Operating Experience Summary

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Missed Opportunities to Identify a Hazard Result in Electrical Shock

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On January 15, 2008, at Hanford, a subcontractor maintenance worker plugged a metal-bodied welding rod oven into an electrical outlet that was not protected by a ground fault circuit interrupter (GFCI) and received an electrical shock when he tried to unplug it. Although the worker received only a mild shock, it was a near miss to a more serious injury, and he did not immediately report it to his supervisor. (ORPS Report EM-RL--WCH-ERDF-2008-0001; final report issued April 20, 2008)

The worker received the welding rod oven (Figure 1-1) from another Hanford contractor's equipment maintenance shop the day before this incident occurred. He tried to warm up the oven twice using one GFCI-protected outlet, then tried again on a similarly protected outlet in another building, but each time the GFCI tripped the circuit. When he contacted personnel in the equipment maintenance shop to determine the status of the oven, he was told that the oven had worked properly before shipping; however, shop personnel indicated they had used an outlet without a GFCI during testing.

The following day, the worker decided to re-create conditions at the maintenance shop. He plugged the oven into an outlet that was not protected by a GFCI, and it began to heat up. As he was checking the thermostat at the back of the oven, he noticed that the electrical cord was in poor condition and decided to unplug the oven. The worker's hand was on the thermometer housing when he pulled out the plug, and, when he accidentally brushed a damaged area of the cord with his fingertips, he felt the slight tingle of a minor electrical shock.

Figure 1-1. Welding rod oven

Investigators identified a number of opportunities to avoid this event. The oven was not inspected when it first arrived on site, and the worker did not inspect it after he received it from the maintenance shop. The damaged power cord (Figure 1-2) would have been noticed in either of these inspections, and the oven would not have been used. In addition, the worker did not stop work and notify a supervisor after any of his attempts to use

the oven in a GFCI-protected outlet. The GFCI faults clearly signaled that the welding oven should not be used, but these signs were ignored. Unfortunately, the worker's lack of a questioning attitude led him to use the non-protected outlet, which resulted in the electrical shock. He should have notified his supervisor and tagged the equipment out of service instead of contacting the maintenance shop and deciding to try an unprotected outlet.

Lessons learned from this event included the following.

- Inspect all electrical equipment, both new and used, when it arrives on site.
- Inspect electrical equipment before using it to check for hazards such as exposed wires, frayed ends, or cracked insulation.

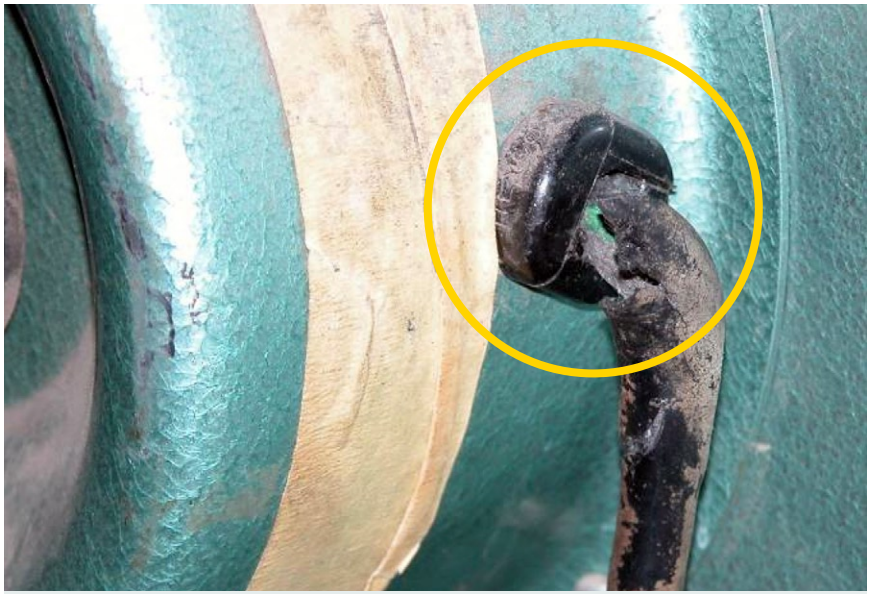

Figure 1-2. Damaged power cord

- If a GFCI trips, tag the equipment out of service to alert others that the equipment is damaged and should not be used.
- Notify a supervisor about the problem so that faulty equipment can be repaired or replaced.

