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STANDARD OPERATING SAFETY GUIDES

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.0 INTRODUCTION

Protecting the health and safety of workers is a major consideration when hazardous substances are present at a site. Not only must site personnel perform a variety of technical tasks correctly and efficiently, but they also must work in an often unpredictable and potentially dangerous environment. By adequately equipping and training personnel, and by using appropriate standard operating procedures, the potential for harm from exposure to hazardous substances can be greatly reduced.

The purpose of this document is to provide guidance for ensuring the health and safety of site personnel who work with hazardous substances or who work at uncontrolled hazardous waste sites. This guidance is intended for federal, state, and local managers and personnel at sites where hazardous materials are present. It is meant to supplement professional training, experience, and knowledge, and can be used as:

- A planning and management tool for field managers;
- An educational tool that addresses fundamental aspects of the required health and safety programs and plans at hazardous waste sites;
- A reference document for site personnel who may need to review important aspects of on-site health and safety.

The U.S. Occupational Safety and Health Administration (OSHA) has established regulations governing the health and safety of employees engaged in hazardous waste operations and emergency response. These regulations, codified at 29 CFR §1910.120, contain general requirements for health and safety programs, site characterization and analysis, site control, training, medical surveillance, engineering controls and work practices, personal protective equipment, exposure monitoring, informational programs, material handling, decontamination, and emergency procedures. EPA has incorporated these standards by reference into its regulations at 40 CFR Part 311. Both sets of regulations are discussed in further detail in Section 1.1.

A number of documents have been developed to provide guidance for protecting the health and safety of workers exposed to hazardous substances. The purpose of this document is to update the U.S. EPA's July 1988 *Standard Operating Safety Guides* (SOSG) to incorporate the new requirements at 29 CFR §1910.120 and 40 CFR Part 311. This document also includes information presented in the *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (the "Four-Agency document"), which was written jointly by OSHA, EPA, the National Institute for Occupational Safety and Health (NIOSH), and the U.S. Coast Guard (USCG). The Guide also draws from other EPA documents, including the EPA *Health and Safety Manual*, the EPA *Health and Safety Audit Guidelines*, and the EPA's Standard Operating Procedures for hazardous waste site operations. Refer to **Appendix** A for a list of other useful sources of information.

This revised SOSG is intended to provide a comprehensive overview of the information needed by employers to meet their responsibility to assure the health and safety of employees engaged in operations at hazardous waste sites. Developing and implementing a worker protection program is a dynamic process that requires both initial and ongoing planning, periodic revision, and attention to a variety of site details. This guidance document provides a comprehensive overview of the structure of that process as a whole, as well as a more detailed discussion of each of the individual components. Thus, this document is intended to supplement the OSHA regulations at 29 CFR §1910.120, but is not meant for use as a legal document or as a replacement to those regulations. This document is structured as follows:

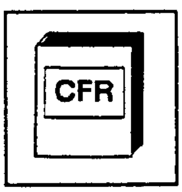
- **Chapter 1** provides an overview of the purpose and scope of the document, and discusses how the requirements at 29 CFR §1910.120 and 40 CFR Part 311 fit into the regulatory framework of worker protection standards.

- **Chapters 2 and 3** discuss initial planning activities that take place before work may begin at the site. *Chapter 2: Comprehensive and Site-Specific Health and Safety Program* outlines the components of the health and safety requirements at both the corporate and the site-specific level, and describes the relationship of the site characterization process to the development of the site-specific Health and Safety Plan (HASP). *Chapter 3: Training* discusses the health and safety training program required for workers and managers engaged in hazardous waste operations.

- **Chapters 4 through 11** provide a discussion of health and safety considerations for preliminary and on-going site activities. These include:

  Chapter 4: Site Control
  Chapter 5: Personal Protective Equipment
  Chapter 6: Air Monitoring
  Chapter 7: Medical Surveillance Program
  Chapter 8: Heat Stress and Cold Exposure
  Chapter 9: Decontamination
  Chapter 10: Drum Handling
  Chapter 11: Other Requirements and Safety Considerations.

1.1 REGULATORY BACKGROUND



Under the authority of section 126 of the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA and OSHA promulgated identical health and safety standards to protect workers engaged in hazardous waste operations and emergency response. The OSHA regulations, codified at 29 CFR §1910.120, became effective on March 6, 1990 (54 FR 9294). (Corrections to the OSHA regulations were published on April 13, 1990 (55 FR 14072).) The EPA regulations incorporate the OSHA standards by reference and are codified at 40 CFR Part 311 (54 FR 26654).

The EPA and OSHA worker protection standards for hazardous waste operations and emergency response (HAZWOPER) apply to five groups of workers, as shown in **Exhibit 1-1**. This document addresses the standards as they apply to the first three groups of workers, those engaged in voluntary or mandatory cleanups at uncontrolled hazardous waste sites, or in corrective actions at treatment, storage, and disposal (TSD) facilities regulated under the Resource Conservation and Recovery Act (RCRA).

EXHIBIT 1-1

HAZWOPER standards apply to workers engaged in:

- Mandatory cleanups at uncontrolled hazardous waste sites
- Voluntary cleanups at uncontrolled hazardous waste sites
- Corrective actions at RCRA TSD facilities
- Routine hazardous waste operations at RCRA TSD facilities
- Emergency response operations without regard to location

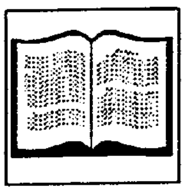
The HAZWOPER requirements for these workers, specified at 29 CFR §1910.120(a) through (o), are summarized in **Exhibit 1-2**. In addition, these provisions apply to any activities performed during the preliminary planning and evaluation stages of the remedial investigation and feasibility study (RI/FS), such as the preliminary assessment and site investigation (PA/SI).

HAZWOPER does not, however, apply to employees who do not have the potential to be exposed to hazardous substances. For example, administrative support personnel in the Site Command Post may not be covered by HAZWOPER, but are, of course, protected by other OSHA standards. They should also be made aware of the provisions of the emergency response plan, and must be briefed on emergency procedures and general site operations, such as the location of work zones.

EXHIBIT 1-2
Hazardous Waste Operations and Emergency Response at Uncontrolled Hazardous Waste Sites
(29 CFR §1910.120(a)-(o))

(a) Scope, application, and definitions.
(b) Safety and health program.
(c) Site characterization and analysis.
(d) Site control.
(e) Training.
(f) Medical surveillance.
(g) Engineering controls, work practices, and personal protective equipment for employee protection.
(h) Monitoring.
(i) Informational programs.
(j) Handling drums and containers.
(k) Decontamination.
(l) Emergency response by employees at uncontrolled hazardous waste sites.
(m) Illumination.
(n) Sanitation at temporary workplaces.
(o) New technology programs.

1.2 REGULATORY SCOPE



The occupational safety and health standards, published at 29 CFR, established minimum requirements to ensure protection for all private sector employees in the U.S. The general industry standards at 29 CFR Part 1910 were derived largely from standards developed by industry consensus organizations and non-OSHA Federal safety and health standards. These requirements reflect practices previously recognized by most industrial sectors prior to regulation under the OSHA. The OSHA standards, however, make these practices mandatory.

Many of the OSHA standards at 29 CFR Part 1910 establish generic specifications for using worker tools, maintaining industrial structures, installing equipment to make the workplace safer (e.g., sprinkler systems), providing medical attention, and other general health and safety practices applicable to all types of employment. Other sections in 29 CFR Part 1910, however, are specific to employees engaged in a specific activity or industry, such as hazardous waste operations.

Specifically, §1910.120 (HAZWOPER) contains requirements to minimize the health and safety hazards associated with conducting hazardous waste operations at uncontrolled hazardous waste sites and RCRA TSD facilities, and conducting emergency response. In some instances, the HAZWOPER standards incorporate general worker protection provisions by reference. For example, §1910.120(g) requires employers engaged in hazardous waste operations and emergency response to follow the provisions in §1910.94 through §1910.100, which require controls to protect employees from exposure to hazardous substances and safety and health hazards. Those referenced sections may apply to other industries and activities as well, but HAZWOPER applies only to hazardous waste operations and emergency response during the covered activities and locations.

In addition to the requirements set forth at 29 CFR Part 1910, OSHA codified regulations at 29 CFR 1926, Subpart C, that set forth safety and health standards specifically applicable to the construction industry. Both 29 CFR Part 1910 and Part 1926 require employers to provide whatever training and education is appropriate for employees to safely perform a given task. **Exhibit 1-3** presents a list of the OSHA standards that might apply at uncontrolled hazardous waste sites. **Appendix B** describes these standards in greater detail. The remainder of this guide discusses the types of activities that must be undertaken during hazardous waste operations to ensure worker health and safety and to comply with the HAZWOPER requirements.

EXHIBIT 1-3
Other Potentially Applicable OSHA Standards under 29 CFR*

1910.20	Access to Employee Exposure and Medical Records
1910.24	Fixed Industrial Stairs
1910.27	Fixed Ladders
1910.28	Safety Requirements for Scaffolding
1910.38	Employee Emergency Plans and Fire Prevention Plans
1910.94	Ventilation
1910.95	Occupational Noise Exposure
1910.101	Compressed Gases
1910.133	Eye and Face Protection
1910.134	Respiratory Protection
1910.135	Occupational Head Protection
1910.136	Occupational Foot Protection
1910.141	Sanitation
1910.151	Medical Services and First Aid
1910.157	Fire Extinguishers
1910.212	General Requirements for all Machines
1910.165	Employee Alarm Systems
1910.181	Derricks
1910.252	Welding, Cutting, and Brazing
1910.307	Hazardous Locations
1910.1000	Toxic and Hazardous Substances
1910.1200	Hazard Communication
1926.20	General Safety and Health Provisions
1926.21	Safety Training and Education
1926.56	Illumination
1926.58	Asbestos
1926.59	Hazard Communication
1926.151	Fire Prevention
1926.152	Flammable and Combustible Liquids
1926.200	Accident Prevention Signs and Tags
1926.301	Hand Tools
1926.400	Electrical General Requirements
1926.401	Grounding and Bonding
1926.651	Specific Excavation Requirements
1926.652	Trenching Requirements

*Not intended as a complete list

FURTHER GUIDANCE: For additional information on employee health and safety at uncontrolled hazardous waste sites, see:

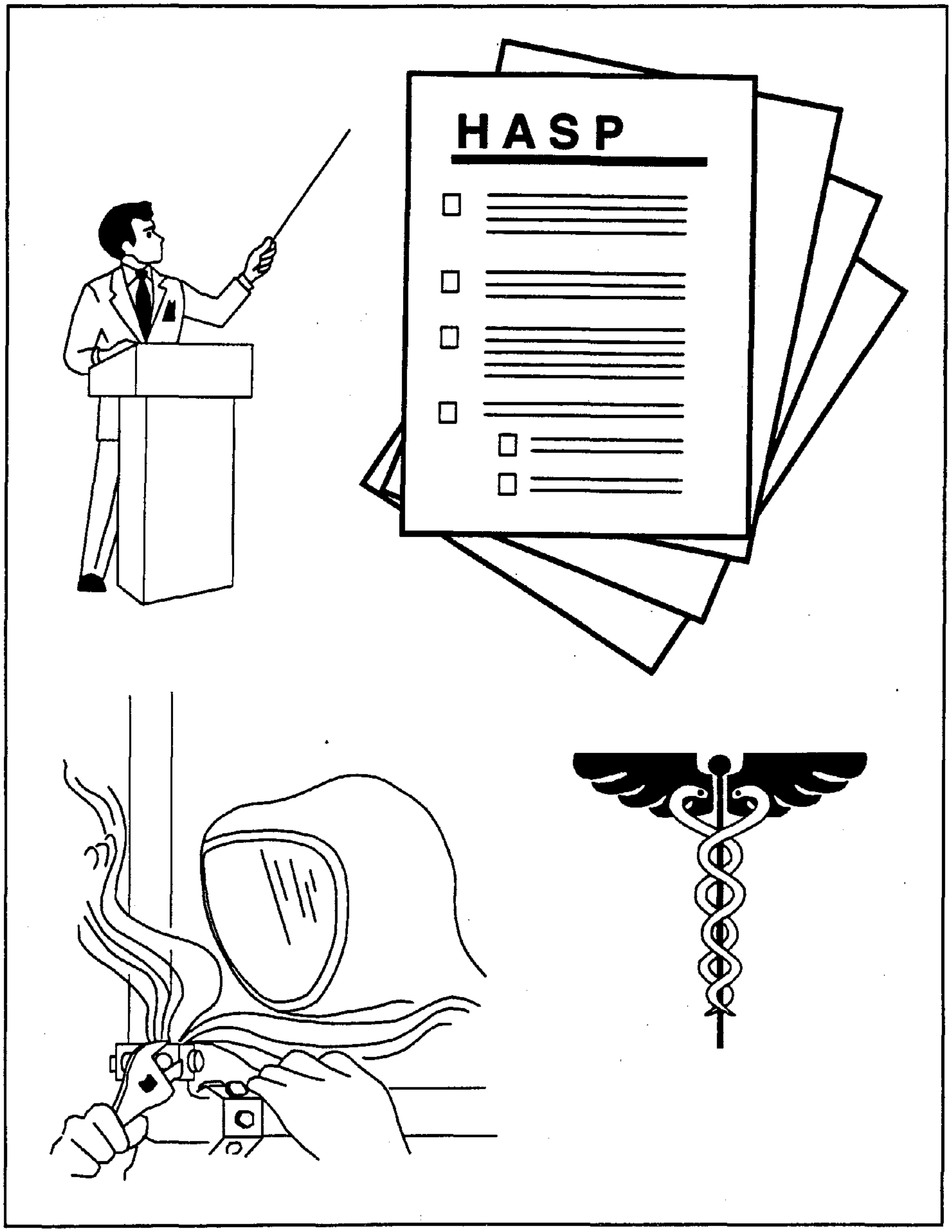
1. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH/OSHA/USCG/EPA, 1985, NIOSH Publication 85-115).

2. *EPA Health and Safety Audit Guidelines* (U.S. EPA, 1989, EPA 540/G-89/010).

3. *OSWER Integrated Health and Safety Standard Operating Practice* (U.S. EPA, 1992, Publication 9285.0-01).

4. *Standard Operating Procedures for Site Safety Planning* (U.S. EPA, 1985, Publication 9285.2-05).

CHAPTER 2 COMPREHENSIVE AND SITE-SPECIFIC HEALTH AND SAFETY PROGRAM



CHAPTER 2 COMPREHENSIVE AND SITE-SPECIFIC HEALTH AND SAFETY PROGRAM

2.0 INTRODUCTION

The HAZWOPER regulations at 29 CFR §1910.120(b) require that any employer whose workers engage in hazardous waste operations at an uncontrolled hazardous waste site or who perform corrective actions at a RCRA TSD facility must develop and implement a written health and safety program. This program must be designed to identify, evaluate, and control health and safety hazards at any site, and to provide for emergency response during site operations. The program must be maintained by the employer and made available to: (1) any employee or employee representative; (2) any contractor, subcontractor, or other representative working for the employer who may be potentially exposed to hazardous substances; (3) OSHA personnel; and (4) personnel of federal, state, and local agencies with regulatory authority over the site. If an employer already has developed a health and safety program to meet the requirements of other federal, state, or local regulations, the employer may use the existing program to satisfy the HAZWOPER requirements, provided that any additional information not covered in the existing program, but required under HAZWOPER, is incorporated into the program.

