Operating Experience Summary

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Seemingly Unimportant Changes Result in Crane Accidents

1

On May 18, 2009, during construction of the River Protection Pre-Treatment Facility, a tower crane operator attempting to locate and pick up a trash skip hit the pendant of a stationary Demag track crane with the boom of the crane. Although normal crane operating quadrants had been formally established and documented on a quadrant map, neither the map nor the hazards analysis was reviewed and updated when a new hazard (i.e., the track crane) was introduced to the area. After the event, both cranes were taken out of service and crane operations were paused. (ORPS Report EM-RP--BNRP-RPPWTP-2009-0011; final report issued July 2, 2009)

Both cranes were located outside the Pre-Treatment Facility, which is under construction. Figure 1-1 shows the boom of the tower crane (yellow) and the track crane (pale red). The tower crane was operating above the unfinished building, and the skip was inside the building in a location that was not obvious to the tower crane operator. Inspectors determined that neither crane sustained structural damage as a result of the accident, but both were slightly scraped and scuffed. Damage to the tower crane boom (a 21-inch scrape) is shown in Figure 1-2.

Investigators determined that event causes included the following: informal communication used to convey information; no formal established boom limits; lack of knowledge about the location of both the trash skip and the stationary track crane; and treating a new element (the track crane) as commonplace. They concluded that the task had been performed based on previous experience without considering how new or additional obstacles introduced into the work environment could impact the process.

Figure 1-1. Tower crane (left) and Demag track crane at the Pre-Treatment Facility

Figure 1-2. Scrape on tower crane boom (highlighted)

When the track crane was first brought to the building project, several actions should have been triggered, including updating the quadrant map showing the new boundaries; performing a new hazard assessment; and updating the STARRT (Safe Task Analysis Risk Reduction Talk) cards to provide an opportunity for workers to discuss hazards during pre-job briefings.

In addition, specific information should have been provided about the location of the trash skip so the tower crane operator did not have to search for it. The search put the tower crane operator at risk of hitting obstacles with the boom of the crane.

Corrective actions included the following.

- Improve three-way communication protocol for everyone involved, particularly when one crane enters the space of another crane. The protocol will include improved methods for radio communication from someone on the lower level to the crane operator.
- Clarify current controls and develop defined quadrants and maps for situations in which the tower crane shares air space.
- Provide human performance improvement training to crane operators, coordinators, and appropriate personnel.
- Remind operators to take their time during crane operations because a "pick list" of tasks does not have to be completed each day. (Some daily "pick list" items for the tower crane were assigned to other cranes to more evenly distribute the task load.)

Similar Event

On August 20, 2008, at the Idaho Radioactive Waste Management Facility, a gantry lifting device lever on a crane hit and broke a polycarbonate sheet on the wall of a working platform atop a vault. The crane operator was rotating the crane slowly around in tight quarters to pick up a cask hoist assembly when the event occurred. (ORPS Report EM-ID--CWI-ICPWM-2008-0002; final report issued September 29, 2008)

Investigators determined that two, seemingly minor changes had taken place in work area configuration since the previous evolution: the hoist assembly had been moved and a 4-inch wood buffer previously located at the base of the vault area had been removed. Normally, the hoist is on a trailer parked within reach of the crane. However, because the trailer was needed for another task, the hoist assembly was off-loaded and placed in a different, but still reachable, location. Investigators also determined that without the 4-inch block acting as a buffer, the crane superstructure was 4 inches closer to the working platform. The change in location and lack of buffer resulted in the operator rotating the crane farther than normal and moved the lifting device lever closer than usual to the wall and polycarbonate sheet. When the operator slowly rotated the crane to pick up the hoist assembly, the gantry lifting device lever on the rear of the crane superstructure hit the polycarbonate sheet, breaking it.

The two configuration changes were discussed in the pre-job briefing, but no one recognized the implications or potential consequences of the changes. Although workers and equipment operators followed procedural steps and instructions, because these seemingly minor changes were overlooked, there was a big impact on work that led to the event.

