Operating Experience Summary

U.S. Department of Energy
Office of Environment, Safety and Health
OE Summary 2006-09
July 21, 2006

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Accidental Activation of Golf Cart Results in Near Miss

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Many workplace accidents occur when machinery accidentally becomes activated while being serviced or maintained. This accidental activation resulted in a near miss involving a “runaway” golf cart at the Hanford Site Waste Treatment Plant (WTP) in March 2006.

On March 21, 2006, a WTP mechanic was assigned to inspect a parking brake on a site golf cart. While he was underneath the cart, the accelerator engaged, the tires began spinning rapidly, and the 815-pound golf cart started moving. The cart traveled about 120 feet (see Figure 1-1), sideswiped several flammable material storage cabinets, and did not stop until it struck a parked articulating boom lift (Figure 1-2). The mechanic had not turned off the ignition or removed the batteries from the cart before he began working on it. Fortunately, he was not injured when the cart began to move. (ORPS Report EM-RP--BNRP-RPPWTP-2006-0010; final report filed April 20, 2006)

The mechanic had to access the undercarriage of the golf cart to inspect the parking brake. He raised the front of the cart about 20 inches with a hydraulic jack, placed jack stands under each front corner to ensure stability, and chocked the rear tires from behind. The mechanic then crawled underneath the cart and, lying on his back, accessed the undercarriage and disconnected the accelerator linkage. As he pushed the linkage to his right and toward the back of the cart, the movement engaged the cart, causing the tires to spin rapidly, and the cart began moving. Figure 1-3 shows the disconnected accelerator linkage on the undercarriage and the lift plate from the jack, which was carried along by the golf cart, stuck in the frame of the cart.

Figure 1-1. Path of cart (note cart at far right, rear)

Figure 1-2. Golf cart stopped by the arm of the manlift

Investigators interviewed the mechanic, who told them that he thought he had turned off the ignition, but he did not remove the key or disconnect the battery. He also had not tagged the cart out of service or put it in neutral. Investigators determined that the mechanic did not follow the site equipment maintenance procedure, which states:

> The equipment should be taken out of service and moving parts de-energized/defeated or blocked before repairs…are performed. The operator or maintenance personnel shall tag the equipment with a "Do Not Use Tag" while the maintenance or repair is performed.

Although no one was injured in this accident, the possibility for a serious injury or fatality existed because measures to control hazardous energy were not implemented.

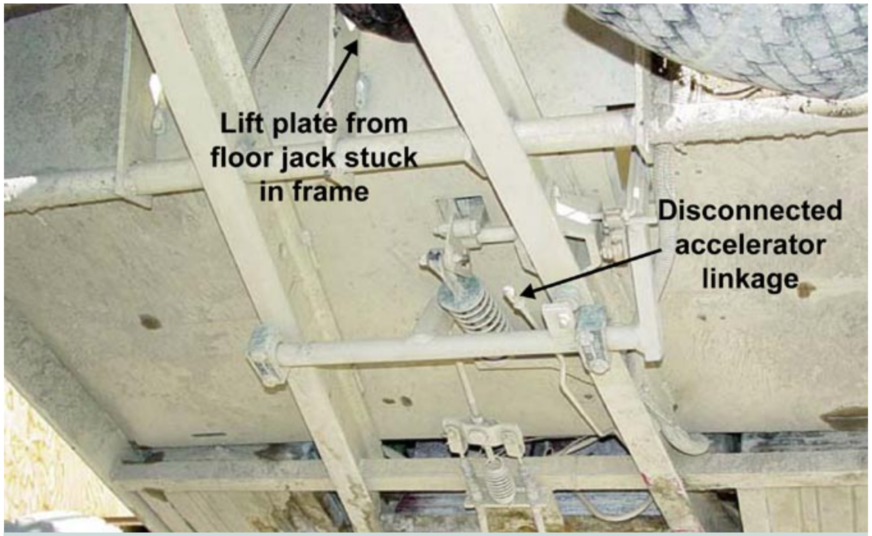

Figure 1-3. Cart undercarriage (note disconnected linkage and lift plate)

Eight hazardous energy control incidents occurred at WTP between June and September 2005. An initial management review of all eight incidents identified the common problem as the failure to prevent or mitigate exposure to hazardous energy sources during routine work activities. One of these events also involved an unexpected startup and a worker who did not follow procedures.

