PART I

Guidance for Applying Process Safety Management Techniques and Technology Safety Data Sheets to the Development of New Cleanup Technologies

Introduction

The Occupational Safety and Health Administration's (OSHA) Standard, "Process Safety Management (PSM) of Highly Hazardous Chemicals," as promulgated in 29 CFR 1910.119, was established to prevent or minimize consequences from the catastrophic releases of toxic, reactive, flammable, or explosive chemicals that may result in fire or explosion hazards. Although the requirements of PSM apply only to specific processes, the principles and guidance in the Standard can be used as aids in addressing safety and health hazards and prevention actions for cleanup technologies. The goals of the PSM Standard are to build safety into the process up-front, and then keep the process operating safely for its entire life cycle.

The Process Safety Management Standard also introduces the concept of a Technology Safety Data Sheet (TSDS) as a tool to assist in managing safety throughout the technology development and implementation process. As discussed in the following pages, the TSDS can be used as a vehicle for collecting most of the safety, health, and emergency response information associated with a new technology. It is anticipated that the TSDS would first be prepared during the technology development process and that it would continue to be updated as the technology evolves throughout the commercialization and implementation phases of technology implementation. An example of a TSDS and a short case study are included here to illustrate how the data could be used in a practical situation. Finally, the TSDS is used to develop a list of standard operating procedures (SOPs) that can be used during construction, operation, maintenance, and decommissioning of a technology.

Getting Started

PSM requires compilation of process safety information that must be completed before any form of process hazard analysis (PrHA) is conducted. Appendix C-2 discusses the various PrHA techniques that can be used. Process safety information is used to conduct the PrHA, to support hazard communication requirements, and to document process design and configuration. Process safety information assists the employer and the employees in understanding processes and their hazards.

Knowledge and awareness begin the flow of information between management and employees. Employees are often the best suited to recognize potential or existing hazards; thus, their participation early in the assessment activity can be important. The following three tasks involve the collection of process safety information.

Task 1: Collect Hazard Information

The following chemical and physical hazard information should be collected:

1. Toxicity information (LD50/LC50 values, Immediately Dangerous to Life and Health [IDLH] values, Emergency Response Planning Guideline [ERPG] concentrations);
2. Permissible exposure limits (PELs) and Threshold Limit Values (TLVs);
3. Physical data (boiling point, freezing point, density, vapor pressure, vapor density, solubility, evaporation rate, appearance, and odor);
4. Reactivity data (polymerization and decomposition by-products);
5. Corrosivity data;
6. Thermal and chemical stability data (upper and lower flammable ranges);
7. Hazardous effects of inadvertently mixing different materials outside of normal operations;
8. Characteristics of any special physical or electrical hazards;
9. Noise levels;
10. Adequacy of machine guarding;
11. Temperature extremes;
12. Information on material handling;
13. Status of walking and working surfaces;
14. Status of pressure vessels;
15. Biohazards; and
16. Other information related to worker health and safety

Note: Material safety data sheets (MSDSs) meeting the requirements of 29 CFR 1910.1200(g) may be used as a source of data. This information should be summarized and may be used to help prepare a TSDS.

Task 2: Compile Technology Process Information

The following information pertaining to process technology should be developed:

1. A block flow diagram or simplified process flow diagram (Appendix B of 29 CFR 1910.119);
2. Process chemistry (e.g., flow rates, chemical equations, chemistry of intermediates, utility systems, and exothermic and endothermic reactions);
3. Maximum intended inventory for all tanks, reactors, and vessels;
4. Safe upper and lower limits for such factors as temperatures, pressures, flows, levels, phases, or compositions; and
5. An evaluation of the consequences of deviations, including those affecting the safety and health of employees.

Note: Where the original technical information no longer exists, such information may be developed in conjunction with the PrHA in sufficient detail to support the analysis.

Task 3: Collect Process Equipment Information

The following minimum information pertaining to the equipment in the process should be collected:

1. Materials of construction and the basis for selection, such as material compatibility or corrosion resistance;
2. Piping and instrumentation diagrams (P&IDs), which generally contain more detailed information than process flow diagrams;
3. Electrical classifications based on flammable materials located near the process;
4. Relief system design and design basis;
5. Ventilation system design, including airflow, and psychometric and sizing calculations;
6. Design codes and standards employed;

7. Material and energy balances for processes; the balances must properly show the mass flows and heat transfers sum; and
8. Safety systems (e.g., interlocks, depressurization, detection of suppression systems, containment and disposal, toxic and flammable material detection systems).

Note: Documentation that equipment complies with recognized and generally accepted good engineering practices should be maintained. For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, it should be determined and documented that the equipment is designed, maintained, inspected, tested, and operated safely.

After tasks 1 through 3 are completed, the PrHA phase can begin. The complexities of the process will determine how detailed the PrHA should be. At a minimum, the PrHA is expected to identify, evaluate, and control identified hazards. It is imperative to involve representatives of various disciplines in the process. All levels of employees should participate in the conduct and development of PrHAs and in the development of the other elements of PSM. Who better to help identify hazards than those involved in the various phases of assembly, dismantlement, operation, and maintenance of new technologies?