On April 12, 2005, a similar event occurred at Hanford. A janitor received an electrical shock, described as "a tingling from hand to elbow," from the housing on a carpet extractor. Subsequent interviews indicated that he was operating the extractor without the required GFCI pigtail. He had plugged the machine directly into a wall receptacle because the maintenance workers had noticed that extractors and tile buffers occasionally caused building breakers to trip. (ORPS Report EM-RP--CHG-TANKFARM-2005-0015; final report issued June 10, 2005)

Testers using a different extractor in the same receptacle, and with the GFCI pigtail in place, found that the receptacle worked properly. There were no power interruptions, nor were there any problems with other receptacles. They examined the extractor used by the janitor and discovered copper wiring on the cord was exposed and had made contact with the housing of the extractor, resulting in the electrical shock.

Investigators believe that intermittent loads on building circuits (e.g., refrigerators) may have exceeded breaker capacity during use of the extractors, causing the breakers to trip. This led to janitorial staff erroneously concluding that the GFCI pigtail caused the problem. They did not report the problem to supervisors and simply stopped using the GFCI pigtail.

Ignoring a GFCI trip can be a dangerous choice. Fortunately the workers in both of these events experienced only a "tingle," but in different circumstances they could have been seriously injured or received a fatal shock. Also, because the workers

did not report any problems with the electrical equipment or receiving an electrical shock to a supervisor, another worker, who was unaware of the problem, may have been seriously, or even fatally, injured.

A GFCI is a fast-acting circuit breaker designed to shut off electric power in the event of a ground-fault within as little as 1/40 second. It works by comparing the amount of current going to and returning from equipment along the circuit current carrying (hot and neutral) conductors. When the amount *going* differs from the amount *returning* by approximately 5 milliamps, the GFCI interrupts the current. GFCIs are rated to trip quickly enough to prevent an electrical incident, and, if properly installed and maintained, this will happen as soon as the faulty tool is plugged in. When a worker becomes part of the circuit they will receive an electrical shock, but the GFCI should trip so quickly that the shock will not be harmful.

It is important to test GFCIs regularly to ensure proper protection. All GFCIs have a built-in test circuit, with test and reset buttons that trigger an artificial ground-fault. NFPA Article 110.9(C) states that GFCI protection devices "shall be tested per manufacturer's instructions." In most cases, manufacturers recommend testing GFCIs monthly or before each use.

OSHA regulations in 1926.404, *Wiring Design and Protection*, state that all 120-volt, single-phase 15A and 20A receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground fault circuit interrupters for personal protection. The requirement also states that each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for

Missed Opportunities in This Event

1. Equipment was not inspected when it arrived onsite.
2. Equipment was not inspected before use.
3. Supervisor was not notified when the equipment first tripped the GFCI or after it tripped the GFCI for the second time.
4. After the second trip of the GFCI, the equipment was not tagged out of service; instead, the equipment was moved to another location and plugged into a non-GFCI outlet.
5. Supervisor was not notified of the minor electrical shock (i.e., tingle).

external defects such as deformed or missing pins, insulation damage, or indications of possible internal damage. Equipment found damaged or defective shall not be used until repaired. An OSHA e-tool provides additional information on GFCIs and the types used for various applications. The e-tool can be accessed at http://www.osha.gov/SLTC/etools/construction/electrical_incidents/gfci.html.

Always inspect power cords and test the GFCI before plugging electrical equipment into a receptacle, and do not continue to use equipment if the GFCI trips. Workers should notify a supervisor in the event that a GFCI is tripped or they receive even a minor electrical shock. The equipment should be tagged out to ensure that no one else attempts to use it before it is inspected and repaired or is removed from service.

KEYWORDS: Electrical shock, welding oven, GFCI, power cord

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

Office of Independent Oversight Review of Non-Radiological Workplace Exposure Monitoring

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From January 2006 through June 2007, the DOE Office of Independent Oversight evaluated the effectiveness of the Department's workplace monitoring programs for non-radiological hazards at eight sites—Savannah River Site, Sandia National Laboratories, Nevada Test Site, Idaho National Laboratory, Idaho Cleanup Projects, Oak Ridge National Laboratory (Cleanup), Stanford Linear Accelerator Complex, and Fluor Hanford Waste Stabilization Project.

The inspection team's evaluation was based on requirements in 10 CFR 851, *Worker Safety and Health Program*, which became effective for all DOE sites in May 2007; and on DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, for those sites that were still transitioning to 10 CFR 851 when the review occurred. Under 10 CFR 851, contractors are required to "assess worker exposures to chemical, physical, biological, or safety workplace hazards through appropriate workplace monitoring." Figure 2-1 shows an example of workplace monitoring for worker exposure to noise during machine operations.