Corrective actions included emphasizing situational awareness and revising pre-job checklists to require crane operators to physically verify clearance before starting work. The primary lesson learned from the event was the importance of asking if anything had changed before work begins, especially if the task involves frequently-performed operations when it is easy to become complacent. Operators were reminded to ask "what if?" and take preventive actions based on the answers.

Safe crane operation is addressed in DOE Standard 1090-07, *Hoisting and Rigging* (http://www.hss.doe.gov/nuclearsafety/ns/techstds/standard/std1090-07/index.html). OSHA crane safety requirements are included in 29 CFR 1910.179-182, *General Industry Standard* (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9830), and in Subpart N of 29 CFR 1926, *Construction Industry Standard* (http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=1926). Crane-related OSHA eTools can be accessed at http://osha.gov/pls/oshaweb/searchresults.category?p_text=cranes&p_title=&p_status=CURRENT.

The *Safety Daily Advisor* has published additional resource information about OSHA crane requirements. The text box below shows some "quick tips" available on the *Safety Daily Advisor* website (http://safetydailyadvisor.blr.com/archive/2009/04/30/training_cranes_derricks_slings_OSHA_requirements.aspx).

Safe Crane Operation

Workers must carefully follow procedures such as the following.

- Performing prescribed inspections on a regular schedule, sometimes daily.
- Taking out of service any equipment with one or more defective parts so it cannot be used until it has been repaired.
- Never exceeding the rated capacity of equipment (rated capacity should be posted on the equipment).
- Understanding the nature (weight, size, shape) of the load in order to use the correct slings.
- Ensuring that the operator and anyone else involved in the task agree before the job starts on proper signals and the final destination of the load.
- Ensuring that there are no obstructions in the swing path.
- Prohibiting employees from working in the area where materials are being loaded or unloaded or beneath the swing path.

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Crane safety has been the topic of a number of articles in the *OE Summary*, including the following.

- *Industry Tower Crane Collapses Lead to Savannah River Site Crane Shutdown* (2008-07)
- *Near Miss to Serious Injury When Crane Outrigger Float Falls and Hits Worker* (2006-09)
- *Avoid Overhead Crane Accidents—Check For Travel Path Obstructions* (2005-05)

Crane operators and workers must be aware of changes that have occurred since they last performed the evolution, particularly in frequently-performed operations when it is easy to become complacent. Pre-job planning must consider all crane and large equipment components and put mitigating factors in place to ensure spacing and avoid contact. Asking "What if?" will help ensure preventive action and safe operations.

KEYWORDS: Crane, hoist assembly, tower crane, track crane, boom, trash skip

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

Configuration Control Errors Can Affect the Operation of Safety-Related Equipment

2

On July 7, 2009, the Nuclear Regulatory Commission (NRC) issued Information Notice 2009-11, *Configuration Control Errors,* to inform licensees of configuration control errors that can affect the operation of safety-related equipment. The NRC Notice focused on an event at the two-unit Prairie Island Nuclear Generating Plant (Figure 2-1) in which a turbine-driven auxiliary feedwater (AFW) pump was rendered inoperable by a mispositioned valve. (NRC Information Notice 2009-11)

Figure 2-1. Prairie Island Nuclear Generating Plant

On July 31, 2008, following an inadvertent reactor trip of Prairie Island Unit 1, the turbine-driven AFW pump automatically started as designed, but tripped 42 seconds later on low discharge pressure. Plant personnel discovered that the isolation valve for the discharge pressure switch was closed instead of open as required. A time delay in the pump protective circuitry trips the pump when a continuing low discharge pressure condition exists. The monthly surveillance to test the operability of the pump does not test the low discharge pressure trip function because the pump is tested in the manual operating mode, which bypasses the low discharge pressure trip.

Plant personnel determined that the isolation valve for the discharge pressure switch was closed sometime between March 11, 2008, and July 31, 2008.

The improper isolation of the turbine-driven AFW pump discharge pressure switch resulted from the failure to adequately control components that affect the operability of safety-related equipment. The following causes were identified.