On September 19, 2005, a subcontractor worker, preparing to perform a radon sampling of aggregate, placed a sampling device on an aggregate feed conveyer belt and the conveyor started unexpectedly. The worker was about 2 feet from the conveyor when it started and was not injured. Investigators determined that the worker had not followed the applicable procedure that required him to lock and tag out the aggregate feed conveyor breaker before he began the sampling task. (ORPS Report EM-RP--BNRP-RPPWTP-2005-0023)

Management at WTP assembled a Root Cause Analysis Team to address the series of hazardous energy control incidents. The team conducted a thorough analysis of the root causes of all eight incidents, reviewed site hazardous energy controls, and recommended corrective actions. The team identified root causes in three categories: work control; supervision; and personal responsibility. The corrective actions for each of these categories are as follows.

Work Control

- Control work on hazardous energy sources using either a lockout/tagout or a Hazardous Work Permit.
- Eliminate the distinction between temporary power and permanent power when applying work controls.
- Provide specific instructions for work on hazardous energy sources.

- During pre-job planning, provide guidance describing actions to take when a change in condition is encountered.
- Establish a centralized work control and planning center to control work on or adjacent to operating systems and hazardous energy sources.

Supervision

- Before work begins, the foreman must specifically address all hazardous energy sources that could affect the assigned work.
- When a work task that requires hazardous energy controls is assigned, a superintendent must document a release to perform work.
- Before a supervisor releases a work crew to leave the work area, barriers must be placed to prevent anyone from being exposed to the hazardous energy source.

Personal Responsibility

- Incorporate comprehension tests and practical evaluations into training for lockout/tagout, confined space, Hazardous Work Permit, zero-energy checks, and excavations.
- Distinguish between awareness training (general population) and user training for critical hazard control programs.
- Determine how often refresher training is required based on the frequency that those executing work under hazardous energy control programs perform such work.
- On a regular basis, test and verify the ability of supervisors to identify hazards.
- Provide timely training that coordinates with the performance of work (e.g., review critical elements of the lockout/tagout program immediately before beginning work that requires lockout/tagout).

OSHA Standard 29 CFR 1910.147 requires employers to establish a program consisting of energy control procedures, employee training, and periodic inspections to ensure that before any employee performs any servicing or maintenance on a machine or equipment where unexpected energizing, startup, or release of stored energy could occur and cause injury, the machine or equipment shall be isolated from the energy source and rendered inoperative.

Hazardous energy is *any* type of energy in sufficient quantity to cause injury to a worker. Common sources include electricity, mechanical motion, pressurized air, and sources of extreme heat or cold. Accidents resulting from the uncontrolled release of hazardous energy are preventable if effective energy control techniques and procedures are in place, workers are trained to use them, and management motivates workers to follow the procedures and enforces their use.

These events point out the importance of identifying hazards, controlling them, and ensuring that all workers understand and follow applicable procedures. Just as important is the need to ensure that all guidance and direction given to workers is clear and sufficient to ensure that they can safely perform the task.