Process Hazard Analysis

The cornerstone of PSM rests on results obtained from performing a PrHA. Depending on the complexities of the process, an appropriate PrHA technique will be selected. The following techniques should be considered:

- What-if;
- Checklist;
- What-if/checklist;
- Hazards and Operability study;
- Failure Mode and Effects Analysis (FMEA);
- Fault Tree Analysis (FTA); and
- Other equivalent techniques.

PrHA techniques are used to identify the causes and consequences of potential accidents related to equipment, instrumentation, utilities, human performance, and external factors. PrHA allows hazards and excessive risks to be identified so they can be controlled or eliminated. The techniques can identify accident scenarios leading to worker injuries or fatalities, property damage, public exposure, environmental impacts, or adverse consequences.

PrHA techniques usually are implemented by a team of two to five individuals. The team should comprise a safety engineer, a process engineer, a maintenance supervisor, an operations supervisor, a facilities engineer, or other disciplines, as needed. At least one person familiar with the process should be involved in the analysis. The three-phase process includes the following activities:

Data Collection

- Work in multidisciplinary teams.
- Involve all levels of employees in the process.

Conduct the PrHA

- Identify process hazards.
- Prepare a process flow chart to include visual and verbal descriptions of each step.
- Evaluate hazardous substances used or generated in the process (e.g., raw materials, wastes).
- Evaluate equipment.
- Evaluate worker exposures.
- Evaluate unplanned events (fault tree analysis and FMEA).
- Review accident history to identify process hazards (accident and incident reports are required to be retained for at least 5 years).
- Look at accident precursors (Have emergency situations been considered? Have the local fire and rescue emergency responders been informed of the technology?)
- Consider lessons learned information.
- Evaluate trends.
- Consider the impacts of human factors (i.e., to what degree process safety depends on human performance). For example:
  - Can workers be reasonably expected to perform their assigned tasks?
  - Do the procedures and training appear adequate to guide the employees to do their tasks?
  - What are the human error causes of accidents?
  - Are safety instruments, alarms, and equipment provided in critical locations?
  - How close are covered processes to workers or high-traffic areas?
- Identify engineering and administrative control measures and their interrelationships.

- Determine the consequence(s) of failure of those control measures.
- Determine the qualitative range of safety and health effects on employees at the worksite.
- Consider the involvement of subtier contractor employees with oversight and coordination as factors for creating hazards.

Develop Recommendations and Resolutions

- Track issues raised by PrHA techniques to completion.
- Communicated and disseminate appropriately any necessary changes to processes or procedures.

Documentation of the PrHA is imperative. Revalidation should be dependent on the number(s) of modifications made and the operating cycle.

Operating Procedures

Written operating procedures are important for establishing a consistent approach for handling the various phases of a remediation technology. These procedures should provide clear instructions for safely conducting activities consistent with the process safety information. They should be easily accessible to all employees who work in or maintain a process or remediation technology. A review process should be implemented at regular intervals to ensure that procedures reflect current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and from changes to facilities. The following elements may be applicable to procedures for cleanup technologies.

Steps for Startup and Operation

A. Delivery
B. Unloading and assembly
C. Initial startup
D. Normal operations
E. Temporary operations
F. Emergency shutdown, including the conditions under which it is required, and the assignment of shutdown responsibility to qualified operators to ensure that emergency shutdown is carried out safely and in a timely manner
G. Emergency operations
H. Maintenance
I. Normal shutdown

J. Startup following a turnaround, or after an emergency shutdown.

Operating Limits

A. Consequences of deviation
B. Steps required to correct or avoid deviation.

Safety and Health Considerations

A. Properties of, and hazards presented by, the chemicals used in the process
B. Precautions necessary to prevent exposure, including engineering controls, administrative controls, and personal protective equipment (PPE) (i.e., lockout/tagout procedures, confined-space entry program). A Job Safety Analysis (JSA) procedure could be used to facilitate and document this activity.
C. Control measures to be taken if physical contact or airborne exposure occurs
D. Quality control for raw materials and control of inventory levels of hazardous chemicals
E. Any special or unique hazards.

Worker Responsibilities

A. During normal operation
B. During emergency response
C. During oversight of contractor employees
D. During maintenance activities (scheduled and unscheduled).

Process Change Management

A. Field process modifications
B. Operating parameter changes outside established limits
C. Waste feed composition changes outside established limits
D. Revisions to worker protection programs and SOPs
E. Additional worker training.

Training

After operating procedures are developed, employees involved in their implementation must be trained. Each responsible person should receive appropriate training before initial assignment and after any change in or revision of the procedure.

The training should include an overview of the process, operating procedures, safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks, including technology maintenance/ repair tasks. The frequency of training should take into consideration changes in the technology. A written record should be required to document the date of training and to verify that the employee understood the training (e.g., testing).

It is important to recognize that worker training associated with set-up, operation, and maintenance of new technologies should occur at the site and be included in the site-specific training activity. The use of JSAs to identify hazards and the methods to manage them in combination with technology-specific SOPs provide benchmarks upon which appropriate learning objectives and technology-specific training modules can be developed. Where possible, such technology-specific training modules should be developed by the technology developer with careful review and revision specific to site application by the site contractor/user.

