Operating Experience Summary

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Inside This Issue

1 OSHA Issues New Instruction on Combustible Dust

On October 18, 2007, OSHA issued a new safety and health instruction detailing OSHA policies and procedures for inspections of workplaces where combustible dusts are created or handled. Combustible dusts are organic or metal dusts that are finely ground into very small particles, fibers, fines, chips, chunks, flakes, or a mixture of these. Such dusts can come from metal, wood, plastic, and textile materials, as well as from grain, flour, sugar, and paper, among others, and can be the cause of fires and explosions. (OSHA Directive CPL 03-00-006; effective date October 18, 2007)

Chemical dust deflagration occurs when the right concentration of finely divided chemical dust suspended in air is exposed to a sufficient source of ignition to cause combustion of the dust. If the deflagration is in a confined area, the potential for an explosion exists. Dust deflagrations, as well as other fire and explosion hazards in industry, are covered by several OSHA standards and the general duty clause. However the new safety and health instruction specifically addresses these hazards as they apply to combustible dusts. Assistant Secretary of Labor for OSHA, Edwin G. Foulke, who announced the National Emphasis Program (NEP) and issued the new instruction, stated that "A combustible dust fire or explosion is a potential hazard to America's working men and women. This instruction will be a valuable resource for those who inspect industrial facilities in the United States."

A combustible dust hazard study conducted by the U.S. Chemical Safety and Hazard Investigation Board (CSB) found that nearly 280 dust fires and explosions have occurred in U.S. industrial facilities over the past 25 years, resulting in 119 fatalities and over 700 injuries. Some of the industries in which combustible dusts are particularly prevalent are agriculture, chemical, textile, tire and rubber manufacturing, and waste water treatment. The following accidents traced to combustible dust occurred in 2003 and resulted in deaths and serious burn injuries.

- On October 29, 2003, at the Hayes Lemmerz manufacturing plant in Huntington, Indiana, a series of explosions resulted in severe burns to three employees, one of whom died (Figure 1-1). The plant manufactured cast aluminum automotive wheels, and the explosions were fueled by accumulated aluminum dust.
- On February 20, 2003, an explosion and fire damaged the CTA Acoustics manufacturing plant in Corbin, Kentucky, killing seven employees (Figure 1-2). The facility produced

Figure 1-1. Hayes Lemmerz manufacturing plant inferno

Figure 1-2. Damaged production floor at CTA Acoustics

Figure 1-3. West Pharmaceutical Plant in ruin

fiberglass insulation for the automotive industry. The resin involved was a phenolic binder used in producing fiberglass mats.

- On January 29, 2003, an explosion and fire destroyed the West Pharmaceutical Services plant in Kingston, North Carolina, causing six deaths and dozens of injuries (Figure 1-3). The facility produced rubber stoppers and other products for medical use. The fuel for the explosion was a fine plastic powder that accumulated above a suspended ceiling and ignited.

OE Summary 2003-16 discusses the explosion at the Kingston plant. The following recommendations for preventing dust particle accumulation are also included in the article.

- Ensure that ceilings in areas where explosive dusts may be present are sealed.
- Practice good housekeeping to ensure that flammable dust from ongoing processes does not accumulate to the extent that it can reach explosive conditions, particularly when fuel, oxygen, dispersion, confinement, and ignition are present.
- When entering a building that has not been occupied or cleaned for extended periods (as in decommissioning), carefully remove any potentially explosive dust that has accumulated.

The article also references a lessons-learned report (SELLS Identifier 2003-RL-HNF-0002) issued by Fluor Hanford to help educate workers about the dangers involved in dust-producing operations.

OSHA initiated the NEP and issued the new safety and health instruction in response to recommendations by the CSB urging the agency to conduct a special emphasis program targeting industries at risk for dust explosions. The instruction, which includes applicable OSHA requirements, as well as NFPA standards and codes relevant to combustible dust hazard controls (Appendix A of the instruction), can be accessed from the OSHA website.

The events cited in the OSHA safety and health instruction illustrate the dangers of explosive dust and the hazards posed when dust unknowingly accumulates. Housekeeping is an effective method of identifying and removing potential hazards. Accumulation of dust, lint, flammable liquids, and oil residues in the facility allows for easy ignition and the possibility of a flash or fast-spreading fire or explosion.