The primary purpose of the written health and safety program is to serve as an organization-wide health and safety policy that applies to all employees of the organization, regardless of the location of the actual site where they are working. The HAZWOPER regulations at 29 CFR §1910.120(b) establish the components of the general program, as shown in **Exhibit 2-1**.

Because the written health and safety program is intended to be organization-wide, only one health and safety program should be developed by an employer, even if the employer has workers who perform operations at several different sites. As required by HAZWOPER, this program should define the organizational structure, describe the general health and safety training and medical surveillance programs, and establish the standard operating procedures for health and safety. In addition, the health and safety program must also require that both a comprehensive workplan and a Health and Safety Plan (HASP) be developed for each site where workers are engaged in hazardous waste operations. Each HASP includes plans for implementing, on a site-specific basis, applicable requirements set forth in the organization's health and safety program (see **Exhibit 2-1**). For this reason, the health and safety program should include procedures needed for coordination between the comprehensive and site-specific health and safety activities.

Section 2.1 below describes in more detail these general components of the written health and safety program. Because HASP development is a complex, iterative process, Section 2.2 focuses on the procedures for developing the HASP.

2.1 GENERAL COMPONENTS OF THE HEALTH AND SAFETY PROGRAM

As required by 29 CFR §1910.120(b), an organization's written health and safety program must include certain general program components. Each of these are described briefly below.

Organizational Structure. The organizational structure component of the written health and safety program identifies the specific chain of command in the employer's organization, and specifies the overall responsibilities of supervisors and employees in carrying out the health and safety program. The structure should identify the general supervisor for all hazardous waste operations; provide a roster of the health and safety supervisors of all the sites; and describe the responsibilities of other personnel engaged in hazardous waste operations or emergency response. The structure should also identify the lines of authority, communication, and coordination among personnel and managers in the organization. It is necessary to review and update the organizational structure periodically to reflect changes in personnel and operations.

EXHIBIT 2-1
Health and Safety Program:
Comprehensive and Site-Specific Components

Comprehensive Health and Safety Program

The HAZWOPER regulations at 29 CFR §1910.120(b)(1) require a comprehensive health and safety program that includes:

- Organizational structure
- Site-specific workplans
- Site-specific health and safety plans (HASPs)
- Health and safety training program
- Medical surveillance program
- Standard operating procedures
- Coordination procedures

Site-Specific HASP

The HASP implements certain components of the health and safety program on a site-specific basis. The HASP includes:

- Key personnel
- Health and safety risk analysis
- Site control measures
- Training assignments
- Medical surveillance requirements
- Personal protective equipment
- Air and employee monitoring
- Spill containment program
- Confined space procedures
- Decontamination procedures
- Emergency response plan

Comprehensive Workplan. As required by HAZWOPER, the written health and safety program should specify that a comprehensive workplan will be developed for each site to evaluate the logistics and resources needed to reach work objectives for site operations. The workplan should identify anticipated cleanup activities as well as normal operating procedures. It should also establish implementation strategies for carrying out the training, informational, and medical surveillance programs of the general health and safety program. The following steps should be undertaken in developing the work plan:

- Review available information, including site records, waste inventories, manifests, sampling data, site photos, and other records;
- Define work objectives;
- Determine methods for accomplishing the objectives (e.g., sampling plan, defining alternate technologies);
- Determine personnel requirements;
- Determine need for additional training (refer to **Chapter 3** for specific requirements); and
- Determine equipment requirements.

Site-Specific Health and Safety Plan (HASP). In addition to the workplan, a site-specific HASP must be developed and implemented for each site where workers are potentially exposed to hazardous substances. Section 2.2 below discusses the components of the HASP and the process for its development.

Health and Safety Training Program. HAZWOPER requires that the health and safety program include a component to establish organization-wide health and safety training requirements for all site workers and supervisors. The training program must address the hazards present on-site, use of personal protective equipment, work practices to minimize risks, safe use of engineering controls and equipment, and medical surveillance requirements. The HASP for a particular site may implement these general training requirements on a site-specific basis (refer to **Chapter 3** for specific requirements).

Medical Surveillance Program. HAZWOPER requires that the written health and safety program also include a detailed program for ensuring and monitoring the general health of workers engaged in hazardous waste operations. As with the training program, the HASP for a particular site will address the medical surveillance program requirements and any special site-specific medical surveillance concerns. (Refer to **Chapter 7** for more information.)

Standard Operating Procedures. The HAZWOPER standards require employers to have established standard operating procedures for safe work practices. Such procedures should be specified in the written health and safety program. If the employer has already written and implemented these procedures, it is not necessary for new procedures to be developed.

Coordination Procedures. Because the health and safety program includes elements that are implemented on a site-specific basis, HAZWOPER requires that the program include procedures needed for coordination between the comprehensive and site-specific health and safety activities.

2.2 HASP DEVELOPMENT AND SITE CHARACTERIZATION

As discussed above, the HAZWOPER regulations at 29 CFR §1910.120(b)(4) require that a site-specific HASP be developed for each site where workers are engaged in hazardous waste operations. The purpose of the site-specific HASP is to address the health and safety hazards that may exist at each phase of site operations and to identify procedures for protecting employees.

A new HASP should not be developed if new tasks or hazards are identified at a site; rather, the original HASP should be updated. If a subcontractor is working at a site, the subcontractor should carefully evaluate and identify all tasks associated with the subcontracted activities, and prepare a health and safety plan addressing any identified hazards. This plan should be submitted to the site manager, who will incorporate it into the general site HASP after it has been reviewed for concurrence with the site workplan.

THE RULE IS: ONE SITE, ONE HASP

Exhibit 2-2 describes in detail the specific components that should be included in the HASP. Also, **Exhibit 2-3** presents a sample HASP Table of Contents. Some of the areas that must be addressed in the HASP are discussed in further detail in later chapters of this document.

Development of the site-specific HASP is a process that incorporates the information collected during the site characterization phase of hazardous waste operations. Site characterization generally is divided into three phases:

- Prior to site entry, the preliminary evaluation (PE) is conducted off-site to gather information about the site and to conduct reconnaissance from the site perimeter.
- During the second stage, initial site entry, a visual survey is taken and preliminary air monitoring is performed. During this phase, site entry is restricted to properly trained and protected reconnaissance personnel.
- Once the hazards have been identified to the greatest extent possible, other activities may commence at the site. Monitoring continues, however, to provide a continuous source of information about site conditions.

It is important to recognize that site characterization (and, therefore, HASP development) is a continuous process. At each phase of site characterization, information should be obtained and evaluated to define the hazards that the site may pose. This assessment can then be used to develop the HASP for the next phase of work. The more accurate, detailed, and comprehensive the information available about a site, the more the HASP can be tailored to the actual hazards that workers may encounter. In addition to the formal information gathering that takes place during the phases of site characterization described here, all site personnel should be constantly alert for new information about site conditions that may indicate a need to update the HASP.

EXHIBIT 2-2
Components of the HASP

Component	Description
Key Personnel and Hazard Communications Plan (29 CFR §1910.120(b)(2))	The HASP should include names of key personnel such as Project Manager, Field Operations Leader, Site Supervisor, and Site Health and Safety Officer, as well as their alternates. The HASP should also identify communication procedures and provide for briefings to be held before site activity is initiated. These meetings should be held at any time they appear necessary to ensure that employees are adequately apprised of the health and safety procedures being followed at the site.
Health and Safety Risk Analyses (29 CFR §1910.120(b)(4))	Health and safety risk analyses should be established for each task and operation identified in the site-specific workplan. Discussion of these analyses should include identification of chemical contaminants, affected media, concentrations, and potential routes of exposure for use in risk analysis. Should also include safety risk analyses to address anticipated on-site operations and safety problems.
Site Control Measures (29 CFR §1910.120(d))	The site control program in the HASP specifies the procedures that will be used to minimize employee exposure to hazardous substances before cleanup operations commence and during site operations. The program must be developed during the planning stages of a hazardous waste cleanup operation, and must be modified as any new information becomes available. The site control program should include a site map, designation of work zones, site communications, safety work practices, identification of the nearest medical assistance, and description of the "buddy system" for site operations. **Chapter 4** describes the requirements of the site control program.
Employee Training Assignments (29 CFR §1910.120(e))	Training assignments should address the employee's initial health and safety training, annual health and safety refresher training, on-the-job training, supervisory training, and first-aid and CPR training. Employees should not be permitted to participate in or supervise field activities until they have received training commensurate with their responsibilities. **Chapter 3** describes the applicable training requirements in greater detail.
Medical Surveillance (29 CFR §1910.120(f))	The medical surveillance program is required for monitoring the health status of personnel who are potentially exposed to hazardous substances in the field and who wear respirators 30 days or more per year. It must include initial and periodic medical examinations, examination upon termination of employment, and medical recordkeeping. **Chapter 7** describes the medical surveillance requirements specified in HAZWOPER.

EXHIBIT 2-2 (cont'd)
Components of the HASP

Personal Protective Equipment (PPE) (29 CFR §1910.120(g))	The HASP must describe the different PPE ensembles that will be used to address potential hazards during site activities. The HASP should also include or refer to a comprehensive PPE program that addresses site hazards, duration of site activities, limitations of PPE during temperature extremes, PPE selection, maintenance, storage, and decontamination, and training for PPE use, inspection, and monitoring. Such PPE should be used only when engineering controls and work practices are insufficient to adequately protect against exposure. **Chapter 5** discusses PPE requirements in greater detail.
Air and Personnel Monitoring (29 CFR §1910.120(h))	The HASP must describe the employee and air monitoring equipment and environmental sampling techniques and instrumentation that will be used on-site for evaluating potential exposure to contaminants that result from site activities. The monitoring program must include procedures for initial entry monitoring, periodic monitoring, and monitoring of high risk employees. **Chapter 6** discusses monitoring requirements and procedures.
Spill Containment Program (29 CFR §1910.120(j))	The HASP should include any elements of the spill containment program that may be relevant to the site, and should provide procedures to contain and isolate the entire volume of any hazardous substance spilled in the course of a transfer, major spill, or an on-site release.
Confined Space Entry Procedures (29 CFR §1910.120(b)(9))	If confined space entry is anticipated on-site, the HASP should describe procedures for entry into confined space. Such procedures ensure the safety of site personnel who must enter areas where natural ventilation is insufficient to reduce contaminant concentrations. **Chapter 11** presents the requirements for developing confined space entry procedures.
Decontamination Procedures (29 CFR §1910.120(k))	The HASP should include decontamination procedures, both for individuals and equipment on-site and in places where there is a potential for exposure to a hazardous substance. These procedures should explain how to minimize contact with hazardous substances and how to conduct personal and equipment decontamination when leaving a contaminated area. **Chapter 9** presents the requirements for a decontamination program.
Emergency Response Plan (29 CFR §1910.120(l))	The emergency response plan in the HASP must include a description of how anticipated emergencies would be handled at the site and how the risks associated with a response would be minimized. <u>The emergency response plan must be developed and implemented prior to beginning site operations.</u> **Chapter 11** discusses the requirements for an emergency response plan at an uncontrolled hazardous waste site.

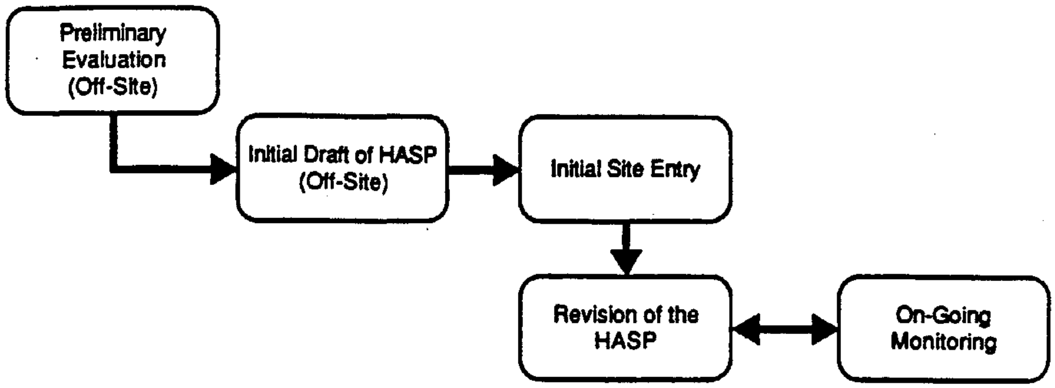
EXHIBIT 2-3
Sample HASP Table of Contents for Site "A"

EPA HASP Version 3.0: This sample HASP Table of Contents reflects specific health and safety considerations for Site "A". Other sites may address different topics in the HASP, subject to site-specific hazards and activities.

EXHIBIT 2-3 (cont'd)
Sample HASP Table of Contents for Site "A"

EPA HASP Version 3.0: This sample HASP Table of Contents reflects specific health and safety considerations for Site "A". Other sites may address different topics in the HASP, subject to site-specific hazards and activities.

EXHIBIT 2-4
The Site Characterization Process



The sections that follow describe the phases of site characterization and HASP development, and provide a general guide that should be adapted to site-specific situations. **Exhibit 2-4** provides a flowchart that illustrates this process. For additional, detailed information on HASP development, see the Environmental Response Team's (ERT) Health and Safety Planner (also referred to as the generic health and safety plan), which is a menu-driven computerized software system designed to assist in the development, implementation, and updating of a HASP.

2.2.1 Preliminary Evaluation

The first step in developing a HASP is to perform a preliminary evaluation (PE) of the site's characteristics. The PE must be accomplished off-site, so as not to endanger the health and safety of site workers. The purpose of the PE is to obtain preliminary information to help identify the specific hazards at the site and determine the appropriate health and safety control procedures (e.g., engineering controls, personal protective equipment (PPE), and any additional medical surveillance needs) that are necessary to ensure the protection of employees who perform tasks on-site.

As set forth in 29 CFR §1910.120(c)(4), the PE should include the following:

- Site location and size.
- Description of response activity and/or the job to be performed.
- Duration of the planned activity.
- Site topography and accessibility.
- Site safety and health hazards expected.
- Pathways for hazardous substance dispersion.
- Present status and capabilities of emergency response teams that would provide assistance for on-site emergencies.
- Hazardous substances and health hazards expected at the site, and the chemical and physical properties of the substances.

There are several ways in which this information can be obtained. For example, records of the site or interviews with persons who are knowledgeable about the site can provide useful information about potential hazards. **Exhibit 2-5** summarizes potentially useful sources of information. **Appendix C** provides a "Sample Incident Safety Check-Off List" to serve as a quick reference on the types of information that must be

EXHIBIT 2-5
Sources of Site-Specific Information

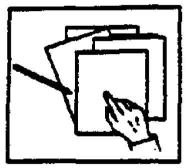
- Company records, receipts, worker compensation claims, logbooks, or ledgers.
- Records and permits from federal and state pollution control regulatory and enforcement agencies, state Attorney General's office, state occupational safety and health agencies, state Fire Marshal's office.
- Interviews with personnel and their families (all interview information should be verified).
- Generator and transporter records.
- Water department and sewage records.
- Interviews with nearby residents (note possible site-related medical problems and verify all information from interviews).
- Local fire and police department records.
- Court and utility company records.
- Verified media reports.
- Previous surveying (including soil, ground-penetrating radar, and magnetometer surveys), sampling, and monitoring data.

obtained prior to initial site entry, and the types of follow-up activities that should be conducted.

In addition to interviewing knowledgeable persons and researching the history of the site, gathering data at the site perimeter (i.e., perimeter reconnaissance) may help in identifying site hazards and potential pathways for exposure and determining the appropriate level of PPE for the initial site entry. To identify the appropriate monitoring techniques for perimeter reconnaissance, the Site Health and Safety Officer should review the information obtained during the records or interview research.

