Office of Health, Safety and Security
Operating Experience Level 3

OE-3: 2012-05 August 2012

Safety Concern: Occurrences of Crushing Injuries To Operators of Industrial Equipment

PURPOSE

This Operating Experience Level 3 (OE-3) document provides information about a safety concern related to the dangers of crushing injuries faced by workers who operate various types of equipment, including electric carts, skid-steers, and lift equipment (Figure 1).

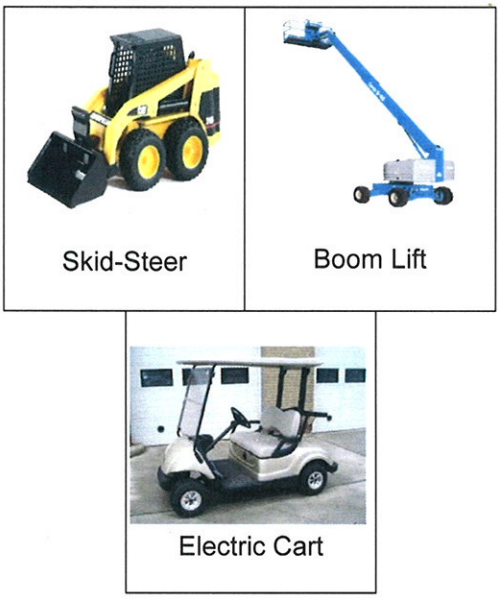

Figure 1. Equipment involved in worker injuries reported through the Occurrence Reporting and Processing System

BACKGROUND

Recent Department of Energy (DOE) events demonstrate the importance of training workers on the dangers of equipment they operate, reviewing and following manufacturers' instructions regarding safety devices/systems, and maintaining situational awareness while operating electric cart, skid-steer, and lift industrial equipment.

On March 14, 2012, at the Portsmouth Gaseous Diffusion Plant, a worker driving an electric cart received significant leg injuries when he turned too close to a building column, trapping his leg between the cart and the column. The driver's compartment in these types of carts is not always compatible with larger-built drivers. These conditions contributed to the driver's inability to maintain his leg inside the cart as it was turning. Subsequent investigation determined that there was no required training for cart operators, cart warning labels were either not posted or were indistinguishable from other labels, and there was no facility traffic control plan or painted lines to establish required cart travel lanes and keep carts away from columns. (EM--PPPO-FBP-FUEF-2012-0002)

On March 8, 2012, at Princeton Plasma Physics Laboratory (PPPL), an equipment operator was pinned between the boom and cab of his John Deere model 250 skid-steer while he and another worker were attempting to install an auger attachment. They had left the engine running, which violated the safety features and allowed the boom and other controls to operate. When the operator reached out of the cab to connect the auger hydraulic hose with the boom, the boom raised and pinned his shoulder between the boom and the cab. His left shoulder blade was fractured and his chest was cut. (SC--PSO-PPPL-PPPL-2012-0001)

On March 1, 2010, a Bonneville Power Administration heavy equipment operator was killed at White Bluffs Substation when he became trapped between a backhoe attachment and the

Bobcat skid-steer he was loading onto a transport trailer. The operator moved into a position between the Rollover Protection Structure (ROPS) cage and the backhoe attachment, lowering the seat bar as if he were seated, which bypassed the Bobcat Interlock Control System. When the hydraulic system started, the Bobcat lift arms raised the backhoe attachment, pinned the operator between the seat and the ROPS, and crushed him. A Level 1 Accident Investigation followed. (EM-RL--GORL-DDSC-2010-0002; and Level 1 Accident Investigation Report)

Some injuries and near misses are due to lack of situational awareness and focus rather than actively overriding a safety system, but still have life-threatening potential. On May 6, 2009, at the Savannah River Site (SRS), a worker installing cross-bracing to construct a temporary work tent was pinned between the aerial lift basket and a support brace because the lift operator misjudged distance and did not pay attention to the direction of travel as he drove and moved the basket at the same time. The worker was pinned with enough force to cause significant bruising and pain whenever he breathed. (EM-SR--PSC-SWPF-2009-0006)

