Operating Experience Summary

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Inside This Issue

Inadequate Industrial Job Planning Has Unintended Consequences

1

As a category, inadequate work planning ranges from minor omissions for which workers' skill of the craft can compensate to situations that could have had serious, or even fatal, results. The following events demonstrate a range of events where planning failed to consider and mitigate all hazards.

On February 16, 2007, at a newly constructed Brookhaven National Laboratory administrative building, Emergency Services responded to complaints of airborne irritants that affected five employees, four of whom were taken to medical facilities for evaluation. Floor cleaning had started that morning, but was stopped 2 hours later, when people arrived for work and complained about irritants in the air. Employees were instructed to shelter in place, building access was restricted, and the Industrial Hygiene (IH) team was called to evaluate both the air quality and the workers. (ORPS Report SC- -BHSO-BNL-BNL 2007-0004; final report issued April 27, 2007)

According to the final report, the floor-tile cleaning work was poorly planned and implemented. IH staff had reviewed the hazards and evaluated planning for the construction phase of the building, both of which were based on the assumption that the building was unoccupied. However, some pre-move-in punchlist items, such as tile cleaning, were not completed before occupancy. The building manager was notified that the tile would be cleaned, but no details were provided about the cleaning solution that would be used. As a result, IH was not given the opportunity to re-evaluate the hazards and the potential effect on building occupants.

The cleaning crew used a solution of 1 part muriatic acid mixed with 20 parts water to clean the tile floor in the lobby of the building. According to its MSDS, muriatic acid (also known as hydrochloric acid) is a dangerous, corrosive poison whose "liquid and mist cause severe burns to all body tissue and may be fatal if swallowed or inhaled. Inhalation may cause lung damage."

Ventilation in the building was inadequate and, because personnel were arriving for the workday, the timing of the work was poor. Inadequate planning for the floor cleaning work resulted in health impacts and work interruptions; additional costs when the IH team was called to evaluate air quality and workers; and lost time when several people were sent to medical to assess their symptoms.

When work was not completed before occupancy, as originally planned, the contractor should have provided a revised, detailed work scope. The revised scope would have allowed IH staff to evaluate the muriatic acid dangers and put proper controls in place. They could have ensured that the floor cleaning was performed during the off-shift and that building ventilation was accelerated to ensure that irritating or harmful vapors were flushed from the building well before personnel arrived to work.

Hazard identification and control are crucial requirements in the Department's Integrated Safety Management program. Those steps complement OSHA's explicit guidance for pre-work analysis of workplace hazards in OSHA 3071, Job Hazard Analysis. The text box on the following page shows examples of questions to ask during the planning stage and before work begins that will help identify hazards and prepare for them.

A search of the ORPS database elicited several recent events across the DOE Complex which demonstrate that neither planners nor those in the approval chain asked enough questions while planning work to ensure that all hazards were identified.

Job Hazard Analysis Questions

OSHA 3071, *Job Hazard Analysis*, recommends outlining the steps in each task, then playing detective to identify hazards before starting work. A hazard is rarely the result of one cause leading to one effect, so be prepared to repeat the process.
Ask questions such as these:

- What could go wrong?
- How could it happen - that is,
  - How likely is it to happen?
  - Where could it happen?
  - What could trigger the event?
  - What will the consequences be?
- How do I prevent the hazards or at least mitigate them?
- Whom should I notify - now?

On November 4, 2006, during demolition work at West Valley, an employee was sprayed in the face when he cut into a sample line containing water and nitric acid. The pressurized line had not been drained of residual liquids before the evolution because everyone assumed the line had been isolated and drained. Work planning was inadequate in the following areas.

- There was no prerequisite for verifying that the sample line had been isolated and drained.
- There was no requirement for PPE.
- There were no reviews of facility history or of DOE lessons learned and lessons from numerous closure/D&D efforts at other sites, nor was information on safe facility demolition, such as that found in the OE Summary, reviewed.

Poor planning, unknown hazards, and emerging conditions combined to endanger workers who may not have been familiar with the facility's history or with current facility conditions and, therefore, did not question the work assignment or its safety.

Planners are responsible for doing the research necessary to protect work teams and to ensure that all prerequisite actions have been taken. (ORPS Report EM-OH-WVDP-WVNS-VFS-2006-0001)

On March 9, 2006, at the Savannah River Site, inadequate planning contributed to a near-miss event when the outer shell of a 30-year-old portable metal building separated from the flooring and collapsed while the building was being secured to a transport trailer. The driver, who had placed security straps over the building's center and front, next planned to go to the rear of the building, where he could have been seriously injured by the section that fell to the ground (Figure 1-1). Work planning personnel failed to consider the age and condition of the building.