Inspections

Inspections and testing must be performed on the process and associated equipment. The frequency of these inspections and testings should be consistent with applicable manufacturers' recommendations and good engineering practices (more frequently if determined to be necessary by prior operating experience). Documentation of the inspections and tests must be maintained.

CASE STUDY

Idaho National Engineering Laboratory (INEL) Test Area North (TAN) has a groundwater contaminant problem that is being addressed through a pump and treatment technology. This factually based situation did not have a PrHA or TSDS developed. The SOPs and TSDS following this discussion are based on information available on the technology.

Background

Contamination was found in the drinking water of the community adjacent to the INEL TAN. The contamination was found to be caused by the Technical Support Facility's (TSF-05) Injection Well, which was installed in 1953 to dispose of process and sanitary waste from TAN operations. From 1955 until 1972, concentrated evaporator sludge from the processing of low-level radioactive and process wastes was pumped into the well. The well was drilled to a depth of 305 feet, which allowed waste to seep into the Snake River Plain Aquifer.

Contaminants in the groundwater were identified as TCE, perchloroethylene, dichloroethylene, lead, strontium-90, americium, uranium, and cesium-137. The

TCE was found to have traveled up to 1.5 miles with the groundwater flow. The local drinking water was contaminated above allowable levels and can not be consumed.

Remediation

The goal of this project is to collect sludge and groundwater from the TSF-05 Injection Well in order to remove cesium-137, strontium-90, and other radionuclides, as well as the identified hazardous chemicals. The process moves mixed waste through equipment and piping. This will be accomplished with a combination of filtration, air stripping, carbon absorption, ion exchange and disposal of treated water back into the aquifer. Containment and automatic controls are in place to prevent spills to the environment.

The technology was developed and delivered to INEL. After installation was complete, the system was energized and immediately experienced a major problem due to a pump failure. The pump and treatment technology was designed for a continuous pump flow rate of 30 gpm. Instead, the process began to pump at 130 gpm. This fourfold increase in flow caused the standing water in the well to be quickly withdrawn and a shock/stress put on the area surrounding the well pipe — a stress that pulled concentrations of contaminant that were greater than expected and greater than design limits, along with grease and oils. This concentrated mess clogged the filters and set off the automatic alarm, which shut down the system.

Once the system was repaired and the problems identified, the process could no longer be operated in a continuous mode. The facility was actually operated in a batch mode as necessitated by the concentrations of cesium-137 and volatile organic compounds (VOCs). The batch mode of operations created several specific problems. The influent tank is 20,000 gallons, while the effluent verification tank is 3,000 gallons. After 3,000 gallons had been processed, it could be released if the concentrations of the analytes were below acceptable levels. If not, then it would be circulated back to the influent tank. Because the sample plan called for time interval sampling, another sample would be drawn at the appropriate time regardless of the number of times the effluent had been recirculated. In this manner, partially processed batches (partially recirculated batches) would be sampled at different times from the same sample point, but would yield, as expected, different results.

Lessons Learned

The lack of a PrHA for this project contributed to the almost immediate failure of the technology. Many of the consequences described below could have been avoided if a PrHA had been completed. As a result of the stress/shock placed on the well, the following conditions were observed:

- The grease and oil clogged the resin beds and air strippers. This resulted in increased maintenance of the process, which resulted in increased exposure of the workers to radiation and VOCs.
- The influent had significantly higher suspended particulates than the process was designed to handle. Pre- and post-tank filters had to be retrofitted to the influent 20,000-gallon tank, as well as a larger pump. The particulates were so heavy that, at times, the filters had to be changed every 15 minutes. This resulted in engineering redesign, increased health risks to the workers, and increased waste generation.
- VOCs were found to be 10,000 times greater than the design levels for the process. This resulted in the carbon beds becoming filled sooner than anticipated. This in turn resulted in increased maintenance to change the beds and in increased amounts of waste generated. VOC concentrations needed to be evaluated with regard to flammability limits. Also, classifications of electrical systems had to be reviewed.

STANDARD OPERATING PROCEDURES

The following is a list of generalized SOPs addressing each of the technology phases described in TSDSs. This list is not all-encompassing or task-specific; it is presented as a typical representation of the areas that would need to be addressed with this technology. The SOPs will change depending on the technology and the phase.

Additional technology-specific information will be required to develop a list of SOPs that is directly applicable to workers who will be operating and maintaining the technology. Although clear and understandable SOPs are needed by workers, the PSM techniques and tools described previously may be too complex and cumbersome for workers on a jobsite to use.

One possibility is to use the job safety analysis (JSA) approach (or a focused portion of this approach) as a basis for developing SOPs for operation and maintenance of a technology. The JSA is already the most basic and widely used tool for identifying job hazards. A properly designed tool that uses JSA techniques might provide enough detail to allow technology-specific SOPs to be developed while not overwhelming users with excessive detail.

Construction Phase

1. To ensure the safety of construction-site workers and the public, the worksite shall be kept clean and orderly.
2. The minimum PPE for any worker or visitor to the construction site shall be safety-approved eye, head, and foot protection, generally referred to as safety

glasses, hard hat, and safety shoes or boots. Other safety protective devices or equipment may be required for specific jobs or operations and shall be worn or used as prescribed in the site-specific Health and Safety Plan (HASP).