NOTE: Perimeter reconnaissance activities during the PE must be conducted off-site. The site manager must not, *under any circumstances*, allow a worker to enter the site to collect information for the PE.

2.2.2 Writing the Initial Draft of the HASP



Once the PE is completed and the appropriate information has been obtained, the information is used to develop the initial draft of the site-specific HASP. The initial draft of the HASP must include all elements listed in Exhibit 2-2. Specifically, it must identify each anticipated health and safety hazard for each work operation or activity, and describe how those hazards will be eliminated or controlled. It must also indicate that employees have received training and are enrolled in a medical surveillance program. In addition, the HASP should identify appropriate monitoring procedures and PPE for the initial site entry. The HASP must remain on-site at all times and only one HASP should be developed for each site.

2.2.3 Initial Site Entry

Once the HASP has been developed and implemented, the second stage of the site characterization and analysis (i.e., initial site entry) may begin. The purpose of the initial site entry is to gather additional information and further evaluate the site-specific risks and hazards for use in selecting and developing appropriate engineering controls, site controls, medical monitoring plans, and PPE. Risks that should be considered during the initial site entry include:

- Physical hazards.
- Exposure exceeding the permissible exposure limits (PELs) and published exposure levels.
- Immediately dangerous to life and health (IDLH) concentrations.
- Potential skin absorption and irritation.
- Explosion sensitivity and flammability ranges.
- Oxygen deficiency.
- Confined spaces.

At a minimum, activities during the initial site entry should consist of air monitoring and a visual survey for potential hazards. Multi-media sampling should also be performed if the site manager has any reason to believe that soil or water contamination may be present. Exhibit 2-6

EXHIBIT 2-6
Initial Site Entry: Visual Inspection Checklist

☑ Note the types of containers, impoundments, or other storage systems:

- -- Paper or wood packages.
- -- Metal or plastic barrels or drums.
- -- Underground tanks.
- -- Aboveground tanks.
- -- Compressed gas cylinders.
- -- Pits, ponds, or lagoons.

☑ Note any tags, labels, markings, or other identifying indicators.

☑ Note the condition of waste containers and storage systems:

- -- Sound (undamaged).
- -- Visibly rusted or corroded.
- -- Leaking or bulging.
- -- Size and type of container.
- -- Labels on containers indicating corrosive, explosive, flammable, radioactive, or toxic materials.

☑ Note the physical condition of the materials:

- -- Gas, liquid, or solid.
- -- Color and turbidity.
- -- Behavior, e.g., corroding, foaming, vaporizing, or crystallizing.
- -- Conditions conducive to splash or contact.

☑ Identify natural wind barriers:

- -- Buildings.
- -- Fences.
- -- Vegetation.

☑ Determine the potential pathways of dispersion:

- -- Air.
- -- Biologic routes, such as animals and food chains.
- -- Ground water.
- -- Land surface.
- -- Surface water.

☑ Note any indicators of potential exposure to hazardous substances:

- -- Dead fish, animals or vegetation.
- -- Dust or spray in the air.
- -- Fissures or cracks in solid surfaces that expose deep waste layers.
- -- Pools of liquid.
- -- Gas generation or effervescence.
- -- Deteriorating containers.
- -- Cleared land areas or possible landfilled areas.
- -- Subsiding areas indicating waste burial locations.

☑ Note any safety hazards. Consider:

- -- Conditions of site structures.
- -- Obstacles to entry and exit.
- -- Terrain homogeneity.
- -- Terrain stability.
- -- Stability of stacked material.

☑ Identify any reactive, incompatible, flammable, or highly corrosive wastes.

☑ Note land features.

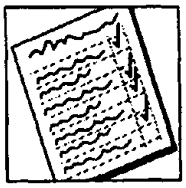
☑ Note the presence of any potential naturally occurring skin irritants or dermatitis-inducing agents, for example:

- -- Poison ivy.
- -- Poison oak.
- -- Poison sumac.

☑ Collect samples:

- -- Air (see Chapter 6, Air Monitoring).
- -- Drainage ditches.
- -- Soil (surface and subsurface).
- -- Standing pools of liquids.
- -- Storage containers.
- -- Streams and ponds.
- -- Ground water (upgradient, beneath site, downgradient).

provides a checklist of conditions and potential hazards that should be noted during the initial site entry. An accurate and comprehensive visual survey of the site will assist the site manager in identifying and determining additional information (e.g., sampling of soil or containers) that may be needed. For example, a visual survey might note the condition of waste containers (e.g., rusted or other unusual conditions) and identify potential exposure pathways.



The specific monitoring requirements for initial site entry are specified at 29 CFR §1910.120(c)(6) and (h)(2) and are summarized in **Exhibit 2-7**. Personnel entering the site should monitor the air using direct reading instruments to detect IDLH conditions (e.g., toxic substances) and for ionizing radiation. Such monitoring, however, need only be conducted if the PE produces information that suggests: (1) the possibility of existing IDLH conditions; or (2) the potential for ionizing radiation. Air monitoring should also be conducted if the information from the PE is insufficient to reasonably conclude that neither of these two conditions exists. When monitoring, entry personnel should look for signs of actual or potential IDLH hazards or other dangerous conditions. Examples of hazards that may be identified at a site include confined space entry, ground subsidence, visible vapor clouds, or areas that contain biological indicators, such as dead vegetation. **Exhibit 2-8** gives examples of frequently used monitoring devices and exposure limits.

The appropriate level of protection for initial entry should be conservative, because there is often little known information on specific hazards at that time. Refer to **Chapter 6** for additional information on selecting appropriate levels of protection.

In addition to air monitoring, soil and water sampling should be performed during the initial site entry if the site manager believes contamination may exist. Soil sampling techniques will differ with each site; for specific sampling strategies, refer to Volume 1 (Soil) of the *Removal Program Representative Sampling Guidance* (Interim Final). Prior to beginning site activities, it is imperative that the purpose of the effort and the ultimate use of the data be established. Specific strategies should be selected based on the information required. **Chapter 6** provides a more detailed discussion of monitoring techniques and equipment.

EXHIBIT 2-7
Specific Monitoring Requirements for Initial Site Entry

As specified in 29 CFR §1910.120(c)(6) and (h)(2), the following monitoring should be conducted at initial site entry:

- Air monitoring with direct-reading instruments for hazardous levels of ionizing radiation.
- Air monitoring with direct-reading test equipment (e.g., combustible gas meters, detector tubes) for IDLH or other dangerous conditions.
- Visual observation for signs of actual or potential IDLH or other dangerous conditions.

One important goal of the initial site entry is to identify the risks and hazards at the site so that the work zones can be established. The three most frequently identified zones are the Exclusion Zone, the Contamination Reduction Zone, and the Support Zone (also known as the clean zone). The Support Zone should be an area of the site that is free from contamination and that may safely be used as a staging area for other hazardous waste operations at the site. The Exclusion Zone is the area with actual or potential contamination and the highest potential for exposure to hazardous substances. For additional information on work zones and site control, refer to **Chapter 4**.

2.2.4 Revising the HASP

Once the initial site entry is completed, the site manager is responsible for updating the HASP to ensure that it adequately identifies any new tasks or hazards at the site. At most sites, any sampling performed during the initial site entry will provide accurate information regarding the appropriate level of PPE to be worn by site employees and the proper designation of work zones.

After the initial site characterization activities have been completed, any information concerning the chemical, physical, and toxicological properties of hazardous substances identified during the initial site entry must be made available to employees prior to the commencement of operations at the site.

2.2.5 On-Going Monitoring

Once the HASP is revised to reflect the information gathered during the initial site entry, on-going monitoring may be needed to ensure that all new hazards are identified in a timely manner and that the appropriate controls are implemented to protect site employees.

EXHIBIT 2-8
Atmospheric Hazard Action Guides

Monitoring Equipment	Atmospheric Hazard[a]	Level	Action
Combustible Gas Indicator	Explosive	< 10% LEL[b]	Continue monitoring with caution.
		10-25% LEL	Continue monitoring, but with extreme caution, especially as higher levels are encountered.
		> 25% LEL	Explosion hazard! Withdraw from area immediately.
Oxygen Level		< 19.5%	Monitor wearing SCBA. NOTE: Combustible gas readings not valid in atmospheres with less than 19.5% oxygen.
		19.5-25%	Continue monitoring with caution. SCBA not needed based only on oxygen content.
		> 25%	Discontinue monitoring. Fire potential! Consult specialist.
Radiation Survey Instrument	Gamma Radiation	Above background: < 1 mR/hr	Continue monitoring. Consult a health physicist.
		≥ 1 mR/hr	Withdraw. Continue monitoring only upon the advice of a Health Physicist.
Colorimetric Tubes	Organic & inorganic vapors/gases	Depends on chemical	Consult reference manuals for air concentration vs. PEL/TLV and toxicity data.
Photoionization Detector	Organic vapors/gases	Depends on chemical	Consult reference manuals for air concentration vs. PEL/TLV and toxicity data.
Flame Ionization Detector	Organic vapors/gases	Depends on chemical	Consult reference manuals for air concentration vs. PEL/TLV and toxicity data.

[a] NOTE: Hazard classes are general and not all compounds in these classes can be measured by realtime instruments.
[b] LEL = lower explosive limit.

NOTE: The correct interpretation of any instrument readout is difficult. If the instrument operator is uncertain of the significance of a reading, especially if conditions could be unsafe, a technical specialist should immediately be consulted. Consideration should be given to withdrawing personnel from the area until approval by the safety officer is given to continue operations.

Periodic monitoring should be conducted whenever there is any indication that exposures have risen above the permissible exposure limits (PELs), when other dangerous conditions exist, such as the presence of flammable atmospheres or oxygen-deficient environments, or when new tasks are initiated or site conditions change. (Refer to **Exhibit 4-4** in **Chapter 4** of this Guide for examples.) Monitoring should be conducted on those employees suspected of having the highest exposures to hazardous substances and health hazards.

FURTHER GUIDANCE: For further information on developing the written health and safety plan and the site-specific HASP, see:

1. *Characterization of Hazardous Waste Sites -- A Methods Manual: Vol.II. Available Sampling Methods, 2nd ed.* (U.S. EPA, 1984, EPA 600/4-84-076).

2. *EPA Health and Safety Planner: Software and User's Guide* (U.S. EPA, 1990, Publication 9285.8-01).

3. *EPA Health and Safety Audit Guidelines* (U.S. EPA, 1989, EPA 540/G-89/010).

4. *Standard Operating Guidelines for Site Entry* (U.S. EPA, 1985, Publication 9285.2-01A).

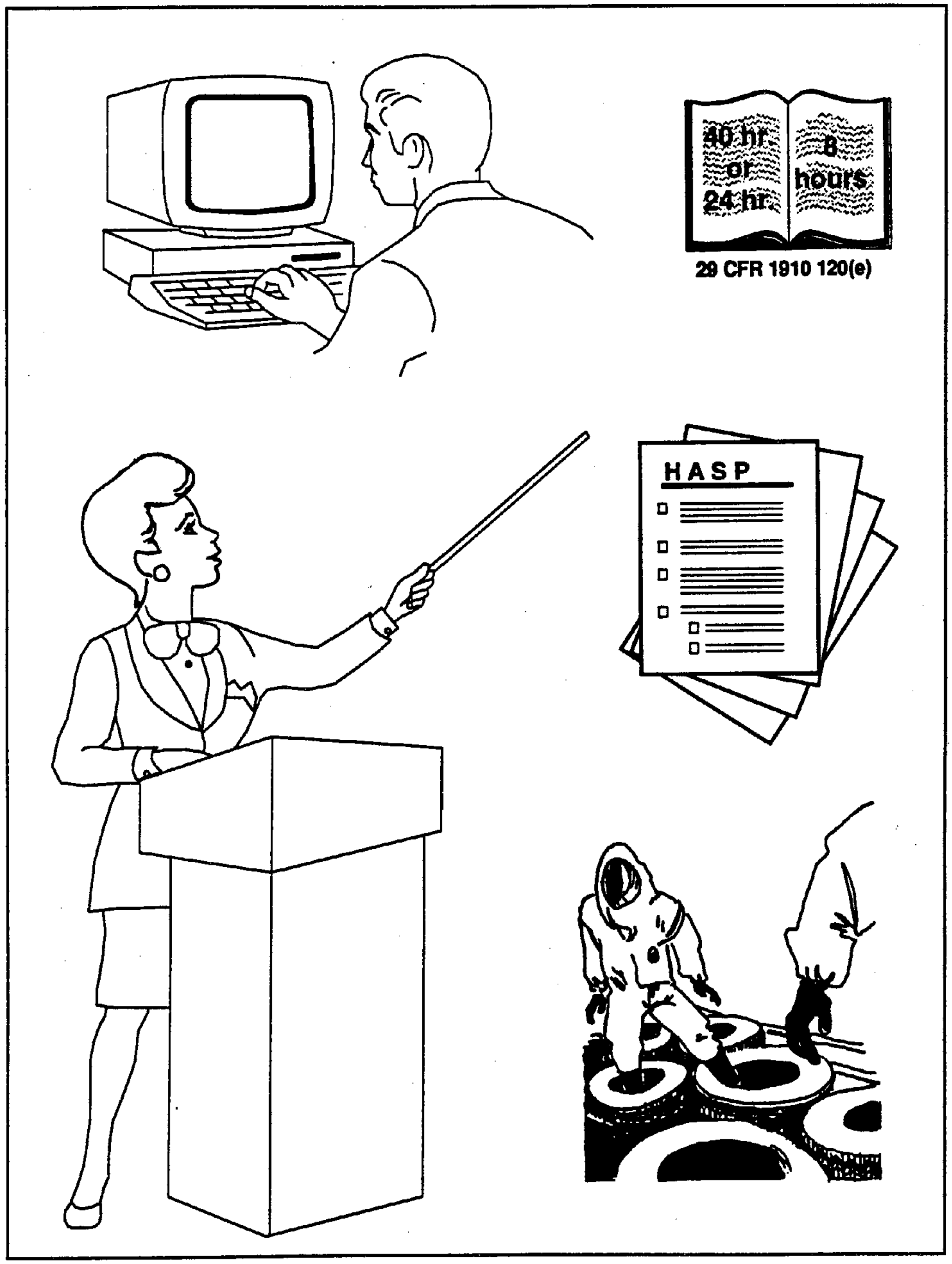
5. *Standard Operating Procedures for Site Safety Planning* (U.S. EPA, 1985, Publication 9285.2-05).

6. *OSWER Integrated Health and Safety Standard Operating Practice* (U.S. EPA, 1992, Publication 9285.0-01).

7. *Hazardous Waste Operations and Emergency Response: Uncontrolled Hazardous Waste Sites and RCRA Corrective Action* (U.S. EPA, 1991, Publication 9285.2-08FS).

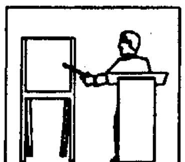
8. *Removal Program Representative Sampling Guidance. Volume 1 - Soil* (Interim Final), (U.S. EPA, 1991, Publication 9360.4-10).

CHAPTER 3 TRAINING



CHAPTER 3 TRAINING

3.0 INTRODUCTION



Health and safety training is an integral part of the total health and safety program. Site response personnel should receive frequent training to maintain proficiency in using safety equipment and knowledge of site safety practices. Personnel who work at hazardous waste sites must recognize and understand the potential hazards to health and safety associated with the cleanup of that site. Personnel actively engaged in cleanup activities must be familiar with the safety programs and procedures at the site, including the HASP and site control measures, and must be trained to work safely in contaminated areas. Employees may not participate in or supervise any site activity until they have been properly trained.