Figure 1-1. Portable building that collapsed

Portable buildings are often meant to be temporary and may be constructed with less rigor than permanent structures or may not receive regular maintenance. As a result, they are more susceptible to wear and tear from the elements and occupants. When the time comes to move such a structure, formerly unseen weaknesses caused by years of water damage, rust, termites, or rot become dangerously apparent. Because of the widespread use of portable structures across the DOE complex, especially at D&D sites, planning to move them safely is an issue with broad implications. Pre-move planning should assume that portable structures are extremely fragile and should mitigate the dangers such structures can pose to workers by including safeguards and checks. (ORPS Report SR--WSRC-FSSBU-2006-0002)

On January 10, 2006, also at the Savannah River Site, a manager received first- and second-degree burns on his unprotected face, neck, and hand from a flash fire caused by isopropyl alcohol-soaked wipes while cleaning an attritor vessel that may have contained pyrophoric residues. (The attritor mill is shown in Figure 1-2.)

The resulting Type B investigation determined that work planning was inadequate because the work scope (i.e., using a flammable liquid to clean a vessel where pyrophoric residues might remain and performing it outside the glovebox) had not been completely defined. As a result, the hazard analysis failed to identify isopropyl alcohol as a hazard and adequate controls were not in place. In addition, the manager performed steps that were not addressed in the work package. Investigators determined that workers conducted their activities without the necessary rigor and performed steps that were not addressed by procedures or hazards analysis.

A 2005 fire that occurred at the Savannah River Site during processing resulted in a hazards analysis revision, but corrective actions from that event were not incorporated into the

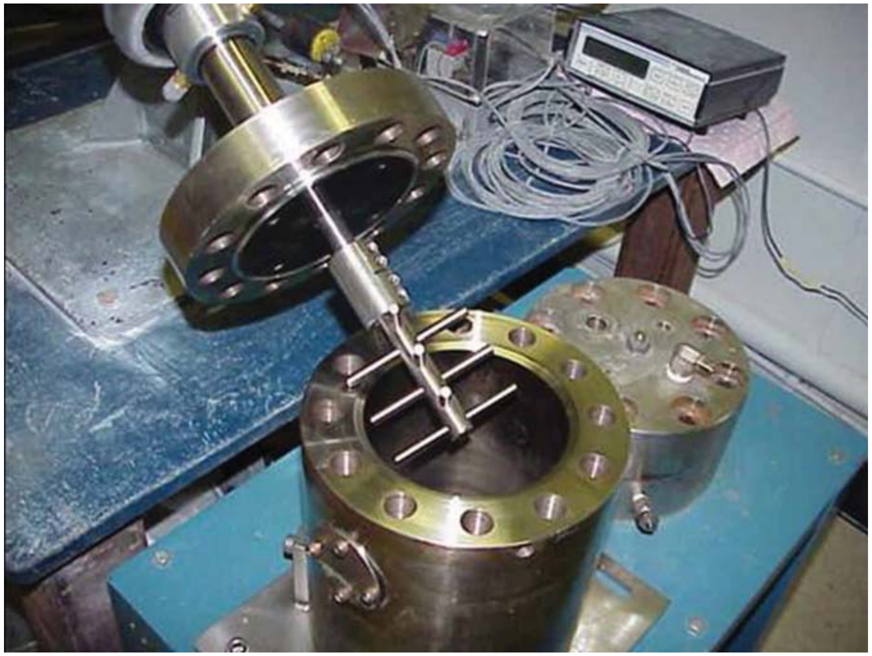

Figure 1-2. Disassembled attritor mill

planning or hazards analysis performed for this particular job; and, thus, failed to prevent the incident. (ORPS Report EM-SR--WSRC-LTA-2006-0002)

On July 14, 2005, at Hanford, inadequate work planning failed to recognize the tight spaces, and resulting dangers, that pipefitters would encounter while installing pipe on hangers .Personnel in a T-Rex extended boom manlift and on a scaffold were working in a tight space where they had to maneuver a 43-foot-long, 4-inch stainless steel pipe under and around other steel in the hot cell. Communication among the workers was hampered by distance and cell noise, and, when the pipe began to swing, the fitter was focused on controlling it to prevent damage to surrounding infrastructure, not on where his hand was placed. As a result, his hand was cut when it was pinched between the pipe and steel beam web, and surgery was required to repair the cut tendons and nerves.