3. Worksite lighting shall be sufficient and meet the minimum lighting requirements specified in 29 CFR 1926.56(a). Emergency lighting shall be provided in accordance with the National Fire Protection Association (NFPA) 101. If work areas contain a flammable atmosphere, only approved devices and lighting shall be used in accordance with 29 CFR 1926.407 and NFPA 70.
4. Backup alarms that are in working order shall be required on all heavy equipment. All personnel shall remain out of the immediate work zone.
5. Gas cylinders and gas system manifolds shall be used and stored in accordance with 29 CFR 1926.350. Welding and cutting shall comply with the applicable regulations in 29 CFR 1926.350-.354.
6. Temperature extremes will require monitoring of the environment as well as the employees. Excessive hot and cold temperatures combined with prevailing winds and/or humidity should be considered when work schedules are designed. Physiological monitoring of the employees shall be in accordance with National Institute for Occupational Safety and Health (NIOSH) Publication No. 85-115, “Standard Operating Safety Guides.”
7. Medical attention and first aid shall be available to the workers. Before the start of the project, provisions should be made for prompt medical attention in the event of serious injury.
8. The Hazard Communication Program shall be made available to all workers and be established and implemented in accordance with 29 CFR 1926.59. MSDSs for chemicals used or anticipated to be encountered in the process technology must be provided.
9. Scaffolding shall not be erected, moved, dismantled, or altered except under the supervision of a competent person and in accordance with 29 CFR 1926.452.
10. Users of electricity, including general site workers, tradespeople, and electrical workers, shall be governed by the installation requirements, interpretations, and definitions in 29 CFR 1926.400-.499 and the National Electric Code (NFPA 70); other national, State, and local codes; and manufacturers’ instructions attached to equipment. All appropriate requirements shall be followed. Before work begins, it shall be determined by inquiry, direct observation, or instrumentation if the electric power circuit, exposed or concealed, is located in a manner such that work may bring the employee into contact with the circuit. Deenergizing, lockout/tagout, signs, guarding and/or other grounding methods shall be in place and verified before any work begins.
11. Heavy equipment that is capable of hitting overhead electric lines must not work within 10 feet of energized lines (or the distance computed based on 29 CFR 1926.550). If work requires that equipment be closer than the prescribed distance, the power line must be deenergized and visibly grounded or insulating barriers installed.

12. Material-handling injuries should be prevented through the use of proper lifting techniques, proper housekeeping, PPE, and mechanical aids.
13. Protruding objects must be adequately guarded/covered and flagged to ensure against inadvertent contact.
14. Ladders must be selected, maintained, and inspected in accordance with 20 CFR 1926.1051, .1053, and .1060.
15. Fire-suppression activities and equipment shall be in accordance with 29 CFR 1926.150 and NFPA 241, "Standards for Safeguarding Construction, Alteration, or Demolition." An appropriately sized hand-held extinguisher shall be available.
16. All components of the technology that represent a confined space according to 29 CFR 1910.146 must be identified and appropriately marked.

Operation Phase

1. Fire-protection equipment shall be provided, inspected, maintained, and conspicuously located, or a trained firefighting organization shall be provided.
2. Ionizing radiation shall be addressed through 10 CFR Part 20, 29 CFR 1910.96, and 29 CFR 1926.53. All employees who could be exposed to the radioactive waste derived from the groundwater shall be instructed in necessary safeguards. This should include all laboratory, maintenance, janitorial, and emergency response personnel.
3. A Hazard Communication Program shall be made available to all workers and shall be established and implemented in accordance with 29 CFR 1926.59. MSDSs for the chemicals used in the process technology and for those in the groundwater must be provided.
4. Hazardous concentrations of contaminants in the air shall be determined as specified in the "Threshold Limit Values of Toxic Chemicals of the American Conference of Governmental Industrial Hygienists" and in 29 CFR 1910.1000.
5. Oil spill and containment plans must be understood and available to operating employees.
6. Drills designed to practice a spill containment and/or cleanup should be held periodically.
7. Spills must be contained with absorbent material and by sealing floor drains.
8. Emergency Response and Emergency Action plans from the HASP should be posted and available to all site personnel. Offsite emergency response teams should be briefed on the plans and should participate in any drills or mock disaster preparedness.
9. Sampling of the groundwater and all other resultants from this process must be in accordance with 29 CFR 1910.1450.
10. If the technology has confined spaces as an element, a confined-space entry program that complies with 29 CFR 1910.1 and .6 must be developed and

referenced for operations, emergency, decommissioning, and maintenance activities.