The objectives of the HAZWOPER training program for employees engaged in hazardous waste site activities are to:

- Educate workers about the potential health and safety hazards they may encounter at the site;
- Provide the knowledge and skills necessary to minimize risk to worker health and safety;
- Provide thorough training in the proper use and potential limitations of safety and PPE; and
- Ensure that workers can safely avoid or escape from emergencies.

The HAZWOPER standards at 29 CFR §1910.120(e) reflect a tiered approach to training. They link the amount and type of training required to an employee's potential for exposure to hazardous substances and other health hazards encountered during hazardous waste operations. The greater the potential hazard to an employee, the more extensive and stringent are the training requirements. The training program should involve both classroom instruction in a wide range of health and safety topics, demonstrations, and "hands-on" practice consisting of off-site drills that simulate site activities and conditions. Any training program for work around hazardous substances should also incorporate on-site experience under the direct supervision of trained, experienced personnel. All employees are required to complete refresher training, at least annually, to re-emphasize the initial training and to update workers on any new policies or procedures.

3.1 TRAINING REQUIREMENTS

3.1.1 General Training Requirements

HAZWOPER outlines a specific set of training criteria based upon a given employee's position, duties, and experience. The intent of the training provisions is to provide employees with the knowledge and skills necessary to perform hazardous waste cleanup operations with minimal risk to their safety and health.

The rule requires that all on-site employees who are exposed, or potentially exposed, to hazardous substances, health hazards, or safety hazards receive training meeting specific requirements before they are permitted to engage in hazardous waste operations. This rule also applies to site supervisors and personnel responsible for health and safety at the site. Employees should not be permitted to participate in or supervise field activities until they have been trained to a level commensurate with their job function and responsibility.

The HAZWOPER standards specify hourly requirements for five different categories of site workers. These hourly training requirements, and the requirements for each category, are discussed in more detail in Section 3.2.

3.1.2 Site-Specific Requirements

Each employer at a site is responsible for ensuring that their respective employees are properly trained and equipped prior to commencing work. HAZWOPER training must enable site workers to identify the hazards present on-site, the medical surveillance requirements, certain elements of the HASP, and operating practices and procedures, including the use of PPE and proper engineering controls. **Exhibit 3-1** outlines the specific issues and topics that are required to be addressed during training.

EXHIBIT 3-1
Elements to be Covered in Training

29 CFR §1910.120(e)(2) requires that health and safety training ensure that employees are thoroughly familiar with the following information:

- Names of personnel and alternates responsible for site safety and health;
- Safety, health, and other hazards present on site;
- Use of personal protective equipment;
- Work practices by which the employee can minimize risks from hazards;
- Safe use of engineering controls and equipment on the site;
- Medical surveillance techniques, and recognition of symptoms and signs that might indicate overexposure to hazards;
- An emergency response plan meeting the requirements for safe and effective responses to emergencies, including all necessary equipment;
- Confined space entry procedures;
- A spill containment program; and
- Decontamination procedures.

It is also recommended that training cover the following:

- Proper use of field equipment; and
- Employee rights and responsibilities.
- First Aid.

3.2 INITIAL TRAINING REQUIREMENTS FOR FIELD PERSONNEL

Although all employees engaged in hazardous waste operations must receive training in health and safety, the type of training required depends on the employee's on-site activities and potential for exposure to hazardous substances. **Exhibit 3-2** summarizes the HAZWOPER hourly training requirements for five categories of site workers. **Exhibit 3-3** provides a matrix of training requirements for site personnel.

General site workers (e.g., equipment operators, general laborers, and supervisory personnel) engaged in hazardous substance removal or other activities that potentially expose workers to hazardous substances and health hazards are required to receive at least 40 hours of off-site instruction, as well as a minimum of 3 days actual field experience under the direct supervision of a trained, experienced supervisor.

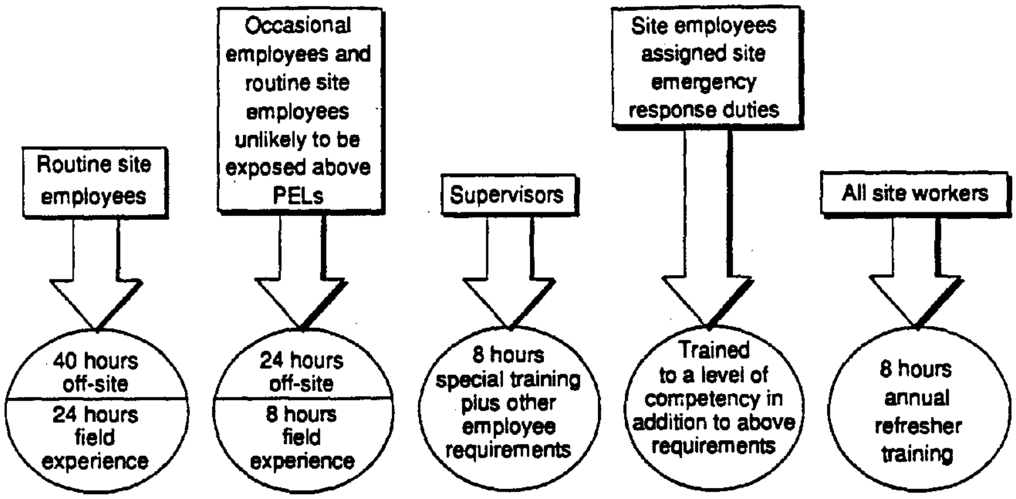
Workers who are on-site only occasionally to perform a specific limited task (e.g., ground-water monitoring or land surveying) and who are unlikely to be exposed to hazardous substances over their PELs, are required to have a minimum of 24 hours of instruction off-site and a minimum of 8 hours of supervised field experience.

Workers regularly on-site who work in areas where exposure levels are monitored and determined to be below PELs, and where no health or atmospheric hazards are posed, must receive 24 hours of off-site instruction and a minimum of one day actual field experience under the direct supervision of a trained, experienced supervisor.

Workers with 24 hours of training who subsequently become general site workers or whose job requires that a respirator be worn are required to obtain the additional 16 hours and 2 days of training to fulfill the training requirements commensurate with the new position's responsibilities.

Managers and supervisors of the four groups of employees described above are required to receive the same amount of initial training and field experience as the employees they supervise, plus 8 additional hours of specialized training in managing hazardous waste operations. For example, a supervisor that only manages employees who work on-site occasionally must have a minimum of 24 hours of instruction off-site and 8 hours of supervised field experience, plus an additional 8 hours of specialized management training. Supervisors will need to be trained in their responsibilities under the health and safety

EXHIBIT 3-2
Initial Training Requirements for Employees at Uncontrolled Hazardous Waste Sites (29 CFR §1910.120(e))



program, the PPE program, the medical surveillance program, and the emergency response plan.

Visitors to the site are not required to have completed any specific training in health and safety, although it is strongly recommended that they be familiar with the hazards on-site as well as PPE, decontamination procedures, and the site emergency plan. Site visitors **may not** enter any hazardous area (e.g., exclusion or decontamination zones) without the proper training.

Although there are no specific training requirements for **on-site** employees with emergency response duties for that site, such employees must be trained commensurate with the duties that will be assumed.

3.3 EQUIVALENT AND REFRESHER TRAINING

Some of the training requirements specified above may be waived if the employee has had prior work experience or training. For example, certain training requirements may be waived if the employee has had experience working at an uncontrolled hazardous waste site or if the employee has participated in training courses offered by independent or federal organizations (e.g., EPA). If the employer believes that an employee has sufficient prior experience or training to waive some or all of the HAZWOPER training requirements, the employer must document the basis for this belief, describing the length and type of experience or training. Equivalent training may include any relevant academic training or the training that may have been gained from actual hazardous waste site work experience. Certified employees new to a site, however, must receive appropriate site-specific training before site entry.

All employees who perform cleanup operations at uncontrolled hazardous waste sites, including managers and supervisors, must receive a minimum of 8 hours of annual refresher training. The purpose of refresher training is to maintain certain competencies essential for ensuring a safe work environment. Attendance at applicable seminars and critiques of actual responses are also acceptable methods of satisfying the annual refresher training requirements. Proper documentation of attendance should be maintained in each employee's personnel file to confirm that every

EXHIBIT 3-3
Recommended Training by Job Category

TRAINING TOPIC	EMPHASIS OF TRAINING	General Site Worker	On-site Management & Supervisors	Health & Safety Staff
Biology, Chemistry, and Physics of Hazardous Materials	Chemical and physical properties; chemical reactions; chemical compatibilities.	✓	✓	✓
Toxicology	Dosage, exposure routes, toxicity, IDLH values, PELs, recommended exposure limits (RELs), TLVs.	✓	✓	✓
Industrial Hygiene	Monitoring workers' need for and selection of PPE.	O	✓	✓
	Calculation of doses and exposure levels; hazard evaluation; selection of worker health and safety protective measures.	O	✓	✓
Monitoring Equipment	Selection, use, capabilities, limitations, and maintenance.	✓	✓	✓
Hazard Evaluation/Recognition	Techniques of sampling and assessment.	✓	✓	✓
	Evaluation of field and lab results.	O	✓	✓
	Chemical/Physical	✓	✓	✓
	Risk assessment.		O	✓
Site Safety Plan	Safe practices, safety briefings and meetings, Standard Operating Procedures, site safety map.	✓	✓	✓
Standard Operating Procedures	Hands-on practice.	✓	✓	✓
	Development and compliance.	O	✓	✓
Engineering Controls	The use of barriers, isolation, and distance to minimize hazards.	✓	✓	✓
Personal Protective Clothing and Equipment (PPE)	Assignment, sizing, fit-testing, maintenance, use, limitations, and hands-on training.	✓	✓	✓
	Selection of PPE.	✓	✓	✓
Medical Program	Medical monitoring, first aid, stress recognition.	✓	✓	✓
	CPR and emergencies drills.	O	✓	✓
	Design and planning.		O	✓
	Implementation.	✓	✓	✓
Decontamination	Hands-on training using simulated field conditions.	✓	✓	✓
	Design and maintenance.	✓	✓	✓
Legal and Regulatory Aspects	Applicable safety and health regulations (OSHA, EPA)	O	✓	✓
Emergencies/Accidents	Emergency help, self-rescue, drills, alarms, reporting.	✓	✓	✓
	Emergency response, investigation, and documentation.	O	✓	✓
Hazard Communication	Per 29 CFR §1910.1200 and §1926.59 (as applicable)	✓	✓	✓
Employee Rights		✓	✓	✓

[1] ✓ = Recommended training O = Optional

person assigned to a task has had adequate training for that task, and that each employee has participated in refresher training activities.

3.4 TRAINER QUALIFICATIONS AND CERTIFICATION

Trainers must be adequately qualified to instruct employees about the subject matter that is being presented in training. Such trainers must satisfactorily complete a training program for teaching the subjects they are expected to teach, or they must have the academic credentials and instructional experience necessary for teaching the subjects. Instructors are required to demonstrate competent instructional skills and knowledge of the applicable subject matter.

Employees and supervisors who have received and successfully completed the required training and field experience must be certified by their instructor or trained supervisor as having successfully completed the necessary training. A written certificate must be given to each person as proof of his or her certification (although certification may only signify attendance, and not competency). Any person who has not been certified or who does not meet the requirements may not participate in hazardous waste operations at the site.

FURTHER GUIDANCE: For more information on employee training requirements and programs, see:

1. *Hazardous Materials Incident Response Training (HMIRT) Program: Course Schedule.*
   Write to: U.S. EPA/ERT, 26 West Martin Luther King, Cincinnati, OH 45268
   or Call: (513) 569-7537 or FTS 684-7537

   The HMIRT program is designed for emergency responders and personnel who investigate and clean up uncontrolled hazardous waste sites. The HMIRT program has a curriculum of 12 courses that provide specific training in worker health and safety and in various technical operations that must be performed by site personnel engaged in hazardous materials response activities.

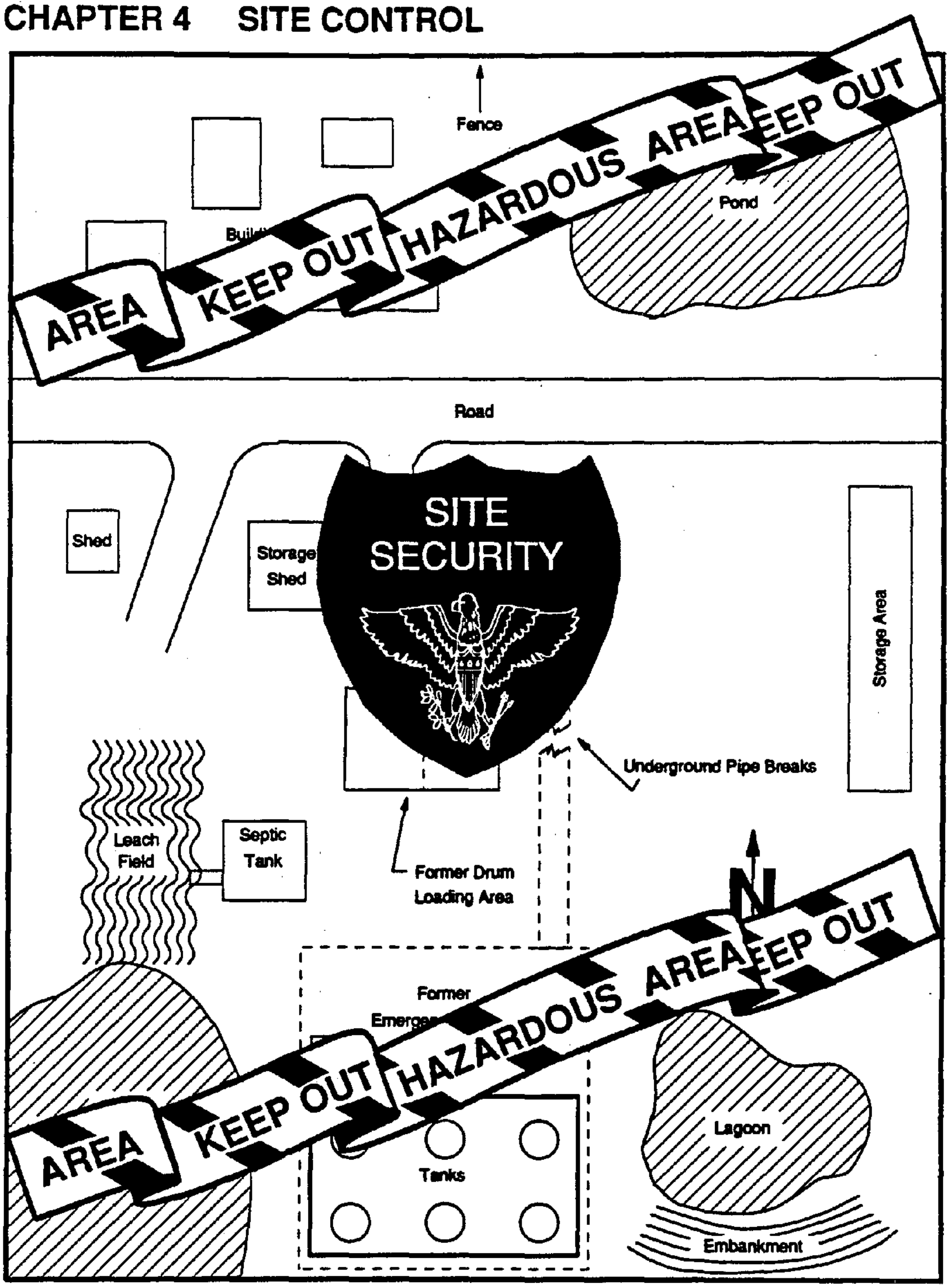
2. *National Institute for Environmental Health Sciences (NIEHS) Worker Health and Safety Training Programs.* Write to: The National Clearinghouse on Occupational and Environmental Health, c/o Workplace Health Fund, 815 16th Street NW, Suite 301, Washington DC, 20006
   or Call: (202) 842-7833

   The National Clearinghouse, established by NIEHS, provides information and support services for occupational and environmental health education. The Clearinghouse can provide information about training programs across the country funded by NIEHS Federal training grants.