On April 23, 2008, at Hanford's Waste Treatment Plant, a subcontractor painter working from a boom lift while cleaning pipe hangers with an electric grinder was caught between the lift and an overhead pipe when the cord of the grinder looped around a toggle switch on the control panel, causing the boom to rise. The painter was preparing to lower himself and applied power, not realizing that the cord looped around the toggle switch was forcing him upwards instead. He received contusions to his back, chest, jaw, and chin and scrapes on his hand, escaping what could have been life-threatening injuries. The painter had not removed his respirator, impairing his vision so he was unable to correctly evaluate his surroundings, putting himself in a dangerous situation. Fortunately, he was able to reverse direction and lower himself safely. (EM-RP--BNRP-RPPWTP-2008-0008)

Analysis and Observations

Industrial equipment events reported to the Occurrence Reporting and Processing System (ORPS) from January 1, 2007, through March 31, 2012, were reviewed to determine common factors and identify lessons learned. The following observations are noted:

- Lack of operator training (or insufficiently detailed training) is a common factor.
- Drivers often lack situational awareness – talking on cell phones; ignoring traffic signs; and passing too close to stationary objects, other workers, or other vehicles.
- Occurrences involving boom lifts fall into categories ranging from a lift falling or tipping due to unstable ground conditions, to inadvertent activation of movement controls where the sudden movement may injure workers in the lift basket.
- The number of occurrences involving industrial equipment is small compared to the total number of ORPS reports, but they often result in injuries to workers or infrastructure damage.
- Override of safety controls or features can have fatal results.

Discussion

These occurrences, one resulting in a fatality, serve as reminders of the need for practicing safety and understanding and following work control processes.

Like many other sites, Portsmouth did not identify training and qualification needs for operating electric carts. In addition, the electric cart driver had grown accustomed to an unsafe condition, i.e., the dangerously cramped cart, and did not report it. He and other drivers were in danger not only because of the cart configuration but also because the facility lacked traffic controls.

In addition to reporting unsafe vehicles, operators must not override or defeat existing safety systems. Skid-steer loaders, for example, are manufactured with safety features to prevent unexpected or inadvertent movement of the loader arm and hydraulics when the operator is not in the cab. In the 2012 PPPL event, work was being performed on the John Deere 250 skid-steer loader while the engine was running. Not only was that clearly an unsafe practice, but the operator also reached out of the cab, placing his arm in a danger zone where the raised boom fractured his arm.

The 2010 White Bluffs fatality occurred when the operator moved into a position between the ROPS cage and the backhoe attachment, and then lowered the seat bar as if he were seated, which bypassed the Bobcat Interlock Control System and engaged the hydraulic systems. Once those systems were operational, the Bobcat lift arms raised the backhoe attachment and pinned the operator between the seat and the ROPS.

The subsequent Level 1 Accident Investigation Board (Board) concluded that the direct cause of this accident was the operator's activation of the hydraulic controls while standing in the pinch point. The operator failed to follow the instructions in the operation and maintenance manual: "always sit in the operator's seat when activating the controls."

However, the Board also concluded that an insufficient pre-job briefing contributed to this event because it did not reflect the actual planned work or the potential hazards; and it could not be determined if the operator had been trained on Bobcat operation.

Equipment operators are also responsible for workers who might be affected by their lack of situational awareness or unsafe equipment operation. The 2009 SRS aerial lift basket injury occurred when the basket operator failed to observe the direction of movement of the basket lift he operated, and the position of his "passenger" relative to the obstacles above. As a result, he extended the basket too far and caught the worker between the basket side rail and the tent's support brace.

The Hanford painter in the 2008 boom lift incident was able to hit the stop switch and lower the lift to the ground before he was severely injured. Occurrences involving industrial equipment often occur when workers are transitioning from one work evolution to the next, and their concentration shifts. In this case, the painter was finished with the task and likely had his mind on getting to the ground, forgetting that he still wore his respirator, which limited his peripheral vision so he didn't see the cord looped around the controls. In addition, later interviews determined that job scoping did not identify special circumstances, such as Personal Protective Equipment or the grinder cords getting in the way.