Workers must maintain a questioning attitude and should ask themselves if they understand the scope of work and the procedures for performing it safely, if all hazards have been identified, and if the appropriate control measures have been implemented to ensure their safety. The control of hazardous *energy requires not only effective control techniques, but also cooperation between workers and their supervisors to ensure that all necessary hazard barriers are in place before work begins.*

KEYWORDS: *Golf cart, uncontrolled hazardous energy, lockout/tagout, work control*

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

Near Miss to Serious Injury When Crane Outrigger Float Falls and Hits Worker

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On May 31, 2006, at the Hanford Tank Farm, a Health Physics Technician (HPT) performing a radiological survey moved a 98-pound outrigger float (pad) and was hit in the right leg, just above the knee, when the pad fell from a mobile crane. The HPT did not understand the operation of the outrigger float and caused it to disengage. (ORPS Report EM-RP--CHG-TANKFARM-2006-0026; RPP Lessons Learned Bulletin SB-06-011)

The HPT was performing release surveys on the 90-ton Grove mobile crane. As part of the survey, he needed to survey the bottom of the floats, which, when deployed, are in contact with the ground, as shown in Figure 2-1. When the HPT pivoted the float to facilitate the surveying task, it unlatched and fell.

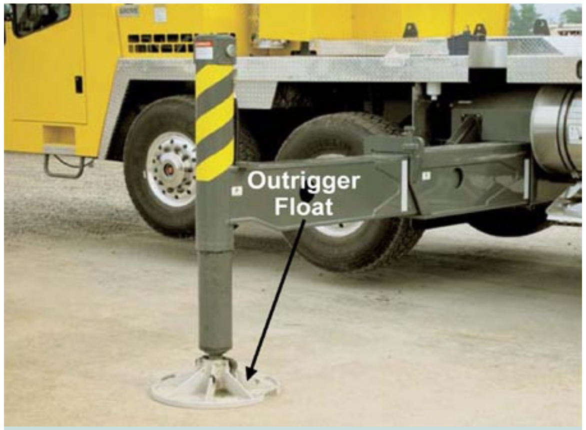

Figure 2-1. Outrigger and float shown deployed

The HPT did not know that the crane was equipped with quick-release floats that were held in place by latches. The outrigger floats on some older cranes do not disconnect and are pinned in place to prevent detaching while in use or during transit. Removing the floats was a new task of the HPT. Previously, riggers removed the floats, but that assignment was changed because of reported HPT back strains.

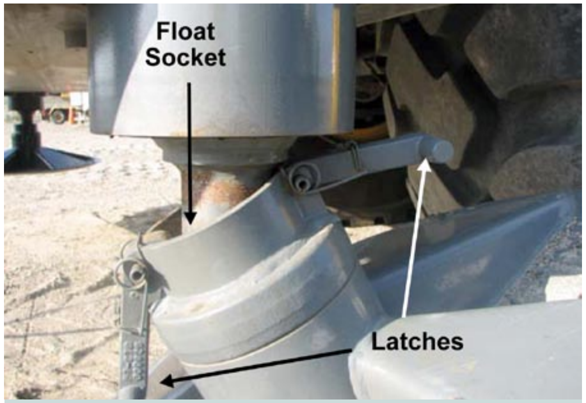

Figure 2-2. Quick-release float showing latches

Figure 2-2 shows the float, as well as the latches on the Grove mobile crane. The latches on this crane have springs that are held in place by roll pins for quick release.

Quick-release floats allow for removal and stowage of the floats during transport. If left in place, the latches disengage when the float is pivoted 30 to 40 degrees from the horizontal plane. There is a warning label on the floats that reads “No Step.”

In the past, riggers would remove the floats as a courtesy to facilitate radiological surveys; however, because of the increase in back strains attributed to handling the heavy floats, this practice was stopped. Health Physics Technicians were left to conduct the surveys without the support of equipment-knowledgeable riggers.

Investigators determined that the float socket was slightly enlarged, which could have contributed to the unexpected release of the float. Repairs were made to the correct this condition as directed by the manufacturer’s representative.

Recommendations

- Position your body such that detachable parts will not strike or pinch you if they fall.
- Use extension tools to reach under detachable parts.
- Brief personnel so they are aware of the operation and design of the equipment before use.
- Consider installation of positive retaining devices on detachable parts.
- Provide additional warning labels on the outrigger floats to remind personnel "Do Not Tilt or Lift."
- Seek assistance from crane and rigging personnel when working with a crane.