3. *National Institute for Environmental Health Sciences (NIEHS) Training Grant Program*, Technical Workshop on Training Quality Report: Minimum Criteria for Worker Health and Safety Training for Hazardous Waste Operations and Emergency Response (1990).

4. "Accreditation of Training Programs for Hazardous Waste Operations," Proposed Standard, (55 FR 2776, January 26, 1990).

CHAPTER 4 SITE CONTROL



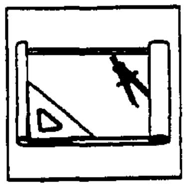
CHAPTER 4 SITE CONTROL

4.0 INTRODUCTION

As an essential element of the HASP, the site control program is used to control the activities and movement of people and equipment at hazardous waste sites in order to minimize the potential for worker exposure to hazardous substances. The provisions at 29 CFR §1910.120(d) require that an appropriate site control program be developed prior to the implementation of response operations. Although the degree of site control necessary for the protection of workers depends largely on site-specific characteristics (e.g., site size, nature of contamination, etc.), 29 CFR §1910.120(d)(3) identifies some essential elements of an effective site control program. These elements are highlighted in **Exhibit 4-1.**

The site control program should be established during the planning stages of a hazardous waste operation. It should be modified as new information becomes available, perhaps as a result of the initial site entry or subsequent site assessments. The appropriate sequence for implementing site control measures should be determined on a site-specific basis; however, it may be necessary to implement several measures concurrently. The remainder of this chapter provides more detail of each of the basic components of a site control program.

4.1 DEVELOPMENT OF THE SITE MAP



As part of the site control program, a map of the hazardous waste site should be developed. The site map represents a central source of information about the site, including the geographic layout and the hazards present at the site. The purpose of the site map is to assist site personnel in planning and organizing response activities. **Exhibit 4-2** presents an example of a site map.

The site map should be developed prior to the initial site entry using information obtained during the preliminary evaluation. The map should include the following information: prevailing wind direction, site drainage points, all natural and man-made topographic features including the location of buildings, containers, impoundments, pits, ponds, tanks, and any other site features. Site maps should be updated often during the course of site operations to reflect:

- New information, such as information gained after initial site entry or from subsequent sampling and analysis activities; or

EXHIBIT 4-1

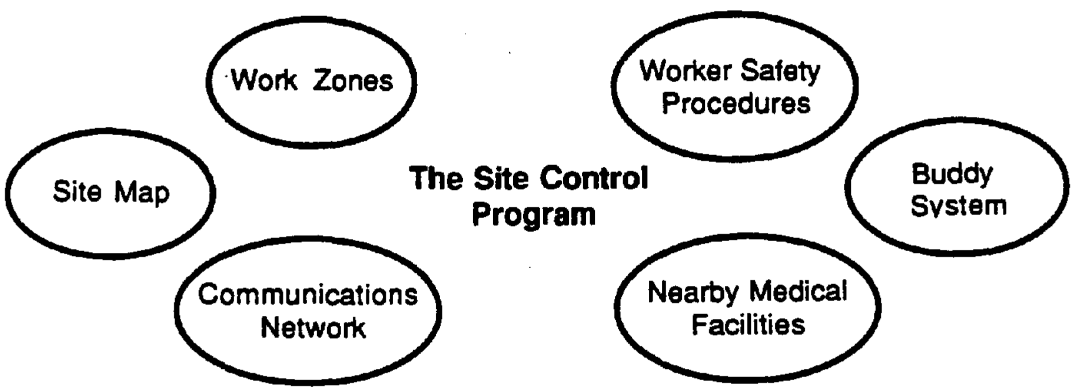
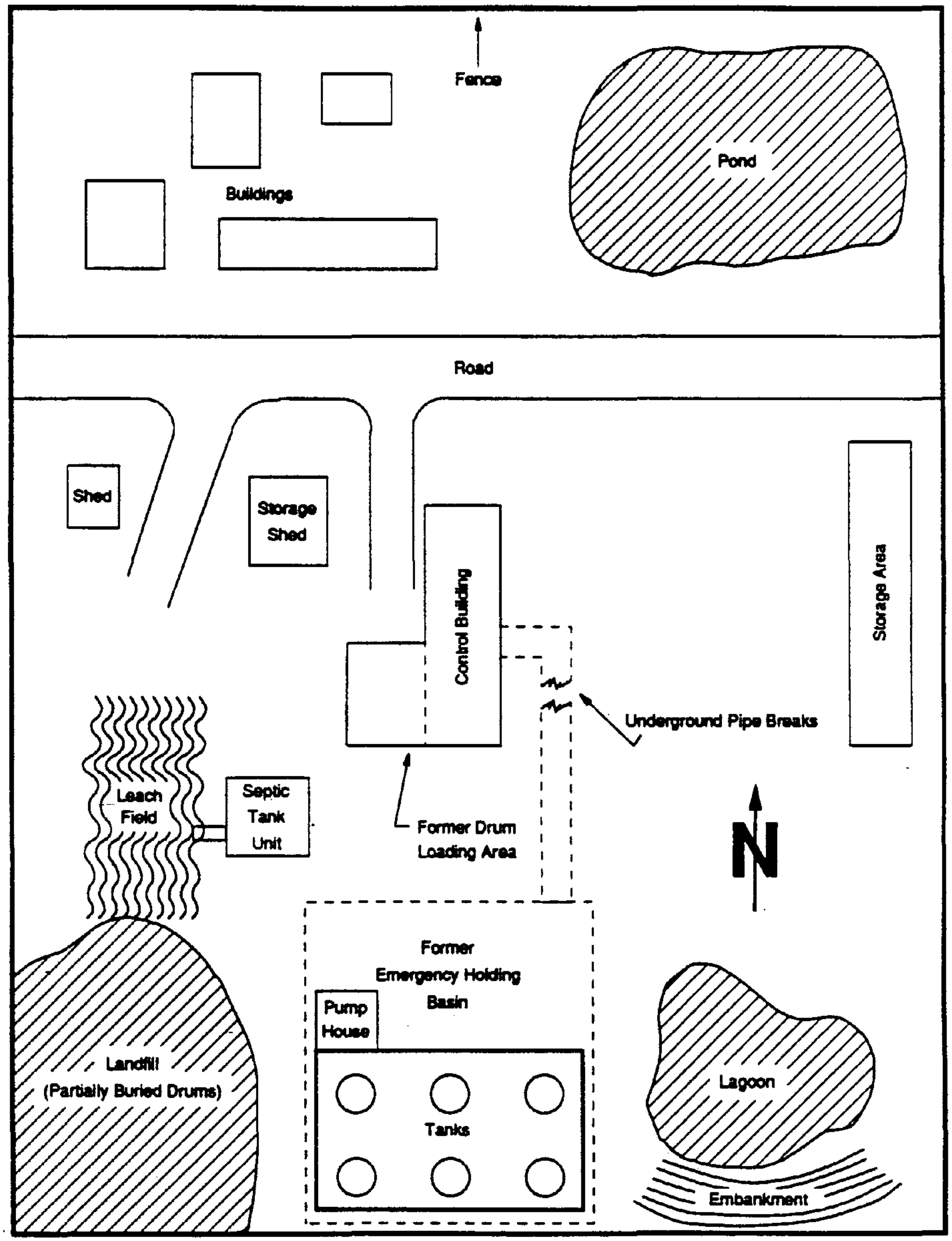


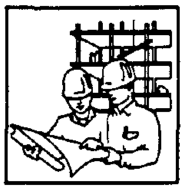
EXHIBIT 4-2
Sample Site Map



- Changes in site conditions, including changes resulting from accidents, ongoing site operations, hazards not previously identified, new materials introduced on-site, unauthorized entry or vandalism, or weather conditions.

As new information is added to the site map, use of overlays and other mapping techniques may reduce the potential cluttering of information.

4.2 ESTABLISHMENT OF WORK ZONES AT THE SITE



One of the basic elements of an effective site control program is the delineation of work zones at the site. This delineation specifies the type of operations that will occur in each zone, the degree of hazard at different locations within the site, and the areas at the site that should be avoided by unauthorized or unprotected employees. Specifically, the purpose of establishing work zones is to:

- Reduce the accidental spread of hazardous substances by workers or equipment from the contaminated areas to the clean areas;

- Confine work activities to the appropriate areas, thereby minimizing the likelihood of accidental exposure; and

- Facilitate the location and evacuation of personnel in case of an emergency.

When establishing the work zones at a site, information from on-site and off-site data collection efforts should be compiled in a format that facilitates a decision concerning the placement of work zones. The site map, as discussed above, can provide a useful format for compiling the relevant data. The locations of all potential hazards that were identified through the interview/records research, the perimeter reconnaissance, and the initial on-site survey should be plotted on the site map. The site map should also indicate both observed and suspected hazards, on- and off-site air and soil sampling results, and potential exposure pathways. It is important to remember that the absence of sampling results should not be considered evidence that an area is clean.

Although a site may be divided into as many zones as necessary to ensure minimal employee exposure to hazardous substances, the three most frequently identified zones are the Exclusion Zone (or "hot zone"), the Contamination Reduction Zone (CRZ), and the Support Zone (or "clean zone"). Movement of personnel and equipment between these zones should be minimized and restricted to specific access control points to prevent cross-contamination from contaminated areas to clean areas. **Exhibit 4-3** illustrates the three most commonly designated work zones. A description of each work zone, and the factors to be considered when establishing them, are provided below.

4.2.1 The Exclusion Zone

The Exclusion Zone is the area where contamination is either known or expected to occur and the greatest potential for exposure exists. The outer boundary of the Exclusion Zone, called the Hotline, separates the area of contamination from the rest of the site. The Hotline should initially be established by visually surveying the site and determining the areal extent of hazardous substances, discoloration, or any drainage, leachate, or spilled material present. Other factors to consider in establishing the Hotline include:

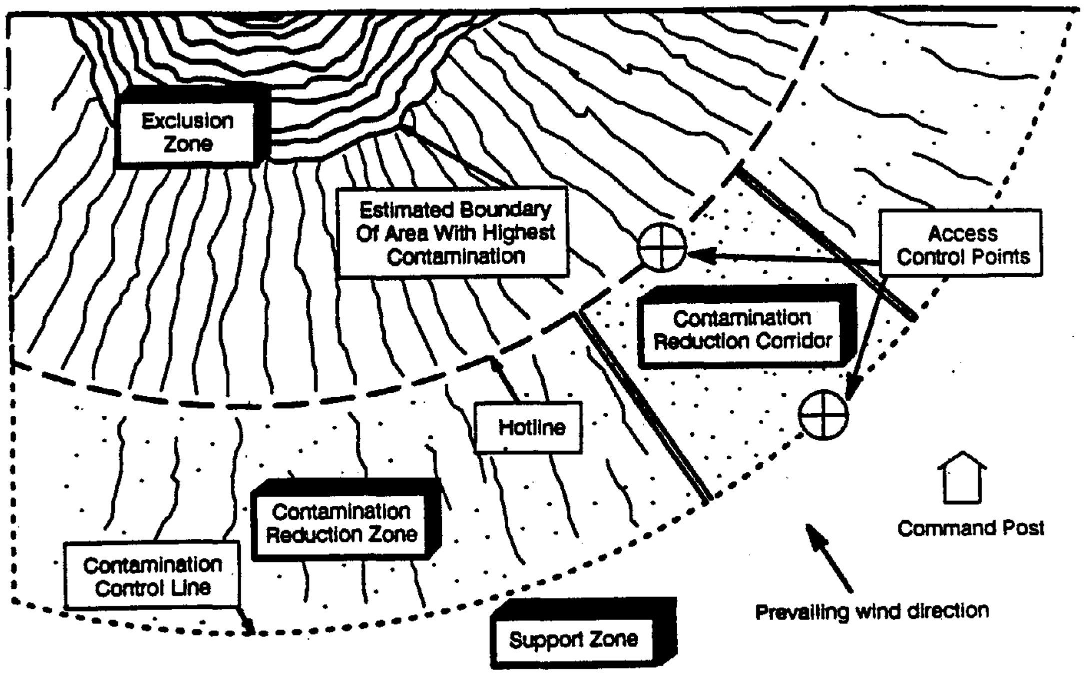
- Providing sufficient space to protect personnel outside the zone from potential fire or explosion;

- Allowing an adequate area in which to conduct site operations; and

- Reducing the potential for contaminant migration.

The Hotline should be physically secured (e.g., using chains, fences, or ropes) or clearly marked (e.g., using lines, placards, hazard tape, and/or signs). During subsequent site operations, the boundary may be modified and adjusted as more information becomes available. In addition, the Exclusion Zone may also be subdivided into different areas of contamination based on the known or expected type and degree of hazards or the incompatibility of waste streams. If the Exclu-

EXHIBIT 4-3
Illustration of Typical Work Zones



Note: Area dimensions not to scale. Distances between points may vary.

sion Zone is subdivided in this manner, additional demarcations (e.g., "Hazards Present" or "Protection Required") may be necessary.

Access to and from the Exclusion Zone should be restricted to Access Control Points at the Hotline. Access Control Points are used to regulate the flow of personnel and equipment into and out of the contamination area and to verify that site control procedures are followed. Separate entrances and exits should be established to separate personnel and equipment movement into and out of the Exclusion Zone. If the Exclusion Zone is subdivided, additional Access Control Points may be necessary to ensure minimal employee exposure.

All persons who enter the Exclusion Zone must wear the appropriate level of PPE for the degree and types of hazards present at the site. If the Exclusion Zone is subdivided, different levels of PPE may be appropriate (see **Chapter 5** for more information on PPE). Each subarea of the Exclusion Zone should be clearly marked to identify the hazards and the required level of PPE.

4.2.2 The Contamination Reduction Zone (CRZ)

As the transition area between the Exclusion Zone ("hot zone") and the Support Zone ("clean zone"), the CRZ is the area in which decontamination procedures take place. The purpose of the CRZ is to reduce the possibility that the Support Zone will become contaminated or affected by the site hazards. Because of both distance and decontamination procedures, the degree of contamination in the CRZ generally will decrease as one moves from the Hotline to the Support Zone.

Initially, the CRZ should be established outside the areas of contamination. Contamination Reduction Corridors, which are Access

Control Points between the Exclusion Zone and the CRZ, should be established for both personnel and heavy equipment. These corridors should consist of an appropriate number of decontamination stations necessary to address the contaminants at a particular site (see **Chapter 9** for more information on decontamination procedures). In some cases, the scale of response operations may require more than two Contamination Reduction Corridors.

The Contamination Control Line marks the boundary between the CRZ and the Support Zone and separates the clean areas of the site from those areas used to decontaminate workers and equipment (i.e., partially contaminated areas). Access Control Points between the CRZ and the Support Zone must be established to ensure that workers entering the CRZ are wearing the proper PPE and that workers exiting the CRZ to the Support Zone remove all potentially contaminated PPE.