KEYWORDS: *OSHA, dust, fire, deflagration, explosion, injury, fatality*

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

Near Miss — Roll Bar on Riding Mower Knocks Down Window Air Conditioner

2

On September 27, 2007, at Brookhaven National Laboratory (BNL), the roll bar of a lawn mower struck a window air conditioning unit, which fell out of its window mount, hit the top of the mower's steering wheel, rolled onto the cutting deck, and landed on the grass. The mower operator immediately stopped the lawn mower and contacted his group leader. The operator was not injured, and the mower was not damaged, but the air conditioning unit was unsalvageable. (ORPS Report SC--BHSO-BNL-PE-2007-0004; final report filed October 24, 2007)

The operator had just maneuvered the mower around the corner of the building and was traveling about 2 to 3 mph when the roll bar hit the air conditioning unit. The 150-pound unit protruded 28 inches from the wall of the building and was hard to see because it was painted the same color as the building and blended in with it (Figure 2-1).

The Toro Model 328-D mower (Figure 2-2) with a rear-mounted roll bar was newly purchased, and the operator was driving it for the first time. He had driven similar-sized Toro mowers that were not equipped with roll bars for many years in his job as a grounds worker at BNL. Although the roll bar was in plain sight of the operator, he said his vision was fixed on the ground in front of him. He also said that he did not realize how high the roll bar was (55 inches) or how far it protruded to the side.

A fact-finding meeting was held at the jobsite immediately following the accident, and carpenters sealed the window opening. The need for the roll bar on Toro lawnmowers will be reassessed, and operators will receive awareness training to emphasize the operating height of the machine and remind them that they need to be aware of low lying branches or protruding objects.

Figure 2-1. Damaged air conditioner on the ground

In this event, the mower operator escaped injury when the heavy air conditioning unit fell forward and away from him. However, on August 19, 2006, a ground equipment operator at the Y-12 Site was less fortunate when his mower went under a steam distribution line that was 45 inches above the ground and he suffered bruises and contusions. A Type B-like investigation was performed following the incident. (ORPS Report NA--YSO-BWXT-Y12SITE-2006-0013)

The operator at Y-12 was mowing grass across an inclined area with a zero-turn-radius riding mower when the left drive wheel went into a wet depression and lost traction at a ground discharge area for a steam trap. The right drive wheel continued to pull, causing the mower to quickly turn 90 degrees left (downhill), forcing the mower and operator under an adjacent

Figure 2-2. Mower next to similar window air conditioner installation

steam line. The operator's torso hit the steam line as he was pushed under the low clearance by the moving mower, resulting in contusions, bruising, and a topical elbow injury. The operator was transported by ambulance to an area hospital.

Events where mowers rolled or flipped over during operation have also been reported at other DOE sites. For example, a riding mower flipped into a ditch at Paducah Gaseous Diffusion Plant while the operator was making a left turn near the ditch. As the left front tire slid, the operator immediately applied the brakes for the left and right side wheels, but his foot slipped off the right brake and the mower flipped. The mower was equipped with rollover protection, and the operator, who was wearing a seat belt, sustained only a bruised shoulder. Investigators determined that the operator was inexperienced in operating the mower and was mowing in an unfamiliar area. They also determined that training was inadequate because the course content did not cover the operation of this particular mower. (ORPS Report EM-ORO--BJC-PGDPENVRES-1998-0011)

Mowing supervisors need to carefully evaluate the potential hazards associated with this fairly common work activity. Ground conditions, weather conditions, buildings, and obstructions present hazards to workers such as hitting or being hit by an object when mowing. Mower operators also sometimes fail to recognize the difficulty associated with mowing in an area with an increasing slope where the equipment may slip or upset.

These events underscore the need to ensure that mowing equipment operators are trained on the equipment; are familiar with the area, its terrain, and potential hazards; and are focused on the task at hand.

Good Practices For Riding Mower Operation

- Understand how to operate the equipment, including all safety features and manufacturer's limitations for speed and grade.
- If unfamiliar with the area, walk it down and look for obstructions and hidden hazards that could damage the equipment or result in operator injury.
- Ensure that the mowing equipment being used matches the work to be performed. Tire type and angle indicators should be part of the consideration.
- Do not mow when the grass is wet or when there is not enough light, and avoid operating the mower in reverse.
- At a minimum, always wear eye and hearing protection.
- Never have the blades turning over gravel or other loose material that can produce flying debris or missiles.
- Mowing on a slope can be particularly hazardous, and very often the mower can not be easily controlled. It is safer to mow up and down a slope to avoid tipping over.
- Use powered grass trimmers in and around tight places to avoid operating mowers near obstructions.
- If the mower should strike something, the engine should be turned off immediately and the damage should be inspected.

KEYWORDS: *Lawn mower, air conditioner, roll bar, near miss*

ISM CORE FUNCTIONS: *Analyze the Hazards, Perform Work within Controls*

Are Proper Cold Weather Protection Measures in Place at Your Site?

