# Operating Experience Summary

## Inside This Issue




**U.S. Department of Energy**
**Office of Environment, Safety and Health**
**OE Summary 2005-14**
**November 16, 2005**


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## EVENTS

### 1. BE AWARE OF OVERHEAD ELECTRICAL LINES WHEN OPERATING DUMP TRUCKS

On September 21, 2005, at the Hanford Central Waste Complex, the raised bed of a dump truck operated by a subcontractor hit an energized 240-volt power line, producing an electrical arc as the line was severed. The driver exited the truck without waiting for verification that the line was de-energized, but was not injured. Equipment damage was limited to the cut power line. (ORPS Report EM-RL--PHMC-SOLIDWASTE-2005-0010)

On the morning of the event, three subcontractor trucks were to deliver gravel to support the installation of two large storage containers in an area beside a newly installed mobile office. A Person in Charge (PIC) was at the work site, but he was not informed that the trucks were enroute. When the first truck arrived, the PIC instructed the driver to position the truck so that the cab was facing away from the overhead line and then dump the load. The PIC then acted as the driver's spotter.

After the first truck departed, the PIC left the work site to determine where the other loads of gravel should be dumped. While he was gone, the second truck arrived. In the absence of the PIC, the second driver communicated with the first driver and was told to dump in the same area. Because the PIC was not at the scene and was unaware of the second truck, the driver received no additional instructions. He dumped his load with the truck facing toward the overhead power line, rather than away from it. An Operations Lead, who was driving by, saw that the raised bed was about to hit the overhead power line and signaled the driver to stop, but the line was hit before the truck stopped. Figure 1-1 shows the raised bed of the truck in contact with the power line. Figure 1-2 shows a closeup of the contact point and burn mark left by the arc when the line was severed.

When the driver realized he had hit the power line, he exited the truck before he knew whether

*Figure 1-1. Raised bed in contact with power line*

the power line had been de-energized. Neither the driver nor the Operations Lead recognized that this was not a safe practice or realized the potential for electrocution. Electrical Utilities personnel de-energized and repaired the power line after the truck was moved away.

The causal analysis has not been completed on this event, but the following factors were identified in a critique.

- Although the PIC did spot for the first truck, there was no dedicated spotter at the work site.
- After arriving at the work site, the second driver did not contact facility personnel before dumping.

*Figure 1-2. Severed power line held in place by support cable*

- There was a breakdown in communication regarding truck arrival as well as one between the two drivers about how to dump the loads safely.

- The loads of gravel could have been dumped in an area farther away from the power line.

- Neither the vendor and contractor training procedures nor their safety manuals addressed the importance of remaining in the vehicle under these conditions. In addition, none of these documents described how to safely exit the truck, if necessary.

Certainly, at least two OSHA requirements were violated in this incident. OSHA regulation 29 CFR 1910.333(c)(3)(III)(A) states, in part: "Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized lines shall be operated so that a clearance of 10 feet is maintained." Further, OSHA regulation 29 CFR 1910.550(A)(15)(IV) states: "A person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means."

The following similar events have occurred within the past 3 years at DOE sites.

- On June 2, 2005, at the Moab Site Project, a subcontractor dump truck hit and severed a neutral electrical power line while dumping soil. The operator chose to deposit the backfill underneath the power line after being instructed not to do so. The operator believed that he was skilled enough not to strike the power line. There were no injuries, and a utility line crew repaired the damaged power line. (ORPS Report EM-ID--MCTC-GJPOTAR-2005-0001)

- On August 30, 2004, at Sandia National Laboratory – Albuquerque, the bed of a 30-yard dump truck came in contact with one phase of a 46-kV power line, causing a phase-to-ground fault that damaged the line and blew out 3 of the 18 tires on the truck. The subcontractor driver pulled the truck forward away from the line. The driver was focused on getting stuck dirt out of the bed rather than on the overhead power line. (ORPS Report NA--SS-SNL-NMFAC-2004-0007)