4.2.3 The Support Zone

The Support Zone is the uncontaminated area where workers are unlikely to be exposed to hazardous substances or dangerous conditions. The Support Zone is the appropriate location for the command post, medical station, equipment and supply center, field laboratory, and any other administrative or support functions that are necessary to keep site operations running efficiently. Because the Support Zone is free from contamination, personnel working within it may wear normal work clothes, and access to and from the area is not restricted to authorized site personnel. Any potentially contaminated clothing, equipment, and samples must remain outside of the Support Zone until decontaminated. However, all personnel located in the Support Zone must receive instruction in the proper evacuation procedures in case of a hazardous substance emergency.

Designation of the Support Zone should be based on all available site characterization data. One of the most important criteria for the selection of the Support Zone is that it must be located in a clean area. That is, the Support Zone should be in an area that is known to be free of elevated (i.e., higher than background) concentrations of hazardous substances. Monitoring should be conducted to confirm that the area considered for the Support Zone does not contain concentrations of hazardous substances that pose health risks (see **Chapter 6** for details on air monitoring procedures). When evaluating on-site concentrations of hazardous substances, it is important to consider the background concentrations of these substances in the area. In some cases, non-zero (low-level) background concentrations of hazardous substances may be encountered.

The size and position of the Support Zone may be directly affected by the size of the exclusion and contamination reduction zones. For example, the Support Zone may be constrained by the distances needed to prevent an explosion or fire from affecting personnel outside the Exclusion Zone, or the physical area required for activities within the Exclusion Zone. In addition, the Support Zone should be upwind and as far from the Exclusion Zone as practicable. Whenever possible, line-of-sight contact with all activities in the Exclusion Zone should be maintained, and accessibility to support services (e.g., power lines, access roads, telephones, shelter, and water) should be maximized. The expected duration of response operations may also affect the placement of work zones.

4.2.4 Ensuring Integrity of the Support Zone

It is conceivable that the Support Zone may inadvertently become contaminated after site remediation begins. For example, changes in wind speed and direction, temperature, and rainfall may result in exposures different from those experienced during the initial on-site survey. Therefore, the integrity of the Support Zone should be reconfirmed during response operations.

Several procedures can be used to ensure that the area chosen for the Support Zone remains clean during removal or remedial operations. First, the strict use of site controls will minimize the transfer of contamination to the Support Zone. In addition, periodic monitoring of the Support Zone will indicate whether changes in site activities or conditions have resulted in contamination. In the event that contamination has occurred, the boundaries of work zones should be reevaluated and, if appropriate, realigned. Procedures used to maintain work zone integrity are described below.

Use of Site Controls. The CRZ is designed to reduce the probability that the clean Support Zone will become contaminated or affected by other site hazards. The distance between the Exclusion and Support Zones provided by the CRZ, together with decontamination of workers and equipment, limits the physical transfer of hazardous substances into clean areas. The Contamination Control Line, which separates the Support Zone from areas of potential contamination, should include two Access Control Points, if feasible: one for personnel and one for equipment. Persons entering the CRZ should be required to wear PPE appropriate for the types and degree of hazards they may encounter when working in this area. To re-enter the Support Zone from the CRZ, workers should remove gross contamination, remove any protective clothing, leave equipment in the CRZ, and exit through the personnel Access Control Point.

Periodic Monitoring of Support Zone. A monitoring and sampling program for the Support Zone should be established to ensure that this area remains free from contamination. Monitoring should take place on a routine basis and whenever exposure is likely to have changed. The monitoring and sampling activities that may be conducted periodically to ensure that the Support Zone remains clean include:

- Air monitoring using direct-reading instruments.
- Collecting air samples for particulate, gas, and vapor analysis.
- Analysis of soil samples from areas of heavy traffic.
- Swipe tests in trailers and other areas used by personnel.

Increased concentrations of hazardous substances in air, soil, or other environmental media may indicate a breakdown in site control procedures or a change in on-site conditions. Site personnel should be constantly alert to changes in site conditions or the presence of any potentially dangerous situations. Certain site activities may increase the potential for exposure to hazardous substances and, therefore, may indicate a need for additional monitoring. These situations are listed in Exhibit 4-4.

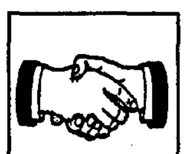
EXHIBIT 4-4
Additional Monitoring Requirements
(29 CFR §1910.120(h)(3))

As specified in 29 CFR §1910.120(h)(3), situations where additional monitoring may be appropriate include:

- When work begins on a different portion of the site;
- When contaminants other than those previously identified are being handled;
- When a different type of operation begins (e.g., drum opening as opposed to exploratory well drilling); and
- When employees are handling leaking drums or containers or working in areas with obvious liquid contamination (e.g., a spill or lagoon).

Additional Site Characterization Information. Additional information concerning locations of contaminated environmental media may become available during monitoring or in the later stages of site investigation and cleanup, particularly for remedial actions. For example, more detailed soil sampling will likely occur during the site inspection and remedial investigation. This additional information may indicate that areas initially thought to be clean are, in fact, contaminated. The location of the Support Zone should be re-evaluated whenever new site characterization studies are conducted.

4.3 ORGANIZATION OF WORKERS USING THE BUDDY SYSTEM



When carrying out activities in the Exclusion Zone, workers should use the buddy system to ensure that rapid assistance can be provided in the event of an emergency. The buddy system is an approach used to organize workers into workgroups so that each worker is designated to be observed by at least one other worker. During initial site entry, it may be appropriate to utilize a buddy system in which two workers are assigned to provide safety backup.

The site manager, who is responsible for enforcing the buddy system, should implement the system at the Access Control Point for personnel entering the Exclusion Zone. This location represents the most logical point to enforce the buddy system as the Site Manager is stationed in the CRZ and all personnel who enter the contaminated area are required to pass through the Access Control Point.

As part of the buddy system, workers should remain close together and maintain visual contact with each other to provide assistance in the event of an emergency. Should an emergency situation arise, workers should use the communication signals established and agreed upon prior to entering the contaminated area (see Section 4.4 below). In general, the responsibilities of workers utilizing the buddy system include:

- Providing his or her partner with assistance;
- Observing his or her partner for signs of chemical or heat exposure;
- Periodically checking the integrity of his or her partner's personal protective equipment; and
- Notifying the site manager or other site personnel if emergency assistance is needed.

Workers should not rely entirely on the buddy system to ensure that help will be provided in the event of an emergency. To augment this system, workers in contaminated areas should remain in line-of-sight or communication contact with the command post or site manager at all times.

4.4 ESTABLISHMENT OF A COMMUNICATION NETWORK AND PROCEDURES

Communication systems should be established at a site for both internal and external communication. Internal communication refers to communication between workers operating in the Exclusion Zone or CRZ, or to communication from the Command Post to these workers. Internal communication is generally used to:

- Alert team members to emergency situations;
- Convey safety information (e.g., air time remaining in SCBA, heat stress check, hazards detected);
- Communicate changes in the work to be accomplished; and
- Maintain site control.

An internal communication system may be established using standard communication devices such as radio, noisemakers, or visual signals (**Exhibit 4-5** lists several common internal communications devices). All communication devices used in a potentially explosive atmosphere must be intrinsically safe (i.e., not capable of sparking) and should be checked daily to ensure that they are operating properly. Because verbal communication at a site can be difficult as a result of on-site background noise and the use of PPE (e.g., speech transmission through a respirator can be poor), pre-arranged commands and audio or visual cues should be developed prior to entering the Exclusion Zone. A secondary set of non-verbal signals should be established for use when communication devices fail or when emergency situations occur (see **Chapter 11** for procedures on communication during emergency situations).

EXHIBIT 4-5
Examples of
Internal Communication Devices

- **Radio**, including FM and Citizens Band;
- **Noisemakers**, including bells, compressed air horns, megaphones, sirens, or whistles; and
- **Visual Signals**, including flags, flare or smoke (only used in the Support Zone), hand signals, lights, signal boards, and whole body movements.

Effective internal communication also requires the identification of individual workers so that commands can be addressed to the right worker. The worker's name should be marked on the suit and, for long-distance identification, color coding, numbers, or symbols can be added. Flags may be used to help locate personnel in areas where visibility is poor due to obstructions such as accumulated drums, equipment, or waste piles.

External communication refers to communication between on-site and off-site personnel. An external communication system must be maintained in order to: (1) coordinate emergency response efforts with off-site responders; (2) report progress or problems to management; and (3) maintain contact with essential off-site personnel. The primary means of external communication are telephone and radio. If telephone lines are not installed at a site, all team members should know the location of the nearest telephone to the site, and the correct change and necessary telephone numbers should be made readily available in the Support Zone. If a radio is used, its location should be clearly marked. Clear instructions for its use should be posted with the radio at all times.

4.5 WORKER SAFETY PROCEDURES

As part of the site control plan, procedures must be established to ensure worker safety. Worker safety procedures include preparation of the site for response activities, engineering controls and safe work practices, and other standing orders to be followed at all times during site operations. Worker safety procedures should be prepared by certified safety professionals in advance of on-site response operations. These procedures should be made available to workers involved in site activities. All workers should be briefed frequently on their use.

4.5.1 Site Preparation

Prior to undertaking response activities, time and effort must be spent in preparing a site for clean-up activities to ensure that response operations go smoothly and that worker safety is ensured. Because site preparation can be as hazardous as site cleanup, personnel should place high priority on safety measures at this stage of site operations. Prior to undertaking on-site response operations, the following site preparation activities should be performed:

- Construct roadways to provide a sound roadbed for heavy equipment and vehicles and arrange traffic patterns to provide ease of access and to ensure safe and efficient operations;
- Eliminate physical hazards from the site to the greatest extent possible, including:
  - -- ignition sources in flammable hazard areas;
  - -- exposed or ungrounded wiring, and low overhead wiring that may entangle equipment;
  - -- sharp or protruding edges (e.g., glass, nails, torn metal, etc.) that may puncture protective clothing and equipment or inflict puncture wounds;
  - -- debris, holes, loose steps or flooring, protruding objects, slippery surfaces, or unsecured railings, that can cause falls, slips, or trips, or obstruct visibility;
  - -- unsecured objects, such as bricks and gas cylinders near the edge of elevated surfaces such as catwalks, roof tops, and scaffolding, that may dislodge and fall on workers;
- Install skid-resistant strips and other anti-skid devices on slippery surfaces;
- Construct operation pads for mobile facilities and temporary structures, loading docks, processing and staging areas, and decontamination pads;
- Provide adequate illumination for work activities. Equip temporary lights with protective guards to prevent accidental contact; and
- Install wiring and electrical equipment in accordance with the National Fire Code.

4.5.2 Engineering Controls and Safe Work Practices

Engineering controls and safe work practices must be specified in the site control program to protect employees from exposure to hazardous substances and other safety and health hazards. Engineering controls and safe work practices should be implemented to reduce and maintain employee exposure levels at or below the permissible exposure levels (PELs) and published exposure levels for those hazardous substances at the site. Examples of engineering controls that may be used include pressurized cabins or control booths on equipment. Safe work practices include such activities as removing nonessential personnel from potential exposure during drum openings, wetting down dusty operations, and locating employees upwind of potential hazards. If, for whatever reason, it is not possible to maintain employee exposure to levels at or below PELs, technical assistance should be obtained before proceeding with site activities (e.g., consult EPA's Environmental Response Team (ERT) or OSHA).

Use of PPE should be a last resort to protect employees against possible exposure to hazardous substances. It should be used only when engineering controls and safe work practices are insufficient to adequately protect against exposure. The PPE used at a site must reflect the potential on-site hazards identified during the PE and site characterization (see **Chapter 5** for detailed information on using PPE).

4.5.3 Standing Orders

Standing orders should be established at a site to maintain a strong safety awareness and to enforce safe work practices. These orders typically are developed for the Exclusion Zone. If the hazards are sufficiently different, standing orders should be developed for the CRZ as well. Standing orders refer to those safety procedures that must always be followed when operating in contaminated areas. Examples of standing orders are provided in **Exhibit 4-6.**

To ensure that all workers are informed of the standing orders, they should be: (1) distributed to everyone who enters the site; and (2) posted conspicuously at the Command Post and at the entrance Access Control Points into the CRZ and/or the Exclusion Zone. In addition, the site manager should review the standing orders at each daily safety briefing and workers should be informed immediately of any new or revised procedures.

EXHIBIT 4-6
Examples of Standing Orders

- Report any signs of radioactivity, explosivity, or unusual conditions to your supervisor immediately
- No Smoking, Eating, Drinking, or Open Flame in the Exclusion Zone or Contamination Reduction Zone
- Check in at the entrance Access Control Point before entering the Exclusion Zone
- Always wear SCBA while in the Exclusion Zone
- Maintain close contact with your buddy in the Exclusion Zone
- Check out at the exit Access Control Point before leaving the Exclusion Zone

In addition to the procedures identified in the standing orders, a hazardous substance information form should be developed that lists the names and properties of all hazardous substances present at the site. This information should be conspicuously posted along with the standing orders. Finally, workers should be briefed on the site's hazardous substances when they first join the response team and when new substances are identified on-site.

4.6 IDENTIFICATION OF NEAREST MEDICAL ASSISTANCE

As part of the site control program, the site manager must post the identification and location of the nearest medical facilities where response personnel can receive assistance in the event of an emergency. Medical facilities typically include area hospitals, emergency clinics, on-call physicians, medical specialists, or emergency, ambulance, fire, and police services. Information to be maintained on the medical facilities should include the names, phone numbers, addresses, and procedures for contacting the facilities. Maps and directions to the medical facilities should also be provided. This information should be posted conspicuously throughout the site, as well as near telephones or other external communication devices. Furthermore, all managers and individuals likely to become involved in medical response at the site should know the directions to the nearest medical facility. The staff at the designated facilities, as well as local Emergency Response personnel, should be aware of site activities and potential hazards prior to any site activity.

FURTHER GUIDANCE: For more information on developing and implementing site controls, see:

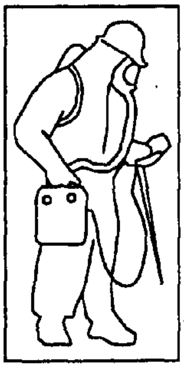
1. *Establishing Work Zones at Uncontrolled Hazardous Waste Sites* (U.S. EPA, 1991, Publication 9285.2-06FS).

2. *Standard Operating Guidelines for Establishing Work Zones* (U.S. EPA, 1985, Publication 9285.2-04A).

CHAPTER 5 PERSONAL PROTECTIVE EQUIPMENT

CHAPTER 5 PERSONAL PROTECTIVE EQUIPMENT

5.0 INTRODUCTION



Vapors, gases, and particulates from hazardous waste site activities place response personnel at risk. For this reason, site personnel must wear appropriate personal protective clothing and equipment (PPE) whenever they are near the site. The purpose of PPE is to shield or isolate individuals from the chemical, physical, and biologic hazards that may be encountered on-site. No single combination of protective clothing and equipment, however, is capable of protecting against all hazards; therefore, PPE should be used in conjunction with (**not in place of**) engineering controls and safe work practices. The effectiveness of the PPE program should be evaluated regularly.

The two basic objectives of any PPE program should be to protect the wearer from safety and health hazards, and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To accomplish these goals, §1910.120(g)(5) of the HAZWOPER standards requires a comprehensive PPE program as part of the site-specific HASP. **Exhibit 5-1** lists the main components of a PPE program. **Exhibit 5-2** lists the other regulations where OSHA has incorporated standards for PPE.

