole in the brush

The crew assigned to replace the pole consisted of one foreman, one journeyman lineman, and the apprentice, who had joined the crew a month before. The replacement pole was loaded on the line truck with the butt over the cab so that it could be moved and set in an area of brush on a hillside (Figure 2-1).

The foreman conducted a job briefing to discuss where they needed to set up the line truck in order to dig the hole with the truck's auger. Because the height of the primary power lines was 26 feet, the foreman decided it would be best to set the pole near the base of the existing pole. The apprentice drove the line truck into position and the foreman climbed up to the controls of the truck and started digging the hole with the auger. After the hole was dug, he re-stowed the auger on the truck in preparation to unload the pole and stage it in a position to be set.

Figure 2-2. Incident reenactment (touching the energized truck and the grounded metal building)

The apprentice climbed onto the truck and hooked up the winch line to the setting chain that was around the pole. The pole was going to be placed with the top uphill in the brush. The foreman then raised the pole off the truck with the boom while the lineman helped to guide the pole from the rear of the truck. The foreman raised the boom to its maximum position and swung it clockwise, towards the rear of the truck. As this was being done, the apprentice climbed down from the truck and walked around to the driver's side to assist the lineman. As the lineman looked up at the boom, he saw the hydraulic lines of auger touch a primary phase. At this instance, while walking between the line truck and a metal building, the apprentice placed one hand on the truck and one hand on the metal building as he stepped over a pallet of electrical cables. Current flow passed through the chest and heart of the apprentice (Figure 2-2). At the same time, the foreman heard an arching sound and immediately swung the boom away from the primary phase.

The lineman saw the apprentice leaning over and asked if he was alright. The apprentice responded that he was not. The lineman called 911 as the foreman climbed down from the truck to assist the apprentice. The apprentice's pulse was weak and he was having difficulty breathing. The foreman removed the apprentice's burned work gloves and saw that his hands were also burned. At this point, the apprentice stopped breathing and had no pulse. The foreman and lineman started administering CPR until medics from the naval base arrived and took over the CPR. Finally, the medics tried to revive him with their defibrillator, but were unsuccessful.

Investigators from the local electrical union identified the following issues that could have been done to prevent this accident.

- The job should have been engineered, planned, and made ready for the work crew. The work was performed as a favor in exchange for materials and the site was congested and filled with obstacles.
- The job briefing should have focused on the line truck boom being in close proximity to the primary zone because the energized overhead power lines were 26 feet above the ground. Also, not touching the line truck while the boom is in the primary zone should have been discussed with the crew.
- The crew should have used protective line barriers, rubber gloves, and grounded the line truck. The apprentice was not wearing rubber electrical gloves.
- Additional manpower could have been used so the foreman would be able to focus his entire attention on the job as a safety watch and spotter.
- The crew did not have an Automated External Defibrillator (AED) with them, which could have changed the outcome of the accident if employed quickly.

Since 2000, there have been 47 events reported in ORPS regarding incursions with overhead electrical power lines. These events involved crane and excavator booms, dump truck beds, and forklift masts. The voltage in some of these incursions was as high as 13,000 volts. The following example occurred while removing a utility pole.

On April 18, 2006, at the Savannah River Site, a 55-foot temporary pole slipped from the grapple hooks of a boom truck and hit a phase of a 13.8 kV power line. An electrical subcontractor was in the process of removing the power pole from a sloped area 23 feet from an overhead power line, when the ground surface gave way. The boom truck operator lifted the pole out of the ground and started to rotate the boom away from the direction of the power line to lay the pole down when the incident occurred. (ORPS Report EM-SR--GOSR-GOSR-2006-0002)

Investigators determined that the operator failed to close the pole guide dogs after he lifted the pole from the ground. Also there were too few workers assigned to the task (i.e., a spotter should have been available).

In 2004, a lack of job planning and hazards identification resulted in the fatality of a contractor for the Western Area Power Administration, which resulted in a Type A Accident Investigation (OE Summary 2004-21). In that accident, a 20-year-old apprentice lineman was electrocuted from induced voltage when he removed personal grounds out of sequence on a de-energized 230-kV power line. The Type A Accident Investigation Board identified many contributing causes including inadequate job planning for not identifying hazards and mitigation measures in a project-specific stringing and grounding plan, as well as reduced resources with less than adequate experience levels and no supervision. (Not reported in ORPS)

These events underscore the importance of adequate planning when work is to be performed around overhead electrical hazards. Adequate resources need to be assigned to support the safe operation of equipment near these types of hazards. In addition, job planning should address work area issues such as congestion or obstacles that could jeopardize worker safety. Pre-job briefings need to thoroughly address all potential hazards and stress the use of proper protective equipment and PPE. It is important that your workers are knowledgeable of the dangers imposed by overhead electrical hazards and that your organization's safety policies regarding proximity to high-voltage power lines are consistent with the requirements of 29CFR1910.333, Electrical – Selection and Use of Work Practices.