- On June 23, 2004, at the Rocky Flats Environmental Technology Site, the elevated bed of a dump truck came within 2 feet of an energized 13.8-kV power line. A manager alerted the driver of the overhead line just in time. The subcontractor responsible for the delivery of crushed aggregate had conducted a walkdown of the area, but did not specifically look for potential hazards in the vicinity of the dump location. Delivery of the rock was considered routine and skill-of-the-craft, not requiring a work package. The expectation was that the drivers would conduct their own inspections for hazards. (ORPS Report EM-RFO--KHLL-D&DOPS-2004-0009)

- On June 12, 2003, at the Hanford Tank Farms, a truck driver spreading gravel raised the bed of his dump truck and hit and damaged a 120/240-volt overhead power line supplying power to an office in a nearby trailer. The truck driver, who was confident that he had enough clearance, was not aware that the line ran diagonally across the road (Figure 1-3) with less clearance than he thought. Also, the driver did not lower the bed soon enough and had apparently outdistanced his spotter. (ORPS Report EM-RP--CHG-TANKFARM-2003-0028)

*Figure 1-3. Cut power line running diagonally across the road bed*

A review of 20 events involving dump truck incursions with overhead power lines indicated that more than half of the events resulted because no spotters were assigned or because the spotters were distracted or not involved full time. Other commonly made errors included the following.

- Drivers were unaware of the overhead hazard, were overconfident, or were in a hurry.
- Drivers drove their trucks with the bed raised for some distance after dumping their loads.
- Visual and audible communication between driver and spotter was lacking (e.g., radios had different frequency).
- Drivers were aware of power lines but forgot about the 10-foot rule.
- Supervision at the work location was lacking, and no direction was provided about where to dump.
- A walkdown of the dump area was not performed to identify potential hazards, or a work package was not prepared because the work was considered to be routine.
- Inspection for hazards was left up to the driver.

When a dump truck or other piece of equipment contacts an overhead power line, the frame of the vehicle becomes energized to approximately line-to-ground voltage, which can be several thousands of volts. Drivers and equipment operators need to be aware that immediately dismounting the equipment could result in contact with the high voltage between the equipment and ground. Also, nearby workers can be electrocuted by trying to help those involved in the incident and should remain clear.

There were two events in 1996 at Argonne National Laboratory where drivers of dump trucks climbed out of their cabs. One attempted to unsnag a line entangled in the raised bed of his truck; the other driver moved the severed line off his truck and placed it on the side of the roadway. Neither driver was injured, but both could have received an electrical shock and might have been seriously injured or killed.

## Remain in the Vehicle Until Electrical Power Has Been De-Energized

If the bed of your truck makes contact with an overhead power line, attempt to lower the bed or move the vehicle to break contact. If you cannot do either of these things, remain in the vehicle until electrical personnel indicate that it is safe to exit. If you must get out because of a fire, jump clear as far as possible with both feet together, ensuring that you do not make contact with the vehicle and the ground at the same time. Shuffle away or hop with both feet together. If you step, you could become a conductor because your feet will move from higher electrical potential to lower potential as the electrical energy dissipates radially while you move away from the source.

Another thing to consider is that power lines, particularly high-voltage lines, may have automatic recloser features. In the similar event at Sandia, the raised bed caused a ground fault, which tripped the 46-kV circuit breaker. The breaker instantaneously reclosed then tripped again, activating a time delay relay. The relay caused the circuit breaker to reclose again after 20 seconds. This time the circuit breaker remained closed because the driver had moved the dump truck clear of the line and the fault no longer existed.

The Office of Environment, Safety and Health published a Just-In-Time report titled *Deficiencies in Planning and Use of Spotters Contributed to Vehicles Striking Overhead Power Lines*. This two-page report includes specific safety information for work planners and workers on vehicle movements near overhead power lines. The report is available

at http://www.eh.doe.gov/paa/jit.html. The considerations shown in the text box to the right are from the Just-In-Time report.