3

Now that fall has arrived, and many parts of the country have had their first frost, if not their first snowfall, freeze protection measures should be in place to protect piping, water lines, sprinkler heads, and other essential systems from damage. Winter can also be a hazardous time for workers, who can slip and fall on icy sidewalks and parking lots, so it is also time to investigate methods for dealing with these hazards and for reminding workers that they need to be wary when traversing ice- or snow-covered walking surfaces.

During the weeks of November 27, 2006, and December 4, 2006, at Los Alamos National Laboratory (LANL), a significant drop in outside temperatures, ranging from a low of 12°F to a high of 45°F, resulted in at least five occurrences of frozen heating, ventilation, and air conditioning (HVAC) coils, causing significant equipment damage and flooding in multiple areas of one facility. In addition, some employees were sent home because there was no heat. (ORPS Report NA--LASO-LANL-LANL-2006-0008)

Investigators found deficiencies in seasonal protection measures that ranged from taking no freeze protection measures at all to taking inappropriate actions or not completing necessary actions. They also identified one area where protective actions were not documented and found weaknesses in implementing freeze protection procedures. Freeze protection issues had been identified previously, but apparently the corrective actions implemented to address them were ineffective.

A second event at LANL traced to freezing temperatures occurred on December 2, 2006. Fire department personnel, who responded to an alarm, found a sprinkler had broken and a gasket on the inlet to a collection tank had ruptured, resulting in the discharge of about 34,000 gallons of water that contained approximately 3,100 pico curies per liter of tritium. An RCT surveyed the firemen and found no evidence of contamination, and there was no water damage to the facility or equipment, as the water spilled onto the ground. Investigators determined that the spill, which was reported to the New Mexico Environmental Department, was a direct result of severe weather conditions. (ORPS Report NA--LASO-LANL-WASTEMGT-2006-0020)

On January 15, 2007, at Pacific Northwest National Laboratory, a water leak from a 1-inch fire sprinkler line activated a fire alarm at the Radiochemical Processing Laboratory, when freezing temperatures resulted in a break in the fire suppression piping for a laboratory. Water spread to several rooms, leaked into the basement, and about 100 gallons of water poured out of the building. Surveys indicated there was no contamination either inside or outside the building. Employees were evacuated, but there were no injuries. (ORPS Report SC--PNSO-PNNL-PNNLNUCL-2007-0001)

Investigators determined that tape used to hold insulation in place failed and some of the insulation had sloughed off, exposing two holes in the exterior wall that allowed the freezing outside air to enter the building. They also determined that established practices were not sufficient to monitor temperatures in the interstitial spaces between the roof and ceiling and ensure they were maintained above the minimum required for the fire suppression system.

As the previous events show, it is important to ensure that appropriate freeze protection measures are taken and that they are adequate to withstand sub-zero temperatures and other severe weather conditions. Facility maintenance personnel can find guidance about establishing and updating seasonal maintenance programs in section 4.18 of DOE G 433.1-1, *Seasonal/Severe Weather and Adverse Environmental Conditions Maintenance*.

Last winter numerous slips and falls on icy walkways resulted in workers being badly injured. The following injuries were among those reported to ORPS.

- **Broken Patella** – On January 2, 2007, at Sandia National Laboratory, an employee slipped on the ice following a major snowstorm (accumulation of 18 to 24 inches) and broke his patella in multiple places. Many parking lots and walking surfaces had not yet been cleared of snow and ice, causing very slippery walking surfaces between the parking lot and the employee's work area. (ORPS Report NA--SS-SNL-2000-2007-0001)
- **Broken Wrist** – On February 21, 2007, at Argonne National Laboratory, an employee slipped and fell while walking from a parking lot to the entry of a building and fractured her right wrist. Although the employee was wearing boots and walking at a normal pace, uncleared black ice in the parking area resulted in the fall. (ORPS Report SC--ASO-ANLE-ANLE-2007-0003)
- **Broken Ankle** – On December 19, 2006, at Pantex, an employee slipped and fell on an icy sidewalk and broke his ankle. The sidewalk had become hazardous because of inclement weather, and ice melt had been applied, but the employee slipped on a small patch of ice at the edge of the sidewalk and fell into the gravel, injuring his ankle. (ORPS Report NA--PS-BWXP-PANTEX-2006-0129)
- **Torn Muscle** – On January 2, 2006, at LANL, an employee fell on black ice in a parking lot and tore his left tricep. The Los Alamos area had received over a foot of snow between December 23, 2006, and January 1, 2007, when the Laboratory was shut down for the holidays. Snow removal crews had cleared the parking lot, but black ice had formed in some areas of the lot following snow removal. (ORPS Report NA--LASO-LANL-BOP-2007-0001)

Because there were multiple worker injuries from slips and falls on ice at LANL during the winter of 2006, an unusual winter when there were two major snowfalls in the area (Figure 3-1), management requested that the injury data be collected and analyzed to determine trends and appropriate corrective actions.