Maintenance

1. Lockout/tagout procedures shall be established, implemented, and enforced during all maintenance procedures. Workers shall be protected from unplanned releases of energy or hazardous materials. Lockout/tagout procedures shall conform to 29 CFR 1910.147.
2. Oil spill and containment plans must be understood and available to maintenance employees. Drills designed to practice a spill containment and/or cleanup should be held periodically.
3. In case of a spill, all operations must be suspended and the spill stopped if possible. However, stopping the spill should not incur excessive personnel hazard.
4. Hazardous concentrations of contaminants in the air shall be determined as specified in the “Threshold Limit Values of Toxic Chemicals of the American Conference of Governmental Industrial Hygienists,” in 29 CFR 1910.1000, and in applicable OSHA health standards.
5. Users of electricity, including general site workers, tradespeople, and electrical and/or maintenance workers, shall be governed by 29 CFR 1926.400-.499 and the National Electric Code (NFPA 70); other national, State, and local codes; and manufacturers’ instructions attached to equipment. All appropriate requirements shall be followed. Before work begins, it shall be determined by inquiry, direct observation, or instrumentation if the electric power circuit, exposed or concealed, is located in a manner such that work may bring the employee in to contact with the circuit. Deenergizing, lockout/tagout, signs, guarding and/or other grounding methods shall be in place and verified before any work begins.
6. Protruding objects must be adequately guarded/covered and flagged to ensure against inadvertent contact.
7. Scaffolding shall not be erected, moved, dismantled, or altered except under the supervision of a competent person and in accordance with 29 CFR 1926.452.

Decommissioning

1. Before workers start operations, a competent person shall make an engineering survey of the structure/machinery to be demolished/disassembled to determine the condition of the structures and/or machinery. All work shall be in accordance with 29 CFR 1926.850.

2. Fire-suppression activities and equipment shall be in accordance with NFPA 241, “Standards for Safeguarding Construction, Alteration, or Demolition” and 29 CFR 1926.150. An appropriately sized hand-held extinguisher shall be available.
3. All power sources (gas, electrical, sewer, and others) shall be shut off, capped, or controlled outside the building line before work begins, in accordance with applicable lockout/tagout requirements. Utility companies should be notified in advance of any work activities.
4. Ladders must be provided, maintained, and inspected in accordance with 20 CFR 1926.851.
5. Decontamination requirements and procedures must be in accordance with the site-specific decontamination plans of the HASP.
6. Decommissioning plans and activities should be in accordance with the Department of Energy Office of Environmental Management “Decommissioning Resource Manual.”
7. Users of electricity, including general site workers, tradespeople, and electrical and/or maintenance workers, shall be governed by 29 CFR 1926.400-.499 and the National Electric Code (NFPA 70); other national, State, and local codes; and manufacturers’ instructions attached to equipment. All appropriate requirements shall be followed. Before work begins, it shall be determined by inquiry, direct observation, or instrumentation if the electric power circuit, exposed or concealed, is located in a manner such that work may bring the employee into contact with the circuit. Deenergizing, lockout/tagout, signs, guarding and/or other grounding methods shall be in place and verified before any work begins.

EXAMPLE

TECHNOLOGY SAFETY DATA SHEET:
Groundwater Pump and Treatment Technology

Section 1. Technology Identity

Manufacturer's Name	**Emergency Contact:** **(800)-000-1234**
Address	**Information Contact:** **(410)-123-0000**
	Date Prepared: **3 November 1995**
Other Names	**Signature of Preparer**

Section 2. Process Description

The pumping and subsequent treatment of groundwater is an important technology that uses a series of filtering and chemical addition steps to render groundwater contaminants innocuous or to remove them from the source. In this application of the technology, groundwater containing trichloroethylene (TCE), perchloroethylene, dichloroethylene, lead, strontium-90, americium, uranium, and cesium-137 is processed. The primary processes involved in the pump and treatment groundwater technology are air stripping, vapor phase carbon adsorption, filtration, and ion exchange.