*These events demonstrate the importance of exercising extreme caution when working in the vicinity of overhead power lines. DOE facility managers should ensure that facility personnel and subcontractors who operate equipment on site property are aware of any overhead electrical hazards. Vehicular contact with overhead power lines presents a significant personnel safety hazard as well as the potential for interruption of electrical power to facility operations and safety systems. Work planners and vehicle operators must know and maintain minimum safe working clearances near power lines. OSHA 29 CFR 1910, Subpart S, "*Electrical*," provides a table for determining the minimum elevation of exposed, energized parts above a working space.*

## Driver Considerations When Working Near Power Lines

- The apparent height of power lines will vary depending on the angle from which they are viewed.
- Windy conditions can cause power lines to sway, increasing the chance of contact when working nearby.
- Overcast days and dim light conditions, such as dusk and dawn, can make power lines difficult to see.
- Hot days can cause power lines to sag, thus reducing clearance.
- Injury and equipment damage can still occur even without direct contact with overhead power lines. Electricity can arc across open space. Always maintain the required safe clearance.
- Power lines may re-energize following a ground fault because of automatic recloser circuit breakers.

## Considerations for Vehicle Movements Near Power Lines

- Have pre-job planning and hazard analyses restricted vehicle travel and activities to include only areas where overhead lines and other hazards are addressed?
- Have overhead power lines been identified and their heights verified for the travel routes and activities to be taken?
- Will any operation of a vehicle place it, its mechanical equipment, or its load within 10 feet of overhead lines, utility poles, or supporting guy wires?
- Are all guy wires, utility poles, and communication lines, as well as overhead power lines, clearly visible to drivers and spotters?
- Are there trained and dedicated spotters provided for all travel routes and for all work activities? (If not, why not?)
- Is the number of spotters assigned adequate to detect all hazards and communicate them to the vehicle drivers or equipment operators?
- Have steps been taken to ensure continuous communications between spotters and vehicle drivers or operators?

***KEYWORDS:*** *Overhead power line, dump truck, raised bed, spotter, power outage, electrical incursion*

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

## 2. FOLLOW MANUFACTURERS' INSTRUCTIONS WHEN MODIFYING WIRING

On September 6, 2005, at the Office of River Protection at Hanford, an electrician found a floodlight with the lens glass broken. Broken glass from the lens could be seen on top of a tarp that covered a pit opening. No one witnessed this event, and no one was injured. (Not reported in ORPS)

The floodlight was one of a series that are attached to the ceiling beams (Figure 2-1) 45 feet above the floor of the facility. The 480-volt floodlight was manufactured by Hubbell and rated for 1,000 watts.

Electricians modified the light units by attaching two leads to the back of them, so they could fasten the units to the ceiling beams and interconnect the power cords. However, they did not consult with the manufacturer about making this modification. The electricians found that the support bracket did not provide enough room for the connections, so they made the connections inside the lamp fixture instead.

The label on the back of the unit specified the use of supply wire rated to 90ºC (194°F). The electricians used wiring and wire nuts that were properly rated; however, the components inside the fixture are rated for 150ºC (302°F). One of the lower-rated wire nuts inside the lamp melted, and the wire grounded to the bulb reflector, resulting in an arc (Figure 2-2) that blew out the lamp lens. Figure 2-3 shows the floodlight after the lens broke. Inspectors later found other floodlights with discolored wire nuts and brittle wire insulation.

*Figure 2-1. Facility lighting*

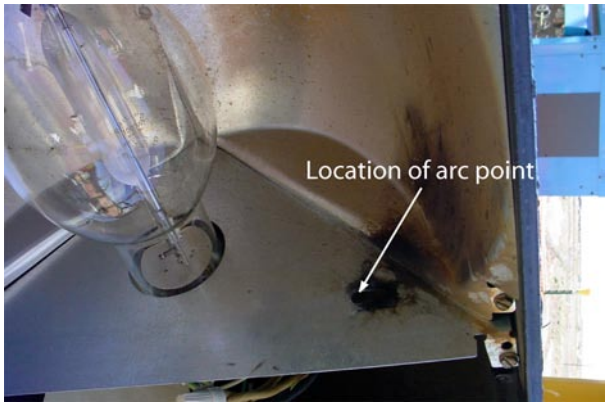


*Figure 2-2. Arc point*

*Figure 2-3. Floodlight with broken lens*

The electricians should have attached a junction box to the outside of the floodlight and made the connections inside the junction box to prevent the wiring components from overheating. Figure 2-4 shows the original modification and the corrected modification.