Figure 3-1. Aftermath of Albuquerque snowstorm, December 2006

From November 1, 2006, through January 8, 2007, there were 13 weather-related injuries, 9 of which occurred in Laboratory parking lots. (ORPS Report NA--LASO-LANL-LANL-2007-0002)

The results of the LANL review and analysis provide some insight into the reasons behind similar winter injuries across the Complex and also identify actions that may help reduce the number of slip and fall injuries in the upcoming winter.

Interestingly, analysts found that none of the workers involved in the 13 slip and fall incidents had been wary of changes in the walking surfaces from morning to evening. To address this issue, management took actions to increase worker awareness through all-employee memos and postings on the LANL safety website. An electronic message sent to all employees asked them to take personal responsibility for wearing appropriate winter footwear, walking defensively, and spreading de-icer on walkways if they noticed a problem. The message also listed precautions to take while walking in winter conditions.

Because the majority of worker injuries occurred in parking lots, snow removal operations were investigated to identify deficiencies. Roads and Grounds managers indicated that when snow is removed, snow piles are left in parking lots until they can be moved to a disposal site. When the snow melts and refreezes overnight, it can result in slipping hazards in the parking lots. They also indicated that the parking lots were only plowed, not sanded, and that the process normally took 2 days to complete. The use of sand for parking lots and procedures for addressing snow piles were not incorporated into the Laboratory's snow removal plan. Both of these issues are being reviewed to develop more effective ways of dealing with them.

Another factor that contributed to ice and snow in parking lots was that employees did not remove their private vehicles from the lots to permit plowing, even though they had been asked to do so. Also, although a hotline was set up so that employees could alert snow removal crews to areas needing attention during and after snowstorms, information about it was never communicated to site personnel. Management is considering the feasibility of closing the parking lots and towing personal vehicles from parking lots to permit snow removal. They are also addressing the notification requirements and identifying a mechanism that can best be used to disseminate snow removal hotline information about how to report problems.

OE Summary articles that address winter preparations are issued each year, and various tips, checklists, pertinent information, and reports of occurrences related to severe weather the previous winter are included. OE Summaries 2002-22, 2003-23, and 2004-19 contain freeze protection guidance based on occurrences reported to ORPS in each of those years. Issue 2004-19 also includes an example of the cold weather checklist provided in DOE G 433.1-1. OE Summary 2005-15 includes a list of typical freeze protection measures for fire suppression systems, piping, HVAC systems, and outdoor circuits. Appropriate winter PPE is discussed in OE Summary 2006-14, which also includes a list of protective measures to take when working outdoors in cold weather.

More winter safety tips for driving, work, and home can be found at the websites of the American Automobile Association (AAA) (www.aaa.com), the National Safety Council (www.nsc.org), the Federal Emergency Management Agency (FEMA) (www.fema.gov), and the American Red Cross (www.redcross.org). Useful information can also be found in *Winter Storms: The Deceptive Killers*, a joint publication of the Red Cross, FEMA, and the National Oceanic and Atmospheric Administration.

Useful Freeze Protection Measures

- Increase surveillance of building pipelines, flowlines, and safety-related equipment during periods of extreme cold. Provide sufficient watch service to ensure that all plant areas can be visited each hour.
- Check heating systems to ensure sufficient heat is delivered to keep sprinkler piping from freezing, especially during idle periods when temperatures are extremely cold. Install temperature alarms or automatic backup heat sources on vulnerable systems that require special protection because of hazards or costs associated with freeze damage.
- Develop procedures that detail when and how personnel are informed of cold weather problems and the appropriate steps for repairing, replacing, and safely restoring damaged equipment to service.

These events illustrate the hazards that come with the advent of winter weather and the snow, ice, and freezing temperatures it brings. It is essential to ensure that freeze protection plans are in place before the onset of winter weather. It is also important to communicate protective measures for walking safely on snow- and ice-covered parking areas and sidewalks to all employees and remind them to take personal responsibility for wearing the proper footwear and for being especially careful when traversing these areas in inclement weather.

KEYWORDS: *Freeze protection, snow, ice, slips and falls, injuries*

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