This event underscores the importance of understanding the operation and the design features of equipment before attempting to manipulate it. Radiological control personnel perform many release surveys for heavy equipment, machinery, and large components so that they can be moved out of contamination areas. In some cases, those performing the surveys may not have sufficient knowledge of the equipment to perform these surveys safely. Other workers (e.g., equipment operators or drivers) should be made available to provide assistance. Also, the use of extension tools is recommended when there is a need to reach underneath suspended or detachable equipment to conduct radiological surveys.

KEYWORDS: *Mobile crane, outrigger, radiological survey, injury, equipment knowledge, operation*

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

Work Planning Requires a Thorough Analysis of Respiratory Hazards

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Waste-handling operations at DOE facilities can often present unexpected hazards that must be analyzed. The Office of River Protection at Hanford found this to be true a few years ago, as its waste retrieval operations increased. At the time, ammonia was assumed to pose the greatest exposure potential, and its measurement would bound any other potential exposures. However, beginning in 2004, workers began to raise concerns about the exposure potential of other chemicals they could smell or see coming from the tanks. Pending the results of an investigation, workers were instructed to use supplied-air respiratory protection.

The initial hazard characterization proved to be inadequate, as further investigation revealed the presence of some 1,500 different chemicals in the tanks, more than 1,100 of which did not have exposure limits as defined by OSHA or ACGIH. Some of the chemicals mentioned were particularly toxic, such as mercury and dimethylmercury.

The characterization process involved teams of industrial hygienists and toxicologists working to develop screening values, exposure limits, and analytical methods for these chemicals. An independent toxicology panel oversaw the process.

When the process was complete, a conservative exposure limit of 10 percent of the occupational exposure limit was set for chemical vapor concentrations inside the tanks. Of the 1,500 chemicals present in the tanks, 58 were found to be present above the 10 percent exposure limit. Industrial hygienists then sampled work areas to measure vapor concentrations (Figure 3-1). In the first area that was sampled outside the tanks, eight chemicals were detected at concentrations above the exposure limit, but they were only present near vapor sources such as exhaust stacks and breather filters. No vapors were present above the exposure limit 0.5 feet from the vapor sources.

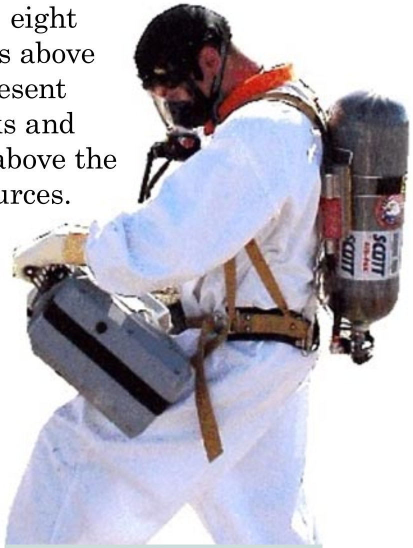

Figure 3-1. Tank Farms vapor monitoring

Barriers were placed around the vapor sources, and workers were required to use supplied-air respiratory protection inside the vapor control zones. Outside the zones, respiratory protection is not required, but is available to those who wish to use it. Engineered controls are being evaluated for the vapor control zones.

Since January 2004, nearly 100 ORPS reports have been filed across the DOE complex describing worker exposures (or potential exposures) to asbestos, lead, respirable silica, chemical vapors, and other hazardous substances. These exposures or potential exposures occurred because of inadequate job planning that failed to characterize all potential exposure hazards and faulty hazard communications or because workers exceeded the work scope without analyzing the changed condition. Examples of these exposure events are given below by material type.

Asbestos

Asbestos has been the most common non-radiological respiratory hazard reported in ORPS, with 22 reports filed since January 1, 2004. The following events demonstrate the potential for asbestos exposure in various settings.