The team identified a number of positive aspects of site workplace monitoring programs. They found that all of the sites reviewed had established work control processes, such as activity-level hazard analyses or job hazard analyses, to identify and document workplace exposures. In addition, all of the sites have identified or developed worker exposure assessment processes for performing qualitative and quantitative analyses of workplace exposures. Other positive aspects of site workplace monitoring programs included performing

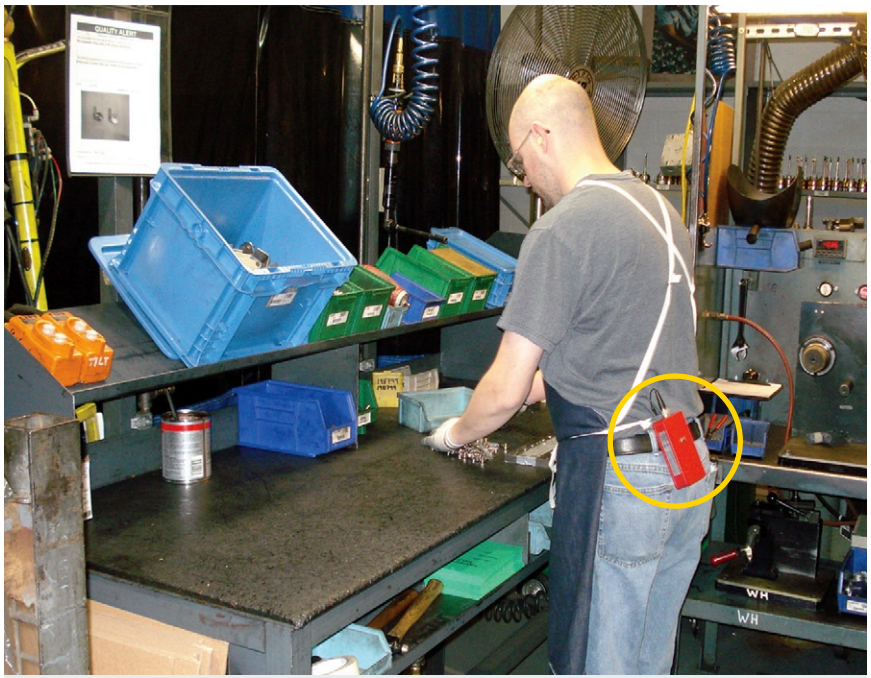

Figure 2-1. Worker wearing noise monitoring equipment (red box) on belt

recordkeeping in accordance with 10 CFR 851, which requires recording observations, testing, and monitoring results; relying on accredited laboratories to analyze workplace monitoring samples; and employing experienced, knowledgeable industrial hygienist staff members, many of whom have broad commercial, DOE, or defense backgrounds and a detailed understanding of the workplace exposure monitoring process.

Despite these positive program attributes, the inspection team concluded that much remains to be done to meet the requirements and expectations of 10 CFR 851 at all of the sites. The team found that several sites did not have sufficient procedures, policies, or guidance to implement 10 CFR 851 requirements and that none of the sites had completed 10 CFR 851 baseline

exposure surveys of all work activities. They also found that exposure records at some sites contained errors and omissions or lacked defensible technical bases to support assumptions and conclusions stated in the records and that worker exposure assessments often were not performed for subcontractor workers. In addition, at some sites, implementation plans to correct noncompliance issues and corrective actions from external reviews did not include realistic goals to achieve full compliance.

For additional information about the inspection team's evaluation, including both positive findings and identified weaknesses of site workplace monitoring programs, contact Marvin Mielke, Office of Independent Oversight, at (301) 903-7362 or by email at marvin.mielke@oa.doe.gov.

KEYWORDS: Workplace exposure monitoring, work control, hazard analysis, recordkeeping

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

Type A Accident Investigation of the Mixed Waste Spill at Hanford Tank Farms — Part 6: Corrective Actions

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On July 27, 2007, at the Hanford Tank Farms, about 85 gallons of tank waste were released from a ruptured dilution hose near a transfer pump. The event resulted in a Type A Accident Investigation because of the potential for adverse consequences to the facility and collocated workers. (ORPS Report EM-RP--CHG-TANKFARM-2007-0009)

The Accident Investigation Board's findings and their Judgments of Need (JON) for five program areas are detailed in previous issues of the OE Summary (2007-08 and -09; 2008-01, -02, and -03). The 16 JONs and the identified deficiencies for each program area can also be viewed on the DOE Office of Health, Safety and Security website at http://www.hss.energy.gov/csa/csp/aip/HanfordTankFarm.html. This article provides an overview of the corrective actions developed to address the JONs for each of the deficient program areas.