Job planners assumed the work would be routine and did not consider what actions to take should the piping not fit as planned. The position of lifts, existing scaffolding and obstructions, and disrupted communication forced the workers to solve problems as they encountered them. At some point the workers should have exercised their-stop-work authority; but, even so, inadequate job planning did not address the difficult conditions they would encounter, and they were unprepared for the "what if?" situation. Pre-job planning done from a worker's perspective provides the best opportunity to include the questions identified in OSHA 3071, *Job Hazard Analysis.* (ORPS Report EM-RP--BNRP-RPPWTP-2005-0017)

In each of these events, work planners failed to identify all the hazards and implement controls for them. Work planners should familiarize themselves with all aspects of the work identified in the planning request—from materials or chemicals to the location. Work performed in a small space (cleaning the attritor vessel) can be just as dangerous as moving an aging trailer. Both situations provide ample opportunity to ask "what if?" and "what could happen?"

OSHA 3071 provides a sample JHA for anyone who wants to know more about job planning, and sites such as http://www.cdc.gov/niosh/database.html or http://msdssearch.com identify hazards and recommend PPE for thousands of materials that may pose a threat to workers.

Emphasizing the importance of work planning does not mean that workers should blindly rely on work-planning documents. They should use their judgment and experience to determine whether performing the work is safe and should exercise stop-work authority if they have doubts.

These events demonstrate the value of careful, thoughtful, detailed job hazard analysis and pre-work planning, with proper notifications and revisions, as necessary. Such a process draws on worker experience, as well as on hypothetical scenarios, to ensure worker safety, best use of resources, and procedural compliance.

KEYWORDS: *Job planning, work planning, hazards analysis, industrial*

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

Never assume.

Before starting work, perform your own hazard analysis by asking:

WHAT IF?

Is There a Fire Hazard Underneath Your Desk?

2

Most electrical fires that occur in the office and at home can be traced to overheated circuits or overloaded equipment or to insulation that has melted, burned, or frayed, exposing live wires. Often, these fires start underneath a desk, where electrical wires and power strips are "out of sight, out of mind."

On January 30, 2007, at Sandia National Laboratory, an employee who had reported a problem with an electrical cord the previous day, and assumed it had been fixed, put her feet on a metal footrest beneath her desk, heard a pop, and saw sparks coming from the cord. Although the electrical problem had been reported to the facilities Helpline, the cord was not replaced before she arrived at work the following day, leading to an incident that could have resulted in a severe electrical shock or fire. (ORPS Report NA-SS-SNL-10000-2007-0001)

As she was preparing to leave work on January 29, the employee heard a loud "pop" coming from underneath her computer workstation. She reported the problem and left for the day. Shortly after she began work on the following day, she again heard popping sounds and saw sparks and smoke, as an electrical arc from the damaged power cord burned the metal footrest (Figure 2-1). After the incident, facility workers replaced the power cord and removed the footrest.

Investigators learned that the footrest was not fixed in place, so it could slide forward during use. They also determined that the power cord was routed through the footrest, and when the footrest moved, the power cord got caught in a pinch point on the footrest. Over time, the shearing action of the footrest cut

Figure 2-1. Burn mark at top of footrest

the insulation on the cord, creating a shock and fire hazard. Because the employee had recently moved into the work area, a walkthrough inspection of her work area had not been performed. Following the event, all power cords were checked and all similar footrests were removed from service.

Investigators believe that, had an inspection been performed, both the routing of the power cord through the footrest and the shearing action on the cord would have been identified as potential hazards. In the future, management surveillance walkthroughs will include checking power cords to ensure that they are properly secured and to identify any potential problems.

An under-desk fire linked to a surge protector occurred on August, 21, 2006, at Portsmouth Gaseous Diffusion Plant. The fire activated sprinklers that quickly extinguished the flames. Analysis of the burn patterns and charred residue indicated that the fire originated in the surge protector power strip. A computer, a monitor, and a fluorescent light were plugged into the power strip, and some heavy clothing was resting on top of it. (EM--PPPO-LPP-PORTENVRES-2006-0006)

Investigators determined that the primary contributing cause of the fire was the clothing on top of the power strip. Because power strips generate significant amounts of heat, they must have open air around them to prevent overheating. Following this incident, all office areas were inspected to ensure that power strips had clearance around them and that no high-load personal electrical devices (e.g., coffee makers, electric heaters) were in use.