- The mispositioned valve was not labeled, which bypassed barriers that are normally in place to assist in proper component identification.
- The mispositioned valve was not locked in the required position, making it more likely to be mispositioned. The procedure used to align the AFW system does not define which valves shall have locks, blocks, or lock wires installed.
- The procedure for component blocking or locking contains a definition of which components should not be controlled, but does not contain a definition of which components should be controlled.

Plant management implemented the following corrective actions.

- The suction and discharge pressure switch manifold isolation valves for all four AFW pumps were lock-wired open.
- The procedure for component lockout/tagout was revised to address this issue.
- A review was conducted to identify all other components that could affect operability of safety-related systems and to establish that each identified component was included in the equipment database and drawings, had a locking device installed, and was labeled in the field.

The NRC Operating Experience Branch reviewed recent component mispositioning events that were the subject of NRC inspection findings and Licensee Event Reports. The review found that these events occur or remain undetected because of one or more of the following causal factors.

- Failure to use or establish administrative controls, including: proper component labeling, proper valve locking, use of valve checklists, work and testing procedures, and use of post-maintenance flow testing confirmation (when necessary).
- Dependence on a single administrative control to prevent valve mispositioning events.
- Insufficient training (i.e., lack of refresher training) or experience in determination of valve position by individuals (e.g., using rising stem position to help confirm valve position).
- Improper independent verification or incorrect valve locking techniques.
- Lack of operator awareness of unique valve design or valve operating characteristics.
- Unrecognized operator burdens that increase the likelihood of error.
- Failure to effectively apply site and industry operating experience.

Corrective actions taken by some licensees for preventing configuration control errors included the following.

- Labeled components with a unique plant equipment number and name and ensured they are consistent with the designations used in plant procedures, drawings, and labels on the operating controls.
- Provided initial and periodic refresher training to operators, maintenance, and supervisory personnel related to configuration control.
- Used a corrective action program to track and trend configuration control errors.
- Discussed site and industry operating experience and used operating experience feedback mechanisms.
- Identified incorrect procedural steps or improper valve labeling as procedures were performed so that they could be corrected.

The NRC archive of information notices can be accessed at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/.

Information Notice 2009-11 identifies deficiencies and issues that could be applicable at DOE facilities where the operability of equipment is critical to facility safety. A review of Lessons Learned and the Occurrence Reporting and Processing System identified the following similar event in which a system important to safety was challenged by a configuration error.

Similar Event

On June 23, 2008, at the Y-12 National Security Complex, Oxide Conversion Facility (OCF) operators discovered that the low pressure sensing line test valve for flow control valve (FCV) was in the “Aligned to Atmosphere” position versus the required “Aligned to FCV” position. This mispositioned valve prevented the flow control valve from being able to sense actual hydrogen gas differential pressure across an installed orifice and control hydrogen flow as intended per the OCF Technical Safety Requirements. OCF operations were suspended until the cause of the out of position valve was identified. (ORPS Report NA--YSO-BWXT-Y12NUCLEAR-2008-0023)

Investigators were unable to determine when the test valve had been closed. The last time it was confirmed to be open was on June 16, 2008. It is speculated that, because the valves are located in an open and accessible area, the valve could have been accidently bumped and, in an attempt to correct the problem, someone could have returned the valve to the wrong position. Valves associated with equipment important to safety and in easily accessible areas should be checked to determine if protective measures need to be taken to ensure the valves are not inadvertently operated and left in the wrong position.

Chapter VIII of DOE Order 5480.19 Chg 2, *Conduct of Operations Requirements for DOE Facilities*, states that it is imperative that equipment and systems in a DOE facility be properly controlled. Not only must the operating shift be aware of how equipment and systems will function for operational purposes but, in order to satisfy the design bases and the operational limits, the proper component, equipment, and system configurations must be established and maintained.