EXHIBIT 5-1
Elements of the PPE Program
(29 CFR §1910.120(g)(5))

- PPE selection based upon site hazards.
- PPE use and equipment limitations.
- Work mission duration.
- PPE maintenance and storage.
- PPE decontamination and disposal.
- PPE training and proper fitting.
- PPE donning and doffing procedures.
- PPE inspection procedures.
- Evaluation of program effectiveness.
- Limitations due to external or medical conditions.

5.1 SELECTING THE LEVEL OF PPE

As required by HAZWOPER, PPE must protect employees from the specific hazards they are likely to encounter on-site. Selection of the appropriate PPE is a complex process that should take into consideration a variety of factors. Key factors might include: (1) identification of the hazards or suspected hazards; (2) potential exposure routes (e.g., inhalation, skin absorption, etc.); and (3) the performance of the PPE materials and seams in providing a barrier to these hazards.

The amount of protection offered by a particular type of PPE is material/hazard-specific. That is, certain types of PPE will protect well against some hazards and poorly, or not at all, against others. Other factors in the selection process include matching the PPE to the employee's work requirements and task-specific conditions. The durability of the PPE material, as well as its performance in extreme heat or cold, must also be considered.

Several guidelines and data bases exist that provide information on protective clothing (e.g., Guidelines for the Selection of Chemical Protective Clothing, and the Chemical Protective Clothing Performance Index). The National Fire Protection Association (NFPA) also issues information and standards (e.g., NFPA 1991: *Stand on Vapor-Protection Suits for Hazardous Chemical Emergencies*). These standards and guides provide data on chemical resistance, design and construction application, reuse and costs. The NFPA standards also provide information on flammability resistance.

The more that is known about the hazards at the site, the easier it becomes to select PPE. As more information about the hazards and conditions at the site becomes available, the site manager can make decisions to upgrade or downgrade the level

EXHIBIT 5-2
Additional Regulations Incorporated by OSHA for Personal Protective Equipment

29 CFR 1910.120: Hazardous Waste Operations and Emergency Response

29 CFR 1910.132: 41 CFR 50-204.7 (General Requirements for Personal Protective Equipment

29 CFR 1910.133(a): ANSI* Z87.1-1968 (Eye and Face Protection)

29 CFR 1910.134: ANSI Z88.2-1969 (Standard Practice for Respiratory Protection)

29 CFR 1910.135: ANSI Z89.1-1969 (Safety Requirements for Industrial Head Protection)

10 CFR 1910.136: ANSI Z41.1-1967 (Men's Safety Toe Footwear)

29 CFR 1926.100: Head Protection
29 CFR 1926.101: Hearing Protection
29 CFR 1926.102: Eyes and Face Protection
29 CFR 1926.103: Respiratory Protection

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* American National Standards Institute
1430 Broadway, New York, NY 10018

of PPE protection to match the tasks at hand and the site hazards. One method of selecting the appropriate level of PPE is to use a numerical criterion -- the total atmospheric vapor/gas concentration. **Exhibit 5-3** outlines the level of PPE required for different ranges of vapor/gas concentrations. (**Chapter 6** provides more detailed information on using action levels to select appropriate levels of protection.)

The following sections present additional guidelines for selecting the appropriate level of PPE. **Exhibit 5-4** provides examples of typical protective clothing, and **Exhibit 5-5** provides sample protective ensembles for each of the four levels of protection (i.e., levels A-D).

5.1.1 Level A

Level A protection is required when the greatest potential for exposure to hazards exists, and when the greatest level of skin, respiratory, and eye protection is required. The following are examples of appropriate Level A equipment: positive pressure, full face-piece self-contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA; totally-encapsulating chemical-protective suit; inner and/or outer chemical-resistant gloves; and disposable protective suit, gloves, and boots.

Meeting any of the following criteria warrants use of Level A protection:

- Hazardous substances have been identified and require the highest level of protection for skin, eyes, and the respiratory system;
- The atmosphere contains less than 19.5 percent oxygen;
- Site operations involve a high potential for splash, immersion, or exposure to unexpected materials that are harmful to the skin;
- Operations are being conducted in confined, poorly ventilated areas, and the absence of hazardous substances has not yet been determined; or
- Direct-reading instruments indicate high levels of unidentified vapors or gases in the air.

EXHIBIT 5-3
Suggested Action Levels for PPE*

Level of Protection	Action Level (in ppm above background)
A	500 to 1,000 ppm
B	5 to 500 ppm
C	Background to 5 ppm
D	N/A

* Note that action levels for PPE based on vapor concentration are <u>only</u> for situations where the identity of the vapor or gas constituents are unknown. They do not address IDLH environments. Refer to Section 6.9 for more information.

EXHIBIT 5-4
Typical Protective Clothing

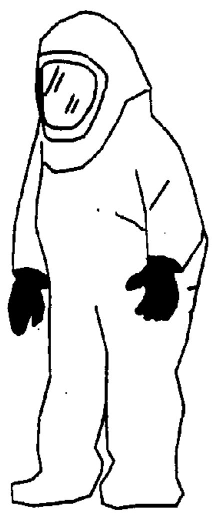
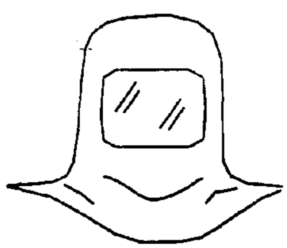
Body Part Protected	Type of Clothing	Type of Protection and Precautions
FULL BODY 	Fully-encapsulating suit (one-piece garment. Boots and gloves may be integral, attached and replaceable, or separate).	Protects against gases, dusts, vapors, and splashes. Does not allow body heat to escape. May contribute to heat stress in wearer.
	Non-encapsulating suit (jacket, hood, pants, or bib overalls, and one-piece coverall).	Protects against splashes, dust, and other materials but not against gases and vapors. Does not protect parts of head and neck. Do not use where gas-tight or pervasive splashing protection is required.
	Aprons, leggings, and sleeve protectors (may be integral or separate). Often worn over non-encapsulating suit.	Provides additional splash protection of chest, forearms, and legs. Useful for sampling, labeling, and analysis operations.
	Radiation-contamination protective suit.	Protects against alpha and beta particles. Does NOT protect against gamma radiation. Designed to prevent skin contamination.
	Flame/fire retardant coveralls (normally worn as an undergarment).	Provides protection from flash fires. May exacerbate heat stress.
HEAD 	Safety helmet (hard hat, made of hard plastic or rubber). May include a helmet liner to insulate against cold.	Protects the head from blows, must meet OSHA requirements at 29 CFR §1910.135.
	Hood (commonly worn over a helmet).	Protects against chemical splashes, particulates, and rain.
	Protective hair covering.	Protects against chemical contamination of hair, prevents hair from tangling in equipment, and keeps hair away from respiratory devices.
EYES & FACE 	Face shield (full-face coverage, eight-inch minimum) or splash hood.	Protects against chemical splashes, but does not protect adequately against projectiles. Provides limited eye protection.
	Safety glasses.	Protects eyes against large particles and projectiles.
	Goggles.	Depending on their construction, can protect against vaporized chemicals, splashes, large particles, and projectiles.

EXHIBIT 5-4
Typical Protective Clothing (cont'd)

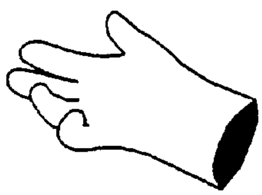
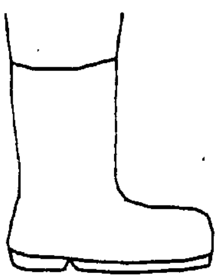
Body Part Protected	Type of Clothing	Type of Protection and Precautions
EARS 	Ear plugs and muffs.	Protects against physiological damage from prolonged loud noise. Use of ear plugs should be reviewed by a health and safety officer because chemical contaminants could be introduced into the ear.
	Headphones (radio headset with throat microphone).	Provides some hearing protection while allowing communication.
HANDS & ARMS 	Gloves and sleeves (may be integral, attached, or separate from other protective clothing).	Protects hands and arms from chemical contact. Wearer should tape-seal gloves to sleeves to provide additional protection and to prevent liquids from entering sleeves. Disposable gloves should be used when possible to reduce decontamination needs.
FEET 	Chemical-resistant safety boots.	Protects feet from contact with chemicals.
	Steel-shank or steel-toe safety boots.	Protects feet from compression, crushing, or puncture by falling, moving, or sharp objects. Should provide good traction.
	Non-conductive or spark-resistant safety boots.	Protects the wearer against electrical hazards and prevents ignition of combustible gases or vapors.
	Disposable shoe or boot covers (slips over regular foot covering).	Protects safety boots from contamination and protects feet from contact with chemicals. Use of disposable covers reduces decontamination needs.

EXHIBIT 5-5
Sample Protective Ensembles[1]

LEVEL OF PROTECTION A			
Equipment	**Protection Provided**	**Should Be Used When:**	**Limiting Criteria**
RECOMMENDED: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Fully-encapsulating, chemical-resistant suit. • Inner chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Two-way radio communications. **OPTIONAL:** Hard hat. Coveralls. Cooling unit. Long cotton underwear. Disposable gloves and boot covers.	The highest available level of respiratory, skin, and eye protection.	1. The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either: - measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or - site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin. 2. Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible. 3. Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined.	Fully encapsulating suit material must be compatible with the substances involved.

LEVEL OF PROTECTION B			
Equipment	**Protection Provided**	**Should Be Used When**	**Limiting Criteria**
RECOMMENDED: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. **OPTIONAL:** Coveralls. Face shield. Disposable boot covers. Long cotton underwear.	The same level of respiratory protection but less skin protection than Level A. It is the minimum level recommended for initial site entries until the hazards have been further identified.	1. The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres: - with IDLH concentrations of specific substances that do not represent a skin hazard; or - that do not meet the criteria for use of air-purifying respirators. 2. Atmosphere contains less than 19.5 percent oxygen. 3. Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.	Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin.

[1] Based on EPA protective ensembles.

EXHIBIT 5-5
Sample Protective Ensembles (cont'd)

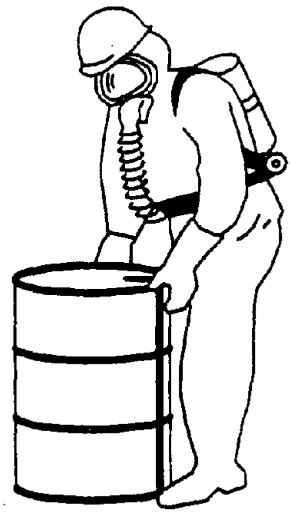
LEVEL OF PROTECTION C			
Equipment	**Protection Provided**	**Should Be Used When:**	**Limiting Criteria**
RECOMMENDED: • Full-facepiece, air-purifying, canister-equipped respirator. • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. **OPTIONAL:** Coveralls. Disposable boot covers. Face shield. Long cotton underwear. Use of escape mask during initial entry is optional only after characterization (29 CFR 1910.120(c)(5)(ii)).	The same level of skin protection as Level B, but a lower level of respiratory protection.	1. The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin. 2. The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant. 3. All criteria for the use of air-purifying respirators are met.	Atmospheric concentration of chemicals must not exceed IDLH levels. The atmosphere must contain at least 19.5 percent oxygen.

LEVEL OF PROTECTION D			
Equipment	**Protection Provided**	**Should Be Used When**	**Limiting Criteria**
RECOMMENDED: • Coveralls. • Safety boots/shoes. • Safety glasses or chemical splash goggles. • Hard hat. **OPTIONAL:** Gloves. Escape mask. Face shield.	No respiratory protection. Minimal skin protection.	1. The atmosphere contains no known hazard. 2. Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.	This level should not be worn in the Exclusion Zone. The atmosphere must contain at least 19.5 percent oxygen.

EXHIBIT 5-5
Sample Protective Ensembles (cont'd)

LEVEL A Protection

Totally encapsulating vapor-tight suit with full-facepiece SCBA or supplied-air respirator.

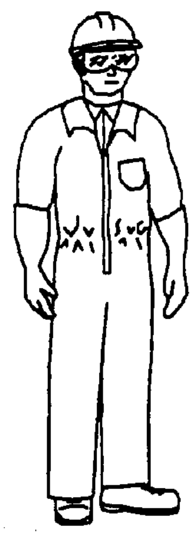


LEVEL B Protection

Totally encapsulating suit does not have to be vapor-tight. Same level of respiratory protection as Level A.

LEVEL C Protection

Full-face canister air purifying respirator. Chemical protective suit with full body coverage.



LEVEL D Protection

Basic work uniform, i.e., longsleeve coveralls, gloves, hardhat, boots, faceshield or goggles.

It may be necessary to base the decision to use Level A protection on indirect evidence. Other conditions that may indicate the need for Level A protection include:

- Confined spaces;
- Suspected or known highly toxic substances, especially when field equipment is not available to test concentrations;
- Visible indicators such as leaking containers or smoking chemical fires; and
- Potentially dangerous tasks, such as initial site entry.

5.1.2 Level B

Level B protection is required under circumstances requiring the highest level of respiratory protection, with a lesser level of skin protection. Potential Level B equipment includes: positive pressure, full face-piece SCBA or positive pressure supplied air respirator with escape SCBA; inner and/or outer chemical-resistant gloves; face shield; hooded chemical resistant clothing; coveralls; and outer chemical-resistant boots.

Meeting any of the following criteria warrants use of Level B protection:

- The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection than Level A;
- The atmosphere contains less than 19.5 percent oxygen; or
- The presence of incompletely identified vapors and gases is indicated but they are not suspected of being harmful to the skin.

The use of Level B protection does not afford as great a level of protection to the skin and eyes as Level A, but it does provide a high level of respiratory protection. At most abandoned, outdoor hazardous waste sites, ambient atmospheric vapor or gas levels have not approached sufficiently high concentrations to warrant Level A protection. Level B protection is often adequate.

5.1.3 Level C

Level C protection is required when the concentration and type of airborne substances is known, and the criteria for using air purifying respirators is met. Typical Level C equipment includes: full-face air-purifying respirators, inner and outer chemical-resistant gloves, hard hat, escape mask, and disposable chemical-resistant, outer boots.

Meeting any of the following criteria warrants use of Level C protection:

- The atmospheric contaminants, liquid splashes or other direct contact will not adversely affect or be absorbed by the skin;
- The types of air contaminants have been identified, concentrations do not exceed IDLH levels, and an air-purifying respirator is available that can remove the contaminants; and
- Oxygen concentrations are not less than 19.5 percent by volume, and job functions do not require SCBA.

Level C protection is distinguished from Level B by the equipment used to protect the respiratory system, assuming the same type of chemical-resistant clothing is used. The main selection criterion for Level C is that atmospheric concentrations and other selection criteria permit wearing an air-purifying respirator.

5.1.4 Level D

Level D is the minimum protection required. Appropriate Level D protective equipment may include: gloves, coveralls, safety glasses, face shield, and chemical-resistant steel-toe boots or shoes. Level D protection is primarily a work uniform. This protection is sufficient under the following conditions:

- No contaminants are present; or
- Work operations preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

While these are guidelines for typical equipment to be used in certain circumstances, other combinations of protective equipment may be more appropriate, depending upon specific site characteristics. As an aid to selecting appropriate protective wear, it is recommended that chemical protective suits meet the standards developed by the National Fire Protection Association (NFPA).