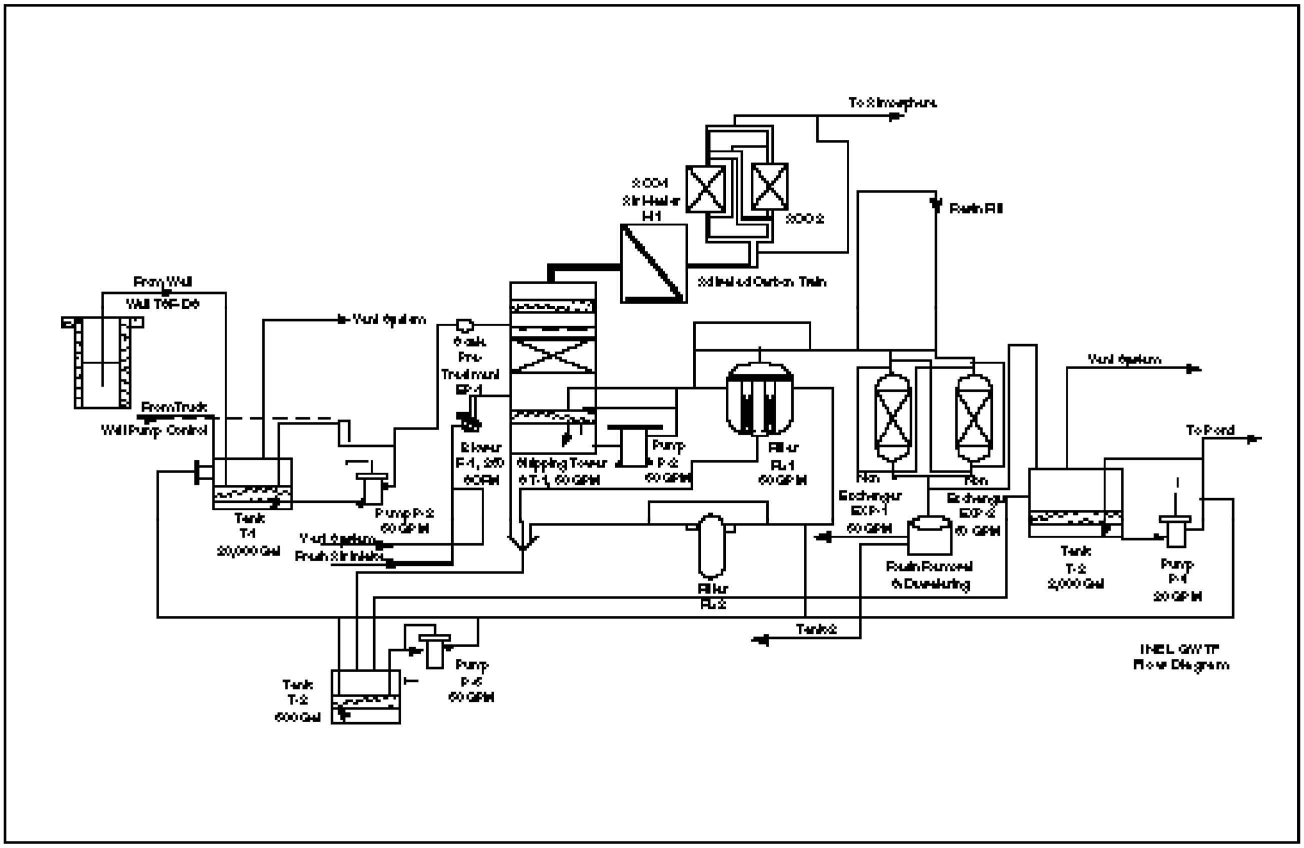
Contaminated groundwater is pumped from a well into a 20,000-gallon surge tank. The water is first treated with a scale inhibitor to reduce fouling of the air stripper. The scale inhibitor process also uses ozone to control bacterial growth. The water travels to the air stripper where the organic components are separated. The organic vapors, tritium, and noncondensable portion are piped to the two activated carbon beds operated in series. The activated carbon traps the organic vapors. As the carbon beds demonstrate breakthrough, they are replaced. The 55-gallon activated carbon beds, once saturated and removed from service, are labeled as hazardous waste.

The liquid phase of the waste stream travels to the multimedia filters, where the solid contaminants are removed. When the pressure differential across the filter increases by 10 PSI above normal, backwashing is required. The solid contaminants removed from the multimedia filters through backwashing are dewatered and sampled to determine if they are hazardous or radioactive waste.

The ion-exchange system consists of two ion-exchange vessels arranged in parallel. Each ion-exchange vessel contains a strong acid resin for removing the radioactive contaminants and lead. A secondary waste treatment system for resin removal and dewatering is in place to reduce the amount of waste that might otherwise be generated.

Treated groundwater is held in a 3,000-gallon verification tank for sampling. At the conclusion of the treatment process, treated water is discharged to an evaporation pond where the water percolates into the ground.

Section 3. Process Diagram



Section 4. Contaminants and Media

The contaminants in the groundwater have been identified as TCE, perchloroethylene, dichloroethylene, lead, strontium-90, americium, uranium, and cesium-137. The media used in the collection systems, multimedia filters, charcoal beds, and acid resin, have the potential of becoming a hazardous, radioactive, or mixed waste during normal operation. The rate at which the media become contaminated or saturated to a point where maintenance is required will be dependent on the consistency of the contaminants in the groundwater. The process, when fully operational, will run continuously.

Section 5. Associated Safety Hazards

Hazard	Present	Comment
Electrical (lockout/tagout)	yes	The potential for electrical hazards exists during construction and all maintenance activities. Because water is involved, the potential for electric shock is heightened. For all electrical connections and maintenance activities, adhere to lockout/tagout procedure.

Section 5. Associated Safety Hazards (continued)

Hazard	Present	Comment
Fire and Explosion	no	During construction operations when compressed gases are required for welding, fire and explosion potential exists. During operation and specifically during maintenance activities, the carbon beds will be saturated with volatile organic compounds and the potential for fire and explosion hazards exists. Smoking is not permitted within the parameters of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site; signs are posted.
Confined-Space Entry	no	For this operation, the only confined spaces are the tanks. No work is expected inside the tanks, therefore no confined-space entry program is necessary. However, all entry points into confined spaces must be properly labeled in accordance with 29 CFR 1910.146.
Mechanical Hazards	yes	There are operating pumps and fan equipment that require guarding to comply with 29 CFR 1910.212.
Pressure Hazards	yes	Several tanks and process systems will be under pressure. Several operating and maintenance procedures will require access to these points. Tanks under pressure require special precautions and periodic inspection and testing.
Tripping and Falling	yes	Construction activities will cause the greatest tripping and falling hazards. There are several tight areas and pipes at low levels that have been labeled as hazards. There are several areas also marked with warning labels that are under 7 feet and can be bumped by a person's head. Work above 6 feet will require the use of a full-body harness and lanyard. All lanyard attachment points must be capable of supporting at least 5,000 pounds/employee.
Ladders and Platforms	yes	During the construction phase, there will be work on ladders and elevated platforms. All work above 6 feet requires the use of full-body harnesses attached to a 4-foot lanyard. Once construction activities are completed, the only ladder or elevated-platform work will be during maintenance activities and that is limited to replacing light bulbs.
Moving Vehicles	yes	The technology is surrounded by a fence and is under a waterproof sprung structure. Once delivery, unloading, and construction are completed, there will be no hazards from moving vehicles. All moving vehicles should remain outside the fenced-in area. Those vehicles required for delivery, unloading, and construction will be equipped with back-up alarms and an observer to warn persons of movement.