*Figure 2-4. Back of previously modified (left) light unit and corrected modification (right)*

*This event illustrates the importance of following manufacturers' specifications when modifying an electrical component. It is important to consult product literature to understand rating limitations of the various wiring components to prevent the components from inadvertently overheating and degrading.*

***KEYWORDS:*** *Electrical, light, arc*

***ISM CORE FUNCTION:*** *Perform Work within Controls*

## 3. GOOD PRACTICE: WORKER'S USE OF SAFETY EQUIPMENT PREVENTS SERIOUS INJURY

On April 20, 2005, at the Fernald Closure Project, a scraper operator began to drive down a compost pile exit ramp, and the scraper slid sideways off the ramp and rolled over. The operator escaped injury because he was wearing both his seatbelt and a hardhat. Without the use of this safety equipment it is highly likely that the operator would have been injured, perhaps seriously. (ORPS Report EM-OH-FN-FFI-FEMP-2005-0012; final report issued June 4, 2005)

The scraper operator had been spreading compost from a long, rectangular stockpile of compost material (about 14 feet high) that had an 80-foot-wide entrance ramp and a 40-foot-wide exit ramp. Because of the soft nature of the compost, the rubber-tired, belly-pan scraper was pushed up the stockpile by a bulldozer until it reached the downward slope, then the operator left the stockpile via the exit ramp to spread the compost. When the operator was about 6 feet from the edge of the exit ramp, the right rear corner of the scraper began to slide sideways down the side of the ramp, and he braced himself for the inevitable rollover. After the scraper came to rest on its right side, the operator turned off the engine, removed his seatbelt, and safely climbed out of the scraper and down to the ground. Figure 3-1 shows the scraper following the rollover.

Investigators determined that the hazards associated with using this type of scraper on a large compost pile were not analyzed. The work authorization document identified hazards associated with stockpiles consisting of soil, stone, and rock materials, but did not take into account that the stockpile being spread was compost and a scraper was going to be driven across the top of it. Stockpiles of soil, stone, or rock are much more stable than those of compost, and a track-mounted excavator or bulldozer (which are much more stable on stockpiled materials) is usually used.

Investigators believe that if the differences between compost and other materials had been recognized and analyzed, along with the differences between using an excavator versus a scraper, the work document would have required the stockpiled compost material to be flatter, wider, and more stable allowing a scraper to be driven across the top of the pile.

*Figure 3-1. Scraper following rollover*

Although this event demonstrates the need for adequate hazard analyses, it also demonstrates that when workers take some simple safety measures they may avoid serious injuries in an accident. The operator was uninjured because of his personal safety attitude and his use of appropriate PPE. The scraper operator chose to comply with site requirements and wear his seatbelt, which may have saved him from falling out of the scraper window and being killed or severely injured. (Figure 3-2 shows the cab of the scraper after the accident.) The operator also might have suffered head injuries in the accident without his hardhat. He could have hit his head on components (or loose components could have hit him). However, the operator voluntarily chose to wear a hardhat, even though one was not required by the work order, and was protected from sustaining a head injury. By following site procedures that require drivers to "buckle up" and by choosing to wear a hardhat, the scraper operator walked away from the accident uninjured.

***Figure 3-2. Scraper cab, post-accident***

The Mine Safety and Health Administration (MSHA) investigated a similar scraper rollover accident that occurred in Texas in 1997; however, that incident resulted in a fatality. The operator, who was employed by a public-sector construction company, was not wearing a seatbelt or any other form of PPE when the scraper he was driving rolled over. He was thrown from the seat and pinned under the rollover protection structure. The operator's left arm and leg were partially amputated in the accident. Despite efforts to save his life at the accident scene, the operator died on the way to the local hospital. MSHA investigators identified the primary cause of the accident as failure to maintain control of the scraper when driving from the upper level of a stockpile onto a slope leading to the lower level. They also cited the failure to wear a seatbelt as contributing to the severity of the accident.