Configuration control errors, such as mispositioned valves or switches, can render technical safety-required systems inoperable or result in a violation. Proper configuration control is particularly important when a single component, if mispositioned, would cause the system to become inoperable. Proper configuration control is especially important when the mispositioned component might not be readily detected because (a) there is no alarm or other condition to alert operators of the error, (b) the component is in a flow path that is not testable by surveillance procedures, or (c) due to unique conditions the mispositioned equipment may not be detected during routine surveillance testing as was the case in the Prairie Island event.

KEYWORDS: Configuration control, valves, mispositioned, safety equipment, technical safety requirements, independent verification

ISM CORE FUNCTION: Provide Feedback and Continuous Improvement

Unidentified Drilling Hazards Result in Two Near-Miss Events

3

Two near-miss events occurred during operations at a Hanford drilling project within days of each other. One event resulted in a worker receiving a minor burn that required first-aid; the other resulted in damage to equipment, but could have resulted in a serious injury.

On June 19, 2009, a driller helper recovering soil from the core barrel of a sonic drill placed the core barrel over a bucket, hit it with a hammer to dislodge the material into the bucket, and received a first-degree burn to his arm when the material was forcefully expelled, along with a plume of hot air, steam, and dust. The worker received first-aid for the burn at the onsite medical facility and returned to work. (ORPS Report EM-RL--CPRC-GPP-2009-0006; final report issued July 16, 2009)

Figure 3-1 shows a sonic drill rig similar to the one being used. The core barrel in use when this event occurred was approximately 5 feet long and open at both ends. During core drilling operations, the core barrel is forcibly driven into the ground until the hollow barrel is filled with soil, then removed from the ground to unload the soil before repeating the process. When the core barrel is struck with a hammer, the intent is for the soil to fall out the end. The soil should not be "ejected" or "extruded," but should simply be unloaded (or dislodged) from the barrel.

Investigators determined that heat generated by friction during the drilling process resulted in pressure buildup in the core barrel, resulting in the worker's burn. Although they were aware of the heating phenomenon, heat buildup to an extreme that would create steam had not been experienced previously. In an attempt to determine the frequency of such occurrences, investigators contacted drilling companies regarding heat generation and steam/pressure production during sonic drilling. They received inconsistent information from the companies about whether any of their personnel had observed pressure or steam buildup during drilling operations.

Pressure buildup in the core barrel is not a widely recognized hazard, and investigators found no hard data on this type of event. However, they believe that the pressure buildup was the result of interaction among the following.

1. Dry drilling to ensure the integrity of the sample.
2. Heat buildup in the core barrel during drilling operations.
3. Moisture in the soil at between 8 and 10 feet below grade.

Figure 3-1. Sonic drill rig

To alleviate this problem, the drilling contractor will limit the potential for pressure buildup by addressing heat buildup in the core barrel. Drilling runs will be limited to no more than 2½ feet to reduce heat buildup, and a thermometer will be used during drilling to ensure that the temperature is less than 175°F before the core barrel is unloaded. In addition, if the temperature exceeds 200°F, drilling will be discontinued until the temperature returns to normal operating temperature. Also, to minimize potential worker exposure to the end of the core barrel, the driller and the driller helper will stand to the side of the core barrel when unloading the core barrel and will wear the appropriate PPE for extreme temperature conditions when handling the core barrel (i.e., leather gloves).

A lessons learned submitted to the DOE Lessons Learned database on this event reported that workers did not stop work when it became apparent early in the drilling process that a substantial amount of heat was being generated. In addition, management was not alerted to the changed conditions, which likely would have led them to suspend the drilling operation. Among the corrective actions identified in the lessons learned was the importance of ensuring that workers understand they need to stop work and notify management when they identify new hazards. (Lessons Learned ID: 2009-RL-HNF-0025)

The second event took place on June 11, 2009, during extraction drilling operations at the same Hanford project, where a piece of a ½-inch thick “dog collar” broke off when it struck a metal, ground-level U-plate, flew approximately 55 feet from the drill rig, and landed on the gravel access road outside the drilling exclusion area. Work was suspended pending a fact-finding meeting. This event was also categorized as a near miss, but with no injuries. (ORPS Report EM-RL--CPRC-GPP-2009-0005; final report issued July 16, 2009)

The workers used the U-plate (i.e., a hold-fast device) to suspend a 12-inch casing from the top of a 16-inch casing when the 12-inch casing was disconnected from the drill rig. Casing is a pipe (larger in diameter and usually longer than the drill pipe) that is used to line a hole to maintain the well opening. Figure 3-2 shows a casing being prepared for use on an oil rig.