Section 5. Associated Safety Hazards (continued)

Hazard	Present	Comment
Buried Utilities, Drums, and Tanks	no	These hazards do not exist with this application of the technology. No digging or drilling will be required. The contaminated well already exists and electricity is the only utility being provided; it will be brought in from a pole.
Protruding Objects	yes	All bolts, brackets, hangers, and framing under 7 feet shall be properly capped and/or labeled.
Gas Cylinders	yes	During construction, welding is necessary. It is important that all compressed gases are used and stored in a manner that complies with 29 CFR 1910.101. During operation, an onsite laboratory will be functioning and compressed gases will be used for the analytical instruments. It is important that they be used and stored in accordance with 29 CFR 1910.101.
Trenching and Excavations	potential	All trenching must satisfy the requirements of OSHA 29 CFR 1926.650-652 before employees can enter. All excavations deeper than 5 feet must be sloped or have shoring installed. Excavations deeper than 4 feet must have ladders every 25 feet. Persons not entering trenching must remain 2 feet from edge at all times. Be alert for unknown buried drums, tanks, or utilities.
Overhead Lifts	yes	Hazards during construction and decommissioning. All high-consequence lifts will require a procedure approved by the project superintendent. Overhead lifts will be required during construction activities when placing equipment into place. A competent person is necessary to oversee the crane and load rigging. Overhead lifts will occur during maintenance activities when the carbon beds and ion-exchange vessels become saturated and require replacement. No employees are permitted under a load that is being or has been lifted.
Overhead Hazards	potential	Entry into the fenced-in CERCLA site requires, at a minimum, level D protection, even though there are fewer overhead hazards after the construction phase is completed. There are low-lying pipes and bolts that pose both eye and head hazards. Hardhats are required during the construction phase.

Section 6. Associated Health Hazards (continued)

Hazard	Present	Comment
Inhalation Hazard	potential	Because the entire operation is a closed system, a direct inhalation hazard is unlikely. The several instances where indirect inhalation hazards exist include: when a leak in the system develops, while water samples are being collected, when a pressure release valve blows, and during maintenance activities. There are controls in place for exhaust fans in the process areas and in the sprung structure to operate if exposures exceed the alert levels established in the site-specific health and safety plan. Prior to entering the interim waste storage facility, make sure the engineering controls have been activated. When an unexpected inhalation occurs, immediately notify the project superintendent. Call the emergency response staff when necessary.
Skin Absorption	potential	Because the entire operation is a closed system, a skin absorption hazard is unlikely. However, there are several instances where skin absorption hazards may exist, including: when a leak in the system develops and it must be controlled and cleaned, while water samples are collected, and during maintenance activities. The SOPs and maintenance procedures address the use of personal protective equipment (PPE) when performing these activities. When skin absorption occurs, immediately notify the project superintendent. Call the emergency response staff when necessary.
Heat Stress	potential	Only during the construction and assembly phase. Once these activities are complete, the two persons necessary to operate the technology will be performing sedentary to moderate activities for short periods. The sprung structure is equipped with an exhaust fan to control the temperatures during the summer months. Extended maintenance activities shall comply with the heat stress work/rest regimen identified in the site-specific health and safety plan.
Noise	potential	The operating equipment is housed in metal enclosed containers. The metal containers contain no noise absorption materials. Sound level meter measurements collected in accordance with a health and safety procedure found noise levels to be below the site-specific requirement of 85 dBA. Hearing protection is available for those persons requesting it, but is not required. During construction activities, hearing protection may be required for operators of powered tools and heavy equipment.