Engineering Design

The Board concluded that the direct cause of the spill was an overpressure of a hose connected to a dilution line on the retrieval pump system, resulting from the lack of an isolation device (e.g., a backflow preventer) between the dilution water system and the waste transfer route. Four JONs addressed deficiencies in the Engineering Design program area that contributed to the event. Corrective actions will include new process hazard analysis procedures, revised procedure development processes, revisions to applicable procedures, and implementation of a change management process and control strategy based on leak prevention.

The process for preparing waste retrieval and transfer operating procedures will be revised to define how design features, operating limits and criteria, and the retrieval process are incorporated into operating procedures. In addition, process hazards analysis procedures, with an emphasis on preventative controls, will be developed to ensure identification of hazards and controls that address both Technical Safety Requirement (TSR) level hazards and those that are of higher frequency, but lower consequence, that are significant for emergency response and environmental compliance.

Design review procedures will also be revised to incorporate an intermediate design review and formal disposition of comment resolution, and an extent of condition review for systems connected to waste storage tanks will be performed to determine potential waste transfer paths and ensure that applicable TSR controls are incorporated. Also a change management process, based on *Process Safety Management of Highly Hazardous Chemicals* (29 CFR 1910.119) will be implemented, as will a revised control strategy based on leak prevention.

Emergency Management/Response

The Board determined that the Emergency Planning Hazards Assessment (EPHA) and Emergency Action Levels (EAL) did not adequately address releases of tank waste below the EAL criteria (i.e., lower consequence events). Additionally, assumptions used for EPHA analyses were not adequately documented, and the EALs did not identify whether the protective action distances were based on radiological or chemical hazards. The Board found that the abnormal operating procedure for responding to a high radiation area did not require precautions be taken for a release until the cause of the high radiation could be determined.

Corrective actions developed to address the three JONs identified by the Board in the Emergency Management/ Response program area focused on revising procedures, processes, and checklists for emergency response and providing additional training.

A process will be developed in accordance with DOE Order 151.1C, *Comprehensive Emergency Management System*, to ensure that both abnormal operating procedures and emergency response procedures adequately address high probability, low consequence events. In addition, the Emergency Management Program Assessment Plan will be revised to incorporate the hazard assessment requirements of DOE G 151.1-2, *Technical Planning Basics*.

The site-wide emergency response procedure will be revised to include steps for evaluating the need for continued protective actions, as well as the criteria for relaxing protective actions (if warranted) and for ensuring those who contact the incident command post receive appropriate information. Procedures related to notification and response will also be reviewed to ensure adequate response to abnormal events and that medical personnel report to the event coordination team upon activation. Contractors will also be instructed to review procedures for directing 911 calls to ensure that calls are made at appropriate times and that proper resources are requested.

Emergency response training will be revised, and all emergency response personnel impacted by procedure changes will be trained. General employee training will also be revised to enhance personnel knowledge on what actions to take during take-cover conditions. In addition, the event coordination team, emergency operations control personnel, and Hanford Patrol personnel will receive written direction regarding instructing employees in actions to take during a take-cover event.

Industrial Hygiene/Medical

The Board evaluated (1) industrial hygiene practices associated with monitoring chemical vapors from the tank and industrial hygiene response to the spill; (2) the chemical and toxicological exposure hazards and pathways associated with the spill; (3) medical symptoms and potential acute and chronic health effects of the workers in the vicinity of the spill; and (4) the adequacy of the medical response to this accident and identified three JONs. Many of the corrective actions for this program area involve developing additional worker training materials, providing training, and identifying methods to enhance communication between site personnel and the external groups (e.g., AdvanceMed Hanford) involved in emergency medical response. Revisions will also be made to procedures, processes, and checklists to ensure a more effective response to abnormal events.

Workers, shift managers, and supervisors will be trained on roles and responsibilities in response to abnormal events and abnormal operating procedures. In addition, industrial hygienists and industrial safety professionals; field work supervisors, work planners, and operations managers; and procedure writers will receive training on the use of job hazard analysis processes, including worksite hazard analysis. Industrial hygienists and technicians will be trained on responding to abnormal events in accordance with abnormal operating procedures, and paramedic and emergency medical technicians will also receive refresher training (e.g., appropriate emergency medical response to hazardous material; hazardous material awareness and operations).

A number of processes, procedures, and guidelines will be revised or developed to address issues identified by the Board. A site-wide process will be developed to contact those who may be exposed to chemical or radiological hazards at a distance from an event and provide medical evaluation and follow-up as needed, and an event exposure tracking database will be designed and implemented. The case management process will specifically ensure that follow-on tests and consultation are scheduled for workers who were potentially affected by this event. In addition, a new procedure will be developed to ensure that the occupational medical service provider is informed when workers are exposed or potentially exposed to chemical or radiological materials and to stress the necessity for adequately completing the patient care report.