OSHA addresses requirements for electrical cords and cables in 1926.405(a)(2)(ii)(I) and 1926.405(a)(2)(ii)(J). Requirements for flexible cords and cables in 1926. 405(a)(2)(ii)(I) state that they "shall be protected from damage," that "sharp corners and projections shall be avoided," and that "flexible cords and cables may pass through doorways or other pinch points if protection is provided to avoid damage." Additional guidance in 1926.405(a)(2)(ii)(J) states that "extension cord sets used with portable electric tools and appliances shall be of three-wire type and…designed for hard or extra-hard usage."

Fire is a threat whenever the protective insulation of wires or cables is damaged, wherever faulty installation or operating conditions result in loose connections and splices, and wherever power strips do not have open air surrounding them. Periodic checks of the maze of wiring underneath desks and work spaces can identify any potential problems before they start and may be the first barrier to avoiding electrical shocks or fires.

Office Electrical Safety Tips

- Electrical appliances can be fire hazards. Be sure to turn off all appliances at the end of the day. Use only grounded appliances plugged into grounded (three prong plugs) outlets.
- If electrical equipment malfunctions or gives off a strange odor, disconnect it and call the appropriate maintenance personnel. Promptly disconnect and replace cracked, frayed, or broken electrical cords.
- Don't fasten extension/power cords with staples, hang from nails, or suspend by wire.
- Don't use equipment with worn or frayed cords and cables.
- Keep power cords clear of doorways and other areas where they can be stepped on or chafed, and never plug one extension cord into another.
- Ensure extension cords and electrical products are listed by an independent testing facility, are properly rated for their intended use (indoor or outdoor), and meet or exceed the power needs of the appliance or tool being plugged into

These events illustrate the importance of proper inspection and management of power cords and power strips in an office setting. Workers and management should inspect power cords periodically for signs that they are frayed, burned, or otherwise damaged and should make sure that cords are not routed through or near anything that has sharp edges that could cut through the insulation. Because power strips generate significant amounts of heat, they must have adequate ventilation to dissipate the heat, and combustible materials should not be stored near them. Power strips should also be equipped with an overload circuit breaker.

KEYWORDS: *Fire, electrical shock, power cord, power strip*

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

Always Consider Potential Electrical Hazards in Non-Electrical Work

3

On February 27, 2007, at the Kansas City Plant, a worker received an electrical shock while installing fire-stop material from an elevated position when metal on the caulking gun he was using contacted an energized buss bar.

The job had been analyzed for falls because it was performed at height, and the worker wore the required fall protection, but the hazards analysis failed to consider the energized buss bar. (ORPS Report NA--KCSO-AS-KCP-2007-0001)

This event demonstrates the potential electrical dangers presented by non-electrical work—in this case, the energized buss bar. Work planning should have included a thorough walkdown of the proposed work area where there were older, legacy wiring systems with exposed parts. During that walkdown, potential hazard scenarios might have foreseen a worker losing balance and grabbing the energized bar to prevent a fall, thus replacing one outcome with an even worse one. A potential corrective action for this event might be to remove the danger by locking out the electrical equipment. As a result, workers could be confident that hazards analysis and pre-work planning had addressed more than only the falling hazard.

OSHA provides explicit guidance for analysis of workplace hazards in OSHA 3071, Job Hazard Analysis from the question-asking stage (What can go wrong?) to a sample JHA form to complete. An OSHA publication, Safety and Health Program Management Guidelines, states that two of the four elements critical to a successful safety and health program are worksite analysis and hazard prevention and control.

Several events in the ORPS database demonstrate work planning that did not take into account potential electrical hazards.

On March 23, 2007, at Princeton Plasma Physics Laboratory, inadequate work planning had the potential for serious consequences when a computer technician cut data cables to obsolete equipment and inadvertently cut the power cable. The technician knew the equipment was obsolete and unused and decided to cut the data cables, which were tangled with the power supply. Unfortunately, pre-job planning had not verified that *unused* meant *unenergized*, and there was a flash when the technician's cutter nicked the energized cable. Although the investigation is incomplete, and the Laboratory has not finalized the report, this is clearly an event where a pre-work walkdown would certainly have noted the tangled wires and put controls in place to ensure the safety of this technician and others who might encounter similar unused equipment. (ORPS Report SC--PSO-PPPL-PPPL-2007-0001)

As table 3-1 shows, the human body is a fragile entity. Carefully planned electrical work requires determining the correct PPE for the work task; however, if the potential for encountering electrical hazards when performing non-electrical work has not been considered, the appropriate PPE may not be provided.