KEYWORDS: *Fatality, electrocution, electrical safety, job planning, protective barriers, congestion, defibrillator*

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

Lessons Learned from Leak at British Reprocessing Plant

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On February 23, 2007, the Health and Safety Executive (HSE) published a report on its investigation of the internal leak of highly radioactive liquid at the Thermal Oxide Reprocessing Plant (THORP) in northwestern England. HSE is the enforcement authority for Great Britain's Health and Safety Commission and their report includes lessons that are applicable to DOE operations.

THORP, which is operated by British Nuclear Group Sellafield Limited (BNGSL), is located on the Sellafield nuclear site (Figure 3-1). THORP operators began chemical separation of uranium and plutonium from spent fuel rods for further use as nuclear fuel in March 1994. 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 is called clarification and is the point in the process where the leak occurred.

Figure3-1. Thermal Oxide Reprocessing Plant

The leak of radioactive material at THORP was classified as a "serious incident" or "Level 3" in accordance with the seven-level International Nuclear Event Scale, which is one level below the accident classification (Figure 3-2). The investigation of this incident resulted in 55 recommendations for improvement and two Improvement Notices to BNGSL. The operating company received fines and costs of approximately $1,123,000 for breaches of their nuclear site license. Although permission to restart THORP was

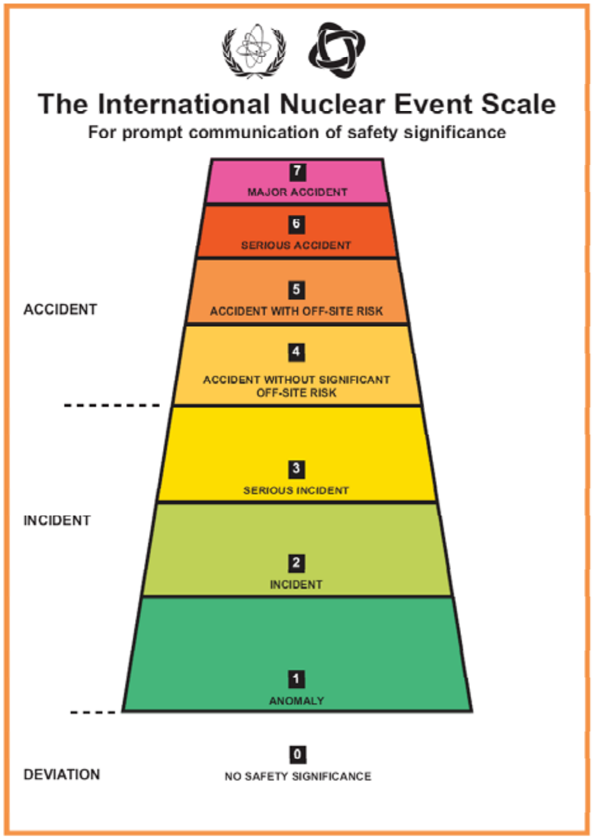

Figure 3-2. International Nuclear Event Scale

granted on January 9, 2007, continuing problems at the plant have delayed a full restart.

Operating Experience Summary (OES), Issue 2005-13, summarized the findings from the initial Board of Inquiry report of the THORP incident, which cited issues associated with conduct of operations, equipment design, and safety culture. These concerns are also discussed in Environment, Safety and Health Bulletin Issue 2005-11, ***"Significant Radioactive Leak at Sellafield due to Operational Complacency."***

The Incident

On April 20, 2005, a camera inspection of a feed clarification cell revealed that a pipe carrying highly radioactive dissolver solution to an accountancy tank had severed (Figure 3-3) and leaked 83,000 liters of nitric acid solution containing approximately 20 metric tons of uranium and plutonium onto the floor of the cell and into a sump. There were no injuries and the highly radioactive solution was contained within the cell. The leaking pipe had gone undetected for a period of 9 months. The camera inspection was initiated because of calculated discrepancies in the nuclear material balance.

Figure 3-3. Failed pipe nozzle on tank head

Why the Leak Occurred

Investigators determined that the nozzle failed from fatigue caused by the motion of the accountancy tank during certain conditions of operation. The initial breach would have been small and would have grown to a complete failure in later stages over a period of months.

The tank is suspended from the cell roof by four rods to allow it and its contents to be weighed for material balance determination. Operators had seen problems with tank vibration during agitation and emptying cycles. Although agitation of a full tank showed imperceptible movement, very visible large movements occurred when the tank was half full. Operator guidance had always been to agitate a full tank just before sampling. However, in 1997, the requirements changed from agitating a full tank to allowing agitation of less than a full tank for prolonged periods. Investigators could not find any procedures for auditing how these decisions were made. Also, the original design of the accountancy tank provided for seismic restraints to prevent lateral movement and induced stresses during pumping and agitation; however, the installed configuration had been modified and the restraint blocks were not installed.