On September 15, 2005, MSHA issued a seatbelt alert following 10 mining-industry fatalities since the first of the year in accidents involving mobile equipment. Investigators found that the victims in seven of the fatalities were not wearing their seatbelts and that their deaths might have been prevented had they worn them. In addition, an MSHA report on fatal accidents in the mining industry, issued in June 2000, indicated that a review of investigative reports for 212 fatalities between 1995 and 1998 showed that in a significant number of these fatalities, failure to use PPE contributed to the fatal accident. The report states: "in at least 51 fatalities, workers did not use seatbelts, safety belts/lines, life jackets, hardhats, or other protective equipment." The report also states the following:

> In a majority of the cases where miners did not use PPE, the mine operator had supplied the appropriate equipment, and often provided required MSHA training regarding its use. . . . Such fatalities correspond with the findings of researchers in the safety field that risk-taking behavior plays a significant role in workplace fatalities.

The scraper operator at Fernald is to be commended for following site procedures, for taking additional steps to ensure his personal safety, and for choosing to avoid the risk-taking behaviors that contributed to the fatalities of the victims identified in the MSHA report.

OSHA requirements for seatbelt use in scrapers, loaders, crawler or wheel tractors, bulldozers, and similar construction equipment are outlined in 29 CFR 1926.602, *Material Handling Equipment*, section 1926.602(a)(2)(i), "Seatbelts." The section states that seatbelts must be provided on all such equipment and that they must meet the requirements of Society of Automotive Engineers Standard J386-1969, *Seatbelts for Construction Equipment.*

*These events show the importance of both adequate hazard analyses and the use of multiple safety barriers. Care must be taken when preparing job safety analyses to ensure that all potential hazards are addressed, particularly when there are changes in routine processes. Supervisors should observe workers to ensure that they comply with requirements for seatbelt use and should stress the importance of wearing seatbelts when operating vehicles both on and off the job. Workers should take responsibility for their own safety and should wear their seatbelts when operating vehicles. They should also use appropriate PPE (e.g., the hardhat the operator wore in the Fernald event), even if it is not specifically required in work orders or procedures. A worker's safety attitude and compliance mentality can be the difference between walking away from an accident or being seriously injured or killed.*

### Mobile Equipment Best Practices

- Always wear a seatbelt when operating mobile equipment.
- Maintain seatbelts in good operating condition.
- Never attempt to jump from a moving truck or machine.
- Conduct preoperational checks to identify any defects that may affect the safe operation of equipment before it is placed into service. Maintain all braking systems in good operating condition.
- Operate mobile equipment at an appropriate speed for the conditions of the roadway, grade, visibility, and traffic.
- Thoroughly review the operator's manual during operator training and stress the importance of seatbelt usage.
- Ensure that management routinely observes and evaluates seatbelt use by workers.

*From MSHA Seatbelt Alert*

***KEYWORDS:*** *Hazards analyses, seatbelts, hardhat, scraper, rollover*

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

## *4. FAILURE TO FOLLOW WORK INSTRUCTIONS RESULTS IN ELECTRICAL NEAR MISS*

On September 29, 2005, at the River Protection Project Waste Treatment Plant, an electrician removed a plug to install a missing weather-protection cap, and the bare ends of an energized 240-volt power cord came together, causing an electrical arc. The electrician, who was not injured, had deviated from work instructions for de-energizing the circuit. (ORPS Report EM-RP--BNRP-RPPWTP-2005-0026)

The electrician was assigned to test power cords for assured grounding and to install missing weather-protection cord caps on the pigtails of a mini load center (Figure 4-1). The electrician was not given written work instructions, but was orally instructed to remove electrical power to the load center by disconnecting the 480-volt power cord (red plug in Figure 4-1) supplying the load center before he began to work. Instead, the electrician decided to keep the load center energized and open the circuit breaker for the specific cord he planned to work on. However, he opened the wrong circuit breaker so the cord he intended to work on remained energized.