On February 13, 2006, at Idaho National Laboratory, a worker removing snow and ice inadvertently cut a power line to a trailer. This event was one of six involving cut power cords at that site during especially heavy snowfall last winter and demonstrates that, as weather conditions change, routine tasks must be reevaluated. Pre-work planning included a

Table 3-1. Effects of Electrical Current* on the Body

Current	Reaction
1 milliamp	Faint tingle.
5 milliamps	Slight shock.
6–30 milliamps†	Painful shock, no muscular control. “Freezing currents” may make it impossible to let go.
50–150 milliamps	Extremely painful shock, breathing stops, death is possible.
1,000–4,300 milliamps	Ventricular fibrillation; muscles contract; nerve damage; death likely.
10,000 milliamps	Cardiac arrest and severe burns; death probable.

*Effects are for voltages less than about 600 volts. Higher voltages also cause severe burns.
†Differences in muscle and fat affect severity of shock.
Source: *Electrical Safety, Safety and Health for Electrical Trades Student Manual*, National Institute for Occupational Safety and Health (NIOSH) at: www.cdc.gov/niosh/pdfs/02-123.pdf

walkdown to identify hazards, but the power line was assumed to be protected by the trailer hitch; before work started, no one verified that the line was actually exposed. The site's approved snow removal plan was inadequate because of special circumstances or conditions (i.e., snow removal in a non-snow removal area). (ORPS Report EM-ID--CWI-RWMC-2006-0004)

On January 9, 2006, at Oak Ridge Y-12, a dump truck spreading asphalt snagged an overhead communication line, which in turn contacted an adjacent 13,800-volt power line, causing a power failure. When a live power line is involved, the primary risks are fatal electrocution or fire. (Figure 3-1 shows an example from the OSHA website.) In this case, the driver could have been electrocuted had he attempted to exit truck while it was in contact with the energized power line. However, he had the presence of mind to stay in his truck until electricians isolated the power. Subsequent investigation determined that three things had not been identified during work planning: the overhead hazard; the driver's inability to see above the plane of the truck cab; and the need for a spotter. Without a documented work scope and hazard analysis, physical and administrative controls were not put into place to avoid the known hazards. Planners must evaluate proposed work in the field or by a walkdown to ensure that all hazards, such as the driver's inability to see clearly, are addressed. (ORPS Report NA--YSO-BWXT-Y12)

On October 11, 2005, at the East Tennessee Technology Park, an operator off-loaded an excavator in an unplanned location, turned to drive to the location listed in the work package, and hit an overhead 13.8K line with the raised jaw crusher attachment. The operator was aware of the overhead line, but thought he had enough clearance, and the spotter was unable to signal and shout loudly enough to stop him. The event was not simply the result of the operator's assumptions. The original work planning document did not include moving equipment, nor did it consider space limitations of the drop-off area. When he saw that the hilltop drop-off area described in the document was too crowded, the truck driver should have stopped. Instead, he delivered the excavator to the bottom of the hill, where an experienced journeyman was waiting to drive the excavator uphill to the work site. As the excavator drove up the haul road, its boom contacted and tripped the power line. Planning was based on hilltop delivery; no

Figure 3-1. Crane cable contacts 7,200-volt power line (Source: OSHA website)

power lines; and, thus, no need for a spotter. When the location changed, the planning document should have been reviewed to consider potential unanalyzed hazards at the new location. (ORPS Report EM-ORO-BJC-K25WASTMAN-2005-0007)

OSHA guidance in 1910.333(c)(3)(iii)(A) recommends, among other things, clearance of at least 10 feet for vehicles or mechanical equipment capable of having parts of its structure elevated near energized overhead lines.

The work planning and performance cycle of Integrated Safety Management (ISM) shown in Figure 3-2 represents how work should be performed across the DOE Complex. By limiting and defining the scope of work, analyzing the hazards, and developing and implementing hazard controls to mitigate those hazards, planners and workers can ensure worker safety every day.

These events demonstrate that planning for non-electrical work where there is even a remote possibility of electrical interaction may be a matter of life and death. Careful planning that includes a work area walkdown and a questioning (what if?) attitude is the best way to identify hazards that exist at all levels, from below ground to above the workers' line of vision.

KEYWORDS: *Electrical, work planning, job planning, overhead lines, hazards analysis*

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

Figure 3-2. ISM Core Functions

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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