Section 6. Associated Health Hazards (continued)

Hazard	Present	Comment
Nonionizing Radiation	potential	The only known source of nonionizing radiation is welding operations. Once the construction and assembly activities have been completed, welding activities will stop. From then on, welding would not be necessary again unless modifications to the system occurred or part of the system failed and repairs were necessary.
Ionizing Radiation	yes	As the contaminated groundwater is treated and the collection media accumulate contaminants, ionizing radiation hazards become an issue. Based on the low-level radioactive materials in the groundwater, it is difficult to estimate potential radiation levels in the surge tank, ion-exchange vessels, air stripper, charcoal beds, or verification tank. It is important to routinely survey those areas expected to accumulate radioactive components. Post radiation levels where necessary. All maintenance activities will require protection from the radioactive components identified. The maintenance procedures identify what controls are necessary to work on the process equipment during normal "hot" operating conditions. Assume all spills or leaks contain radioactive materials.
Cold Stress	potential	Work during the winter months in cold climates must plan for potential cold stress hazards. The temperature extremes procedure provides essential working condition information, including work/rest regimens and recommended warm clothing for specific outside temperatures. Use the outdoor thermometer and wind sock to estimate wind chill factors. Use the buddy system if work requires prolonged exposures to temperatures exceeding those specified in the procedure.
Ergonomic Hazards	potential	Acute musculoskeletal injuries may occur during assembly, maintenance, and disassembly activities. Appropriate staffing and materials handling aids may mitigate potential hazards.
Other	yes	This technology application has built into the process a full-scale quality control laboratory. The hazards associated with quality control laboratory analysis inherent to both radiological and chemical analysis must be considered. Because the laboratory is solely for quality control, the requirements for a Chemical Hygiene Plan under 29 CFR 1910.1450 do not apply. However, all provisions under OSHA's Hazard Communication standard, 29 CFR 1910.1200, are necessary.

Section 7. Systems Safety Analysis (Process Hazard Analysis)

A Tier III analysis was not performed on this technology.

Section 8. Phase Analysis

The following hazards could potentially be encountered or are expected to be encountered during the various phases of the technology life cycle.

Construction/Startup
Electrical, fire and explosion, mechanical, pressure vessels, trips and falls, elevated work surfaces, vehicle and equipment traffic, overhead lifts, inhalation and skin chemical exposures, heat and cold stress, ionizing radiation, nonionizing radiation, noise, ergonomics.

Operation
Fire and explosion, mechanical, pressure vessels, trips and falls, ergonomics.

Maintenance
Electrical, mechanical, pressure vessels, trips and falls, elevated work surfaces, inhalation and skin chemical exposures, heat and cold stress, ionizing radiation, ergonomics.

Waste Handling
Waste-treatment by-products, incinerator ash contaminated with heavy metals.

Decommissioning
Electrical, mechanical, pressure vessels, trips and falls, elevated work surfaces, vehicle and equipment traffic, overhead lifts, inhalation and skin chemical exposures, heat and cold stress, ionizing radiation, nonionizing radiation, ergonomics.

Section 9. Health and Safety Plan Required Elements

In addition to complying with the Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard program requirements, 29 CFR 1910.120, the following site-specific issues must be addressed:

Air Monitoring
Because the technology is a closed system, the focus of an air monitoring program should be in the initial startup and during maintenance operations of the system. If, through initial air monitoring, the exposures to workers can be consistently demonstrated to be low, additional testing would be required only when the system was in maintenance phase, during emergency spills, or if operating conditions changed. Personnel exposure monitoring would be necessary on 6-month or annual frequency to comply with 29 CFR 1910.1000.

Worker Training
Pump and treatment technology, once out of the construction phase and into operation, does not require much labor. The technology is automated so that it can run without an operator and will do so on weekends. Consequently, the focus of training programs should be the operating procedures, hazards associated with construction, startup procedures, and how to recognize alarms indicating the system is not functioning properly. All procedures necessary for the various phases of the technology will have training sessions that include reading the procedure and walking it down in the presence of the project superintendent. All training will be properly documented. The site-specific hazard communication program and the site-specific health and safety plan will require training. It is very important to hold site-specific training dealing with natural disasters, notification and reporting requirements, fires, emergency decontamination, first aid, frisking, personnel and equipment decontamination, spill containment, and emergency phone numbers.

Section 9. Health and Safety Plan Required Elements (continued)

Emergency Response

Automatic shutdown procedures are built into this technology that are triggered by contaminant breakthrough from the collection media, effluent changes, pipe breaks, drastic change in the inflow parameters, or some other perturbation of operating parameters. The hazards of fire and explosion need to be considered and addressed in the emergency response plan. The Test Area North Site will ensure that emergency response personnel are at the site 24 hours a day, 7 days a week and monitor the project radio. The emergency phone number is 777.

Medical Surveillance

The medical surveillance program should be specific for the potential exposures to the contaminants identified in Section 4. Because low exposures are expected from this closed system, biological monitoring for these contaminants may not be warranted. An occupational medicine physician should be consulted when air monitoring results have been obtained for further decisions on biological monitoring. The occupational medicine physician performing the fitness-for-duty physicals must be made aware of the identified hazards on the project (see Sections 5 and 6) and the employees will need to be able to wear negative pressure respirators.

Informational Program

This standard program element should include distribution and availability of this TSDS as well as conveyance of any change in operating procedures.

Section 10. Emergency Conditions Information

Technology-specific information should be provided here to facilitate appropriate emergency response planning and actions in the event that an upset, failure, or other condition develops which can present hazards to operators, site workers, maintenance staff, the public, and emergency response personnel. Part II provides additional information to aid the developer in preparing this section of the TSDS.

Section 11. Comments and Special Considerations

No employees should be assigned to work on this groundwater pump and treatment technology until they understand all the hazards associated with it and know how to handle themselves in the event of an emergency.