The dog collar was used to ensure that the drill string was not dropped into the bore hole when the string was not connected to the rig. The collar, which is attached to the drill string, is wider than the external diameter of the wellbore, and holds the tool assembly to prevent it from dropping through the wellbore and being lost. Figure 3-3 shows the broken dog collar lying on the ground where it fell.

Figure 3-2. Casing being prepared for use on an oil rig

In April 2009, work began on a well at the drill site using a 16-inch casing and drilling to about 215 feet. Although the intent was to continue the well using a 12-inch-diameter casing, that size was temporarily unavailable. Instead, a 10¾-inch casing was used inside the 16-inch casing to drill the well down about 250 feet to collect water samples. When 12-inch casing became available, the 10¾-inch casing was removed so the job could be finished using 12-inch casing, but the hole left by the 10¾-inch casing was not backfilled, thus creating a void.

Figure 3-3. Broken dog collar

Workers lowered the 12-inch casing into the bore until it would go no further, and assumed it was at the bottom of the hole.

Investigators determined that the driller and a geologist tagged the bottom of the hole (i.e., dropped a 1-pound weight into the hole and used a tape measure to determine the depth of the hole) and believed it was approximately 3 feet below the bottom of the 12-inch casing (based upon how much casing workers knew had been placed in the hole). However, they were unaware that a bridge had formed above the void when the walls sloughed in after removing the 10¾-inch casing. This bridge provided a false indication of the actual depth when the hole was tagged.

To prevent the top of the 12-inch casing from going below the top of the 16-inch casing placed earlier, workers attached the steel dog collar about 3 feet above the U-plate. The driller then tapped the casing, intending to work it down until the dog collar rested on the U-plate. When the driller tapped the casing, it rapidly dropped about 9 feet shearing a piece off the dog collar as it passed the U-plate on its way down.

In the future, when a small-diameter well casing is removed and a larger one is installed, the bore hole will be backfilled with sand to prevent voids in the bore hole.

Environmental Remediation Drilling, a guideline prepared by AntiEntropics, Inc., and published in 2005, presents a wide range of information related to safe drilling operations. The guideline, which is a collection of safety practices and lessons learned compiled by knowledgeable remediation drilling and safety, health, and environmental professionals, is available at http://www.riskworld.com/nreports/2005/ERD_Safety_Guideline_R2.pdf. This summary of industry practices and techniques can be used to help drillers enhance safety and environmental performance, as well as overall project quality.

An OSHA e-tool focused primarily on drilling oil and gas wells also provides general safety information for drilling operations, as well as information on the use of casings. The e-tool can be accessed at http://www.osha.gov/SLTC/etools/oilandgas/index.html.

These events demonstrate the type of events that may occur when an unexpected problem arises. Although a detailed job hazard analysis may be in place, potential hazards outside the scope of the job hazard analysis may impact safety during drilling operations, which are among the most dangerous types of operations. It is important to adhere to all safety requirements (e.g., appropriate PPE and identified exclusion areas) to provide as much protection as possible in the event that an unexpected hazard leads to unanticipated consequences. It is also important to stop work when unexpected conditions arise (e.g., high temperatures) to assess and control the new hazard.

KEYWORDS: Drilling, core barrel, sonic drill, pressure buildup, dog collar, casing, burn injury, equipment damage, near miss

ISM CORE FUNCTIONS: Analyze the Hazards, Develop and Implement Hazard Controls, Provide Feedback and Continuous Improvement

The Office of Health, Safety and Security (HSS), Office of Analysis publishes the *Operating Experience Summary* to promote safety throughout the Department of Energy (DOE) complex by encouraging the exchange of lessons-learned information among DOE facilities.

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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

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