Among the guidelines that will be reviewed and updated are those that clarify the need for workers to report to the occupational medical service provider if they are involved in events with potential exposures, as well as notifying the contractor on-call physician for chemical and radiological material exposures, ensuring consistency in the notification process, and documenting necessary changes for medical monitoring. The procedure for on-call medical response in emergencies will also be updated to ensure that the Hanford Fire Department/AdvanceMed Hanford notification process for potential chemical exposures is effective.

Work Control

The Board identified four JONs in three areas of the Work Control program area (operations, maintenance, and radiation protection activities). Corrective actions in this program area included installing enhanced systems to identify small-quantity waste leaks and developing a lighting standard that implements OSHA lighting standards and requirements. An enhanced work planning process that includes representatives from operations, industrial hygiene, radiological control, and emergency preparedness will be used to combine abnormal operating procedures with similar activities and all abnormal operating procedures will be reviewed. Revisions to these procedures will focus on effective flow between alarm response procedures, abnormal operating procedures, and emergency response procedures. A process for implementing safe abnormal operating procedures that minimize planning time for event response and stabilization will also be implemented, and all abnormal operating procedures' changes will be reviewed using a "tabletop drill" format.

Mission Impacts

Cleanup Costs — Over $8 Million
Schedule Delays — Approximately 8 Months

Conduct of operations briefings will be conducted with all field personnel, and training that incorporates conduct of operations lessons learned and operating experiences will be developed and delivered. In addition, field work supervisors will be briefed on discrepancies associated with hazard analysis requirements not met by the maintenance procedure, *Tank Farm Contractor Work Control.*

Approval authorities for active transfer procedures will be established for both industrial hygiene and radiological control, and the procedure for radiological monitoring during waste transfer and waste pump maintenance will be revised to clarify monitoring requirements associated with implementing TSR leak detection requirements. The procedure will include guidance for developing comprehensive monitoring requirements for leak detection and radiological control that flow down into waste transfer monitoring work documents. The work control procedure for performing minor maintenance work will also be revised to clarify when this process can be used.

Management Systems

The Board determined that deficient management controls and oversight contributed to this accident because management failed to apply lessons learned from previous contamination and vapor exposure incidents and contractor oversight and design reviews were inadequate to identify deficiencies in the pump system design. The Board identified two JONs in this program area. Many of the corrective actions for this program area involve conducting independent assessments, evaluating contractor corrective actions, and strengthening contractor oversight.

The contractor will conduct an independent review to determine the effectiveness of causal analyses and corrective actions for all significant events since 2003 and will develop an assessment plan to periodically evaluate the lessons learned program. An independent review of significant events over the past 5 years will also be evaluated to ensure that the reviews were properly scoped and in-depth, captured identified issues, and resulted in adequate corrective actions. An assessment plan will also be developed that defines a strategy for improving oversight of waste retrievals and transfers.

DOE will conduct an independent evaluation of Office of River Protection oversight programs, focusing on tank farm project oversight, and Office of River Protection facility representatives for the tank farm will be required to obtain experience at other DOE facilities to improve their oversight skills. In addition, unannounced, mid-shift and back-shift oversight will be increased to strengthen operations oversight. A minimum of two internal assessments will be performed each year to strengthen the internal oversight assessment program.

DOE will also review the contractor's process hazard analyses and design features for retrieval systems to ensure that all safety requirements, including nuclear safety, are met. An assessment will also be conducted to evaluate contractor actions to improve emergency preparedness and abnormal event response for retrieval activities with a focus on the effectiveness of interfaces between the contractor and other Hanford contractors that have emergency preparedness/response roles.

An additional element of the corrective actions in all of the program areas is the distribution of lessons learned to provide insight into actions that can reduce the potential for a similar accident.

The impact of costs to both the Department and the contractor is another outcome to be considered in this event. The monetary costs and the impact on schedules are shown in the text box. At sites where there is the potential for a similar incident, a review of programs, processes, and procedures and implementation of applicable corrective actions may deter a similar event. A review of site facilities based on this event has already been conducted at the Savannah River Site. An article on Savannah River's proactive approach will be the topic of an article in an upcoming OE Summary.

KEYWORDS: Corrective actions, Type A accident investigation, engineering design, industrial hygiene, emergency response, medical response, work control, oversight

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

The Office of Health, Safety and Security (HSS), Office of Analysis publishes the Operating Experience Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging the exchange of lessons-learned information among DOE facilities.

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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