On October 28, 2005, at Lawrence Livermore Laboratory, workers put themselves at risk when they moved outside the work plan's scope. Unable to start a flooring project in one part of a trailer, the workers simply moved to another area, beginning tile-removal work before asbestos sampling results were complete. Some of those tiles were later determined to contain asbestos. Although subsequent air samples were negative, workers had endangered themselves and others in the trailer. (ORPS Report NA--LSO-LLNL-LLNL-2005-0092)

On August 23, 2005, at the East Tennessee Technology Park, workers removed ceiling tiles that were later found to contain asbestos. Because work planning did not adequately sequence D&D activities such as asbestos abatement, the hazards were not adequately analyzed, and sampling results were not communicated. As a result, the workers were not wearing the correct PPE for the job. (ORPS Report EM-ORO--BJC-K25ENVRES-2005-0024)

Maintenance and D&D workers should expect to encounter asbestos-containing materials (ACM). Although asbestos is recognized as a health hazard and is regulated, exposure opportunities exist when work takes place in aging facilities. Neither the Clean Air Act of 1970 nor the 1989 EPA rule banning asbestos stood as originally passed; much of the EPA rule was remanded in 1991. As a result, ACM continued to make its way into tile and building materials that workers may encounter today, particularly when surfaces are broken or exposed, as they are during D&D work.

Lead

Lead exposure, according to OSHA, is a leading cause of workplace illness, causing muscle and joint pain, memory or concentration problems, infertility, and gastrointestinal, nervous system, and kidney damage. Occupations relating to painting, welding, or remodeling are more likely to expose workers.

At DOE, 13 lead-related ORPS reports have been filed since January 1, 2004. Two examples are given below.

On February 2, 2006, at the East Tennessee Technology Park, a worker was notified that he had exceeded the OSHA permissible exposure limit (PEL) for lead while plasma-arc cutting expansion joints and ductwork 2 days earlier. As a result of this incident, workers are now required to wear powered air-purifying respirators (PAPRs) with HEPA cartridges. (ORPS Report EM-ORO--BJC-K25ENVRES-2006-0004)

On January 27, 2006, at Oak Ridge National Laboratory, air sample results indicated workers had potentially been exposed to airborne lead concentrations above established limits while performing research on lead slug projectiles in an indoor facility. Ballistics testing that had previously been performed outdoors was moved inside to take advantage of available high-speed filming. However, despite room ventilation, a HEPA-filtered device located near the bullet trap, and a snorkel-type ventilator positioned near the firing point, personal air monitors showed higher-than-allowable lead concentrations in the facility, causing work to be suspended. Fortunately, blood analysis was negative; additional PPE, including respirators, will be required for future operations and will ensure additional protection. This event shows the benefits of wearing personal air monitors and timely testing of samples taken from workers in an area that may not be as safe as originally assumed. (ORPS Report SC-ORO--ORNL-X10LEASED-2006-0001)

Respirable Silica

Respirable silica, a material present in concrete construction products, has been a known occupational health hazard for more than a century. According to NIOSH, silica makes up 12 percent of the earth's crust. In some forms, such as beach sand, it is too large to be inhaled; however, when the material is altered by cutting or blasting, particles are small enough to be inhaled and deposited deep within the lungs.

Because human body cells cannot destroy or remove silica particles, the particles accumulate and kill the cells. Dead cells release the silica to attack new cells, then become scar tissue, and, eventually, the victim cannot breathe. Workers who work with or cut concrete products such as roofing tiles are at greatest risk because of the dust. Large structures that are torn down (Figure 3-2) can release huge amounts of silica dust to the atmosphere. Respirators must be worn at the work or exposure site; once the particles are inhaled, they are in the body to stay. The following examples describe DOE workers who were exposed to silica dust.