***Figure 4-1. Pigtails on the back of the mini load center and the exposed wires that arced (circled)***

After opening the circuit breaker, the electrician used a tic tracer to check for the absence of energy. The tic tracer failed to indicate the presence of voltage, even though the wires remained energized. The electrician removed the plug attachment clip, slid the cap cover up the cord, loosened the plug wire connection, and removed the plug from the pigtail. When he slid the cap cover down the cord to remove it, the energized wires touched, producing the arc. Figure 4-2 shows the disassembled plug, and Figure 4-3 shows the weather-protection cap.


***Figure 4-2. Plug attachment clip, cap cover, and plug (left to right)***


***Figure 4-3. Weather protection cord cap (yellow) next to assembled plug***

Although the investigation of this event continues, the following issues have been raised.

- The technician was given only oral instructions on how to de-energize the mini load center, rather than being provided with written instructions.

- A Safe Task Analysis Risk Reduction Talk (STARRT) card, which covers physical and environmental hazards tailored to a work task, instructed the technician to "kill the power to cords" and "test with tic tracer." However, a tic tracer is not an acceptable device for verifying zero energy.

- Using the circuit breaker to de-energize components without using a lockout/tagout is not an authorized method of work under the site lock and tag procedure.

- The site contractor had restricted all work on hazardous energy as a compensatory measure because of two recent lock and tag events.

A similar, near-miss event occurred on September 28, 2005, at Argonne National Laboratory, when a technician drilled holes into an electrical enclosure to install "Danger High Voltage" signs. The technician's instructions were to install these signs and other signage on recently repainted enclosures using an RTV adhesive. The technician decided on his own to drill and tap holes so he could use machine screws to fasten the signs to the electrical enclosure. He drilled and tapped two holes in each of the four enclosures and attached four signs with two machine screws per sign. (ORPS Report SC-CH-AA-ANLE-ANLEAPS-2005-0001)

The electrical enclosures were used to protect transformer/rectifier sets that contained 3-phase, 1.4-kV feed cables and 95-kV, 20-amp DC output cables. The cables were energized while the technician drilled and tapped the holes. The technician stated that he was familiar with the interior arrangement of the enclosures but admitted that he had not thought through the potential consequences had he been mistaken and hit energized components. The drilling and taping of holes in the enclosure cover is technically a modification that could introduce foreign, conductive debris into the enclosure, and any such debris should have been removed.

*These events underscore the importance of following work instructions, whether oral or written. Workers should not change the job task or the scope of work without making appropriate changes to the work package and seeking approval. Deviating from work instructions or performing unauthorized work-arounds can expose personnel to unanalyzed hazards for which no safety barriers have been established. Workers need to remember that they are also part*

*of the work control process, which includes job hazards analyses as well as the identification of lockout/tagout boundaries, applicable permits, appropriate PPE, and any special work instructions necessary to perform the work safely. Any willful disregard for work instructions or procedures should not be tolerated.*

***KEYWORDS:*** *Near miss, work instructions, energized components, lockout/tagout, zero energy*

***ISM CORE FUNCTIONS:*** *Perform Work within Controls*

# 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 |

| Authorization Basis/Documents | |
|---|---|
| JHA | Job Hazards 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 |
| RCRA | Resource Conservation and Recovery Act |
| D&D | Decontamination and Decommissioning |
| DD&D | Decontamination, Decommissioning, and Dismantlement |

| Units of Measure | |
|---|---|
| AC | alternating current |
| DC | direct current |
| psi (a)(d)(g) | pounds per square inch (absolute) (differential) (gauge) |
| RAD | Radiation Absorbed Dose |
| REM | Roentgen Equivalent Man |
| v/kv | volt/kilovolt |

| Job Titles/Positions | |
|---|---|
| RCT | Radiological Control Technician |

| Miscellaneous | |
|---|---|
| ALARA | As low as reasonably achievable |
| 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 |