5.2 ELEMENTS OF THE PPE PROGRAM

The comprehensive PPE program must address a number of specific factors in addition to selection of the appropriate level of protection. These factors are discussed below. Site managers should also refer to the *Standard Operating Procedures for Site Entry* for additional technical guidance in the use and selection of PPE.

5.2.1 Personal Use Factors and Equipment Limitations

Certain personal features of workers may jeopardize safety during equipment use. Prohibitive or precautionary measures should be taken as necessary for the following personal features:

Facial hair and long hair that passes between the face and the sealing surface of the respirator should be prohibited because it interferes with respirator fit and wearer vision, allowing excessive contaminant penetration. Long hair must be effectively contained within protective hair coverings.

Eyeglasses with conventional temple pieces will interfere with the respirator-to-face seal of a full face-piece. A spectacle kit should be installed in the face masks of workers requiring vision correction, providing a gas-tight seal. Contact lenses may trap contaminants and/or particulate between the lens and the eye, causing irritation. Wearing contact lenses with a respirator in a contaminated atmosphere is prohibited (29 CFR §1910.134(e)(5)(iii)).

Gum and tobacco chewing should be prohibited during respirator use because they may cause ingestion of contaminants and may compromise the respirator fit.

It is especially important to understand all aspects of the clothing operation and the limitations of fully-encapsulating ensembles, as misuse could result in suffocation. During equipment use, workers should be encouraged to report any perceived problems or difficulties to their supervisor(s). These malfunctions may include, but are not limited to:

- Degradation of the protective ensemble.
- Perception of odors.
- Skin irritation.
- Unusual residues on PPE.
- Discomfort.
- Resistance to breathing.
- Fatigue due to respirator use.
- Interference with vision or communication.
- Restriction of movement.
- Personal responses such as rapid pulse, nausea, and chest pain.

If a supplied-air respirator is being used, all hazards that might endanger the integrity of the air line should be removed from the working area prior to use. During use, other workers and vehicles should be excluded from the area.

5.2.2 Work Mission Duration

In selecting PPE, it is important to consider the anticipated duration of the work mission. Several factors may limit the mission length, including: air supply, equipment effectiveness, temperature, and coolant supply.

Air Supply Consumption. The duration of the air supply must be considered before planning any SCBA-assisted work activity. The anticipated operating time of a SCBA is clearly indicated on the breathing apparatus. This designated operating time is based on a moderate work rate used in the NIOSH/MSHA certification test. In actual operation, however, several factors can reduce the rated operating time. The following variables should be considered to adjust work actions and operating time accordingly:

- Work rate. The actual in-use duration of SCBAs may be reduced by one-third to one-half during strenuous work (e.g., drum handling, major lifting, or any task requiring repetitive speed of motion).

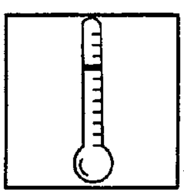
- Fitness. Well-conditioned individuals generally utilize oxygen more efficiently and can extract more oxygen from a given volume of air than unfit individuals, thereby slightly increasing the SCBA operating time.

- Body size. Larger individuals generally consume air at a higher rate than smaller individuals, thereby decreasing the SCBA operating time.

- Breathing patterns. Quick, shallow, or irregular breaths use air more rapidly than deep, regularly spaced breaths. Heat-induced anxiety and lack of acclimatization may induce hyperventilation, resulting in decreased SCBA operating time.

Suit/Ensemble Permeation, Degradation, and Penetration. The possibility of chemical permeation, degradation, or penetration of protective ensembles during the work mission is always a matter of concern and may limit mission duration. Possible causes are suit valve leakage, because of excessively hot or cold temperatures or improper maintenance, and exhalation valve leakage at excessively hot or cold temperatures.

Also, when considering mission duration, it should be remembered that no single clothing material is an effective barrier to all chemicals or all combinations of chemicals, and no material is an effective barrier to prolonged chemical exposure.



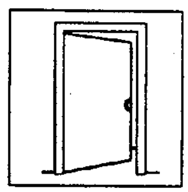
Ambient Temperature. The ambient temperature may have a major influence on work mission duration as it affects both the worker and the protective integrity of the ensemble. Heat stress, which can occur even in relatively moderate temperatures, presents the greatest immediate danger to an ensemble-encapsulated worker. Protecting against heat stress is discussed later in this chapter. Hot and cold ambient temperatures also can affect:

- Valve operation on suits and/or respirators;
- The durability and flexibility of suit materials;
- The integrity of suit fasteners;
- The breakthrough time and permeation rates of chemicals; and
- The concentration of airborne contaminants.

All of these factors may decrease the duration of protection provided by a given piece of clothing or respiratory equipment.

Coolant Supply. Under warm or strenuous work conditions, adequate coolant (e.g., ice or chilled air, refrigeration coils) should be provided to keep the wearer's body at a comfortable temperature and to reduce the potential for heat stress. If coolant is necessary, the duration of the coolant supply will directly affect mission duration.

5.2.3 Storage and Maintenance



Clothing and respirators must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Many equipment failures can be directly attributed to improper storage. Procedures must be specified for both pre-issuance warehousing and, more importantly, post-issuance (in-use) storage.

Potentially contaminated, reusable clothing should be stored (generally bagged) in a well-ventilated area, with good air flow around each item, until the extent of contamination is documented. The garment is then either decontaminated or disposed. Never store these materials near street clothing.

Different types and materials of clothing and gloves should be stored separately to prevent issuing the wrong material by mistake. Protective clothing should be folded or hung in accordance with manufacturers' recommendations.

SCBAs, supplied-air respirators, and air-purifying respirators should be dismantled, washed, and disinfected after each use. SCBAs should be stored in storage chests supplied by the manufacturer. Air-purifying respirators should be stored individually in their original cartons or carrying cases, or in heat-sealed or resealable plastic bags.

The technical aspects of PPE maintenance procedures vary by manufacturer and type of equipment. Manufacturers frequently restrict the sale of certain PPE parts only to individuals or groups who are specially trained, equipped, and "authorized" by the manufacturer to purchase them. Explicit procedures should be adopted in the site work plan to ensure that the appropriate level of maintenance is performed only by individuals trained at that level.

The following classification scheme is often used to divide maintenance into three levels:

- **Level 1**: User or wearer maintenance, requiring a few common tools or no tools at all.
- **Level 2**: Shop maintenance that can be performed by the employer's maintenance shop.
- **Level 3**: Specialized maintenance that can be performed only by the factory or an authorized repair person.

5.2.4 Training and Proper Fitting

The PPE program must ensure that employees are trained in the proper use and fitting of PPE.

Training. Employees should be trained in the proper use of protective equipment prior to using any PPE on-site. The purpose of training is to: (1) become familiar with the equipment in a nonhazardous situation; (2) instill confidence and awareness in the user of the limitations and capabilities of the equipment; (3) increase the operating and protective efficiency of PPE use; and (4) reduce maintenance expenses.

Training must be completed prior to actual PPE use in any hazardous environment and should occur at least annually. At a minimum, the training portion of the PPE program should explain the user's responsibilities and should address the following issues, utilizing both classroom and field training when necessary:

- OSHA requirements as delineated in 29 CFR Part 1910, Subparts I and Z.
- OSHA requirements for respiratory protection at 29 CFR §1910.134.
- The proper use and maintenance of the selected PPE, including capabilities and limitations.
- The nature of the hazards and the consequences of not using PPE.
- Instruction in inspection, donning, doffing, decontaminating, checking, fitting, and using PPE.
- Individualized respirator fit testing to ensure proper fit.
- Use of PPE in normal air for a long familiarity period, as well as use of PPE in a test atmosphere to evaluate its effectiveness.
- The user's responsibility (if any) for decontamination, cleaning, maintenance, and repair of PPE.
- Emergency procedures and self-rescue in the event of PPE failure.
- The elements of the HASP and the individual's responsibilities and duties in an emergency, including the buddy system (see **Chapter 4**).
- The human factors influencing PPE performance. The discomfort and inconvenience of wearing PPE can create a resistance to the conscientious use of PPE. One essential aspect of training is to make the user aware of the need for PPE and to instill motivation for the proper use and maintenance of PPE.

Respirator Fit Testing. The "fit" of the facepiece-to-face seal of a respirator must be tested on each potential wearer to ensure a tight seal; every facepiece does not fit every wearer. Certain features, such as scars, very prominent cheekbones, deep skin creases, dentures or missing teeth, and the chewing of gum and tobacco may interfere with the respirator-to-face seal. Under conditions where these features may impede a good seal, a respirator must not be worn.

For a qualitative respirator fit testing protocol, see Appendix D of the OSHA lead standard (29 CFR §1910.1025). For specific quantitative testing protocols, literature supplied by manufacturers of quantitative fit testing equipment should be consulted.

5.2.5 Donning and Doffing Procedures

The PPE program should include clearly defined donning and doffing procedures.

Donning. A routine should be established and practiced periodically for donning all levels of protective clothing and equipment. As donning and doffing the ensembles can be difficult to perform alone and solo efforts increase the possibility of improper use and suit damage, assistance should be provided. The donning routine should be modified depending on the particular type of suit or the need for extra gloves or boots. Once the equipment has been donned, the fit should be evaluated. The clothing should not be too small, increasing the likelihood of tearing the suit material and accelerating worker fatigue, nor should it be too large, increasing the possibility of snagging the material and compromising the dexterity and coordination of the worker. In either case, better fitting clothing should be provided.

Doffing. Exact procedures for removing PPE must be established and followed to prevent contaminant migration from the work area and transfer of contaminants to the wearer's body, the doffing assistant, and others. These procedures should be performed only after decontamination of the suited worker (see **Chapter 9**). Although they require a suitably attired assistant, both worker and assistant should avoid any direct contact with the outside surface of the contaminated suit throughout the decontamination procedures. If the suit is to be reused, the assistant should also avoid contact with the inside of the garment.

5.2.6 Inspection Procedures

An effective PPE inspection program should feature four different inspections:

- Inspection and operational testing of equipment received from the factory or distributor;
- Inspection of equipment as it is issued;
- Inspection before and after use or training and prior to maintenance; and
- Periodic inspection of stored equipment.

The inspection checklist in **Exhibit 5-6** may be helpful in conducting inspections of PPE prior to and during regular use. Periodic inspection will cover somewhat different areas in varying degrees of depth. Detailed inspection procedures, where appropriate, are usually available from the manufacturer.

Individual identification numbers should be assigned to all reusable pieces of equipment and records must be maintained, by number, of all inspection procedures. At a minimum, each inspection should record the ID number, date, inspector, and any unusual conditions or findings.

5.2.7 PPE Program Evaluation

At a minimum, the PPE program should be reviewed annually to evaluate the effectiveness of the following factors:

- The number of personnel-hours that are spent in various PPE ensembles;
- The degree to which the site complies with the HAZWOPER standards on PPE use, inspection, maintenance, and recordkeeping;
- Accident, injury, and illness statistics, and recorded levels of exposure;
- The adequacy of operating procedures to guide the selection of PPE;
- The degree of coordination with comprehensive and site-specific health and safety programs; and
- Recommendations for and results of program improvement and modification.

5.2.8 Other Considerations

There are other factors, not discussed above, that may also affect the use and effectiveness of PPE. Several of these factors, dealing with the physical state of the user, are discussed below.

Heat Stress. Wearing PPE puts a hazardous waste worker at considerable risk of developing heat stress, which can result in adverse health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and

EXHIBIT 5-6
Sample PPE Inspection Checklists

CLOTHING

Before use:

- Determine that the clothing materials are correct for the specified task at hand.
- Visually inspect for:
  - imperfect seams
  - non-uniform coatings
  - tears
  - malfunctioning closures
- Hold up to light and check for pinholes.
- Flex product:
  - observe for cracks
  - observe for other signs of shelf deterioration
- If the product has been used previously, inspect inside and out for signs of chemical attack:
  - discoloration
  - swelling
  - stiffness

During the work task, periodically inspect for:

- Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects.
- Closure failure.
- Tears.
- Punctures.
- Seam discontinuities.

GLOVES

Before use:

- Pressurize glove to check for pinholes. Either blow into glove, then roll gauntlet towards fingers or inflate glove and hold under water. In either case, no air should escape.

FULLY-ENCAPSULATING SUITS

Before use:

- Check the operation of pressure relief valves.
- Inspect the fitting of wrists, ankles, and neck.
- Check faceshield, if so equipped, for:
  - cracks
  - fogginess

RESPIRATORS*

SCBA

- Inspect SCBAs:
  - before and after each use
  - at least monthly when in storage
  - every time they are cleaned
- Check all connections for tightness.
- Check material conditions for:
  - signs of pliability
  - signs of deterioration
  - signs of distortion
- Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations).
- Check operation of alarm(s).
- Check faceshields and lenses for cracks and fogginess

Air-Purifying Respirators

- Inspect air-purifying respirators:
  - before each use to be sure they have been adequately cleaned
  - after each use
  - during cleaning
  - monthly if in storage for emergency use
- Check material conditions for:
  - signs of pliability
  - signs of deterioration
  - signs of distortion
- Examine cartridges or canisters to ensure that:
  - they are the proper type for the intended use
  - the expiration date has not been passed
  - they have not been opened or use previously
- Check faceshields and lenses for cracks and fogginess

Supplied-Air Respirators

- Inspect supplied-air respirators:
  - daily when in use
  - at least monthly when in storage
  - every time they are cleaned
- Inspect air lines prior to each use for cracks, kinks, cuts, frays, and weak areas.
- Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations).
- Check all connections for tightness.
- Check material conditions for:
  - signs of pliability
  - signs of deterioration
  - signs of distortion
- Check faceshields and lenses for cracks, fogginess

*** Must have NIOSH/MSHA approval**

the individual characteristics of the worker. Heat stress is one of the most common and potentially serious illnesses at hazardous waste sites and, therefore, warrants regular monitoring and other preventive measures. **Chapter 8** provides more detailed information on heat stress and PPE.

Other Factors. Although wearing PPE decreases a worker's performance, the magnitude of this effect varies considerably, depending on both the individual and the PPE ensemble used. One of the physiological factors that may affect worker ability to function using PPE is physical fitness. The more fit someone is, the more work they can perform safely. At a given level of work, a fit person, relative to an unfit person, will have: less physiological strain; a lower heart rate; a lower body temperature, indicating less retained body heat; a more efficient sweating mechanism; slightly lower oxygen consumption; and slightly lower carbon dioxide production.

The degree to which a worker's body has adjusted or acclimatized to working under hot conditions may affect his or her ability to do work. Acclimatized individuals generally have better mechanisms to maintain lower skin and body temperatures at a given level of environmental heat and work loads. Although acclimatization can occur quickly, a progressive 6-day acclimatization period before allowing an employee to work a full shift on a hot day is recommended. With fit or trained individuals, the acclimatization period may be shortened by 2 or 3 days. Acclimatization can occur quickly, and work regimens should be adjusted to account for this.

FURTHER GUIDANCE: For more information on selecting, using, and maintaining PPE, see:

1. *Certified Equipment List as of December 31, 1990.* (NIOSH, 1991, Publication 91-105) Cincinnati, OH. Updated annually.

2. *Standard Operating Guidelines for Site Entry* (U.S. EPA, 1985, Publication 9285.2-01A).

3. Schwope, A.D.; Costas, P.P.; Jackson, J.O.; Stull, J.O.; and D.J. Weitzman, 1987, *Guidelines for the Selection of Chemical Protective Clothing, 3rd Edition.* American Conference of Governmental Industrial Hygienists, Inc. Cincinnati, OH.

4. *National Fire Codes: A Compilation of NFPA Codes, Standards, Recommended Practices and Guides, Vol.8.* (1991, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101).

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