Human Performance Improvement principles indicate that although defenses can prevent an event, layered safeguards provide additional assurance for worker safety. In the events cited here, the layered safeguards would have included training about the dangers of overriding safety features and increased supervision that might have stopped unsafe behavior.

In addition, 10 CFR 851, *Worker Safety and Health Program*, establishes management requirements to maintain worker safety and also requires that workers comply with requirements applicable to the work.

Finally, Integrated Safety Management (ISM) is DOE's approach for achieving its mission while maintaining safe operations. Through ISM, safety must be integrated into every task via its five *Core Functions*: Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work Within Controls, and Provide Feedback and Improvement.

Recommendations

The following recommendations for the safe operation of industrial equipment are provided:

- Verify employee training on the operation of electric carts, skid-steers, lift equipment, and other related types of equipment.
- Include the importance of maintaining situational awareness as part of equipment operation safety training.
- Ensure that all members of a crew assigned to the work receive an adequate pre-job briefing that covers all of the hazards, procedures, and equipment-specific precautions.
- Inspect equipment before use to ensure no modifications/overrides have been made to safety features, and that recall work and repairs have been performed correctly.
- Follow instructions provided in operations and maintenance manuals.

The following corrective actions (CA) were performed by sites that filed ORPS reports on these occurrences, and should be applied as appropriate:

- Portsmouth immediately suspended the use of gas- and electric-powered carts, developed a briefing on safe cart operations, developed a Job Performance Measure, and conducted a sitewide safety pause.
- PPPL's CAs included performing an extent of condition review, conducting operator training, instituting daily checklists, identifying and training equipment owners on their responsibilities to maintain equipment in a safe condition, and performing a Human Factor Assessment with a safety culture survey.
- SRS conducted an all-hands briefing, added a Lessons Learned report on the event to aerial lift training, and enhanced hands-on lift training based on operator feedback.
- Hanford installed additional guards on the control switch and verified a process was in place to receive all manufacturers' safety bulletins.

Conclusion

Safe work starts with evaluating hazards and briefing workers on those hazards, including the hazards of bypassing or overriding equipment safety features. Equipment must be inspected before use to ensure that maintenance has been performed and that nothing will override the safety features. Workers assigned to the task must be trained to that task, and supervisors must verify that training has indeed been accomplished and documented. In addition, equipment operators must maintain continual situational awareness, since they are responsible not only for their immediate area but also for their passenger(s).

References

EM--PPPO-FBP-FUEF-20120-0002, *Electric Cart Accident Resulting in Multiple Fractures of the Leg*

SC--PSO-PPPL-PPPL-2012-0001, *Worker Injured Using Skid-steer Construction Equipment*

EM-RL--GORL-DDSC-2010-0002, *Bonneville Power Administration (BPA) Worker Killed on DOE Land at BPA White Bluffs Substation*

Level 1 Accident Investigation Report, *March 1, 2010 Fatal Bobcat/Backhoe Accident at the White Bluffs Substation*, http://www.hss.doe.gov/sesa/corporatesafety/aip/docs/accidents/typea/BPA_Level_I_Bobcat_Fatality.pdf

EM-SR--PSC-SWPF-2009-0006, *Worker Bruise Injury in Aerial Work Platform*

EM-RP--BNRP-RPPWTP-2008-0008, *Man Injured in Manlift Incident*

Additional Sources of Information

The following websites provide additional information about industrial equipment safety and regulations:

Skid Steer Loader Accident, presentation for SC Laboratory Distribution, June 14, 2012

Occupational Safety and Health Administration, *Hazards Associated with Operating Skid-Steer Loaders with Bypassed and/or Improperly Maintained Safety Devices*: http://www.osha.gov/dts/shib/shib011209.html

Information about 10 CFR 851, *Worker Safety and Health Program*, can be found at http://www.hss.energy.gov/healthsafety/wshp/rule851/851final.html

Questions regarding this OE-3 document can be directed to Ashley Ruocco at 301-903-7010 or ashley.ruocco@hq.doe.gov.

This OE-3 document requires no follow-up report or written response.

Glenn S. Podonsky
Chief Health, Safety and Security Officer
Office of Health, Safety and Security