Figure 3-2. Dust control during demolition

On June 15, 2006, an industrial hygienist (IH) at Sandia National Laboratories informed a subcontractor IH consultant that two of 11 survey samples for crystalline silica exceeded the ACGIH occupational threshold limit. The subcontractor IH had previously reported that the samples, which were collected from April 26 through May 2, 2006, during demolition work, were all within prescribed limits. However, he was using the 2005 threshold limit of 0.05 milligram per cubic meter of air (mg/m^3) and not the 2006 limit, which is 0.025 mg/m^3. One of the samples was from an equipment operator and the other was from the spotter. (ORPS Report NA--SS-SNL-NMFAC-2006-0010)

On July 7 and 8, 2004, workers at Lawrence Livermore National Laboratory used a jackhammer to remove concrete; one operated the jackhammer while the other one wetted the debris in an attempt to control the dust. One worker's air sampler indicated he had been exposed to silica in excess of the ACGIH threshold limit value. The event provided a lesson learned that during silica operations, respiratory protection should be mandatory and not discretionary. (ORPS Report NA--LSO-LLNL-LLNL-2004-0048)

Hexavalent Chromium

Hexavalent chromium is generated during arc welding (Figure 3-3) using stainless steel. The following summarizes one of two occupational exposures to hexavalent chromium fumes that occurred at the Hanford Waste Treatment Plant construction site.

On October 20, 2005, a welder was performing stainless-steel arc welding in a confined space. He was wearing a half-face respirator; another worker, who was assigned to suction the fumes away from the weld area, wore a dust mask. The work package required that both workers wear half-face respirators; also, the confined space was so small that the worker assigned to suction the fumes found it difficult to maintain close proximity at all times during the welding, potentially exposing his co-worker to the hazard as well. (ORPS Report EM-RP--BNRP-RPPWTP-2005-0028)

Figure 3-3. Welding can produce hexavalent chromium

Effective February 28, 2006, OSHA reduced the permissible exposure limit for hexavalent chromium from

52 micrograms per cubic meter of air (μg/m³) to 5 μg/m³. The recently updated EH Safety Bulletin 2006-01, *Hexavalent Chromium*, addresses this change and provides recommendations for preventing exposures.

Other Exposure Events

Other exposure events provide lessons learned on proper ventilation, planning, and PPE in preventing exposure to acids, fumes, and vapors. The following describes one example.

On February 27, 2006, a workplace safety check at Sandia National Laboratories indicated that the occupational exposure limit for ozone was exceeded while workers were plasma-arc cutting. Ozone attacks the eyes and respiratory system and, on the basis of animal research data, a high enough exposure can be fatal to humans. Several factors contributed to this event: the building was not originally designed for welding and a retrofit did not add special ventilation; previous welding and cutting had been conducted in the summer when evaporative coolers provided additional fresh air; and the number of workers varied, impacting the ventilation. This event demonstrates the importance of workplace safety checks to detect breathing dangers before they reach harmful levels when the building itself is not safely configured. (ORPS Report NA--SS-SNL-1000-2006-0005)

These events demonstrate the importance of careful work planning that includes performing industrial hygiene occupational exposure assessments, developing engineering controls, following a work plan, and wearing sufficient PPE. Workers must expect the unexpected, being willing to stop if necessary. Uncertainties surrounding contamination levels should dictate conservative approaches to work planning and the selection and use of respiratory protection equipment. In situations where complex chemical mixtures are expected to be present in work areas, a comprehensive program of characterization sampling and personal monitoring should be undertaken for a complete understanding of worker exposure potential. Industrial hygienists need to ensure that characterization sampling is compared to the latest published threshold limits, and that they repeat the sampling if conditions change.

KEYWORDS: *Asbestos, ozone, silica, lead, chromium, respiratory, toxic chemicals, work planning*

ISM CORE FUNCTIONS: *Define the Scope of Work; Analyze the Hazards; Develop and Implement Hazard Controls; Perform Work within 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

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