Why the Leak Went Undetected

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

In November 2004 and in February 2005, two samples from the sumps in the clarification cell showed positive for uranium but 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 had a history of erratic operation, with over 100 cases of spurious alarms from July 2004 through March 2005. Operators investigated only two of these alarm conditions. There was no evidence that corrective actions were ever performed on the instrument. When the camera inspection showed significant quantities of dissolver solution in the cell sump, the level indicator was reading normal. Investigators later discovered that air flow to the instrument was not set properly, causing the instrument to read much lower than actual levels.

From July 2004 to August 2004, there were slight deviations in nuclear material accountancy that was outside normal expected tolerance, but safeguards personnel did not consider this to be a concern. Hindsight suggests that this could have been an indication of a developing problem. The first significant discrepancy in the material balance occurred in March 2005, but because of the complexity of the calculations, safeguards personnel believed it to be just a calculation error. Eventually, in April 2005, a calculation confirmed that 19 tons of uranium had been lost from the primary system over the course of three separation campaigns.

It had been the belief of operators, safeguards personnel, team leaders, and managers that a physical material loss of this magnitude could not occur in a new plant built to high standards and therefore, the loss had to be an error in paperwork. Besides, a major leak was regarded as unlikely and even if it did occur, operators would be alerted by the sump alarms. The view of the Board of Inquiry is that plant workers had not fully learned lessons from previous events, and therefore, continued to maintain an attitude that a loss of containment was not credible. This resulted in an operational and safety culture at THORP that was complacent with regard to detecting losses from the primary containment.

Lessons Learned

The HSE report identified several lessons for BNGSL and for the industry. These lessons are summarized as follows.

- The technical origins of the leak lay in the design inconsistencies in the later stages of the design process and during construction, together with a modification to the operational mode of the tank that inadequately considered the impact on the piping. The incident has again highlighted the experience in the major hazards industries across the world where ill conceived or inadequately executed changes to design, plant, procedures, process or organizational arrangements have resulted in incidents. It is essential that changes, even those that are apparently minor, are carried out with the appropriate assessment of their potential impact by people who understand their safety significance in relation to the original design intent of the plant or processes to be changed.

- The leak went undetected for many months because the workforce culture condoned ignoring alarms, non-compliance with key operating instructions, and safety-related equipment that was not kept in effective working order for some time. Therefore, it became the norm of the workforce culture to ignore or disregard safety issues/warnings. In addition, there appeared to be an absence of a questioning attitude. For example, even where the evidence from the accountancy data was indicating the possibility of a leak, it was not considered a credible explanation until the evidence of the leak was incontrovertible.

- The International Atomic Energy Agency has published guidance on issues to be addressed in strengthening the safety culture of an organization and they have relevance here. The importance of a questioning attitude towards potential safety issues and the need to encourage challenge are aspects of culture that need to be instilled and demonstrated by the most senior managers. They need to lead by example in this respect.

- Similarly there is a need to encourage a culture where shortcomings in working practices and plant conditions are challenged by the workforce through a system of open reporting, effective follow-up of the concerns raised, and feedback. The workforce needs to understand the key precautions, which are necessary to ensure nuclear safety, and the rules and procedures which support these. This promotes an understanding of why such rules and procedures are necessary and relevant, and reduces the likelihood that short cuts or workarounds will emerge over time.

- There needs to be a method to ensure that safety controls are in place and are working effectively. Senior managers cannot rely on the absence of incidents as an indicator that everything is as it should be or as they would wish. This reinforces the importance of a questioning attitude and a challenge culture.

- The failure to learn from previous events is a contributory factor. The lessons derived from learning should be embedded through a structured system for implementing corrective actions in a timely manner that is rigorously applied and actively followed to completion. Effectiveness reviews should be undertaken to confirm that the changes have delivered the desired improvements.

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.

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. This incident also emphasizes the need to foster a safety culture that sets minimum standards; identifies and resolves problems; is open to criticism and recommendations; and promotes effective communications.

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*

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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 Sharing

Units of Measure	
AC	alternating current
DC	direct current
mg	milligram (1/1000th of a gram)
kg	kilogram (1000 grams)
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
TWA	Time Weighted Average
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
JSA	Job Safety 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
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement
RCRA	Resource Conservation and Recovery Act
TSCA	Toxic Substances Control Act

Miscellaneous	
ALARA	As low as reasonably achievable
HEPA	High Efficiency Particulate Air
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
SME	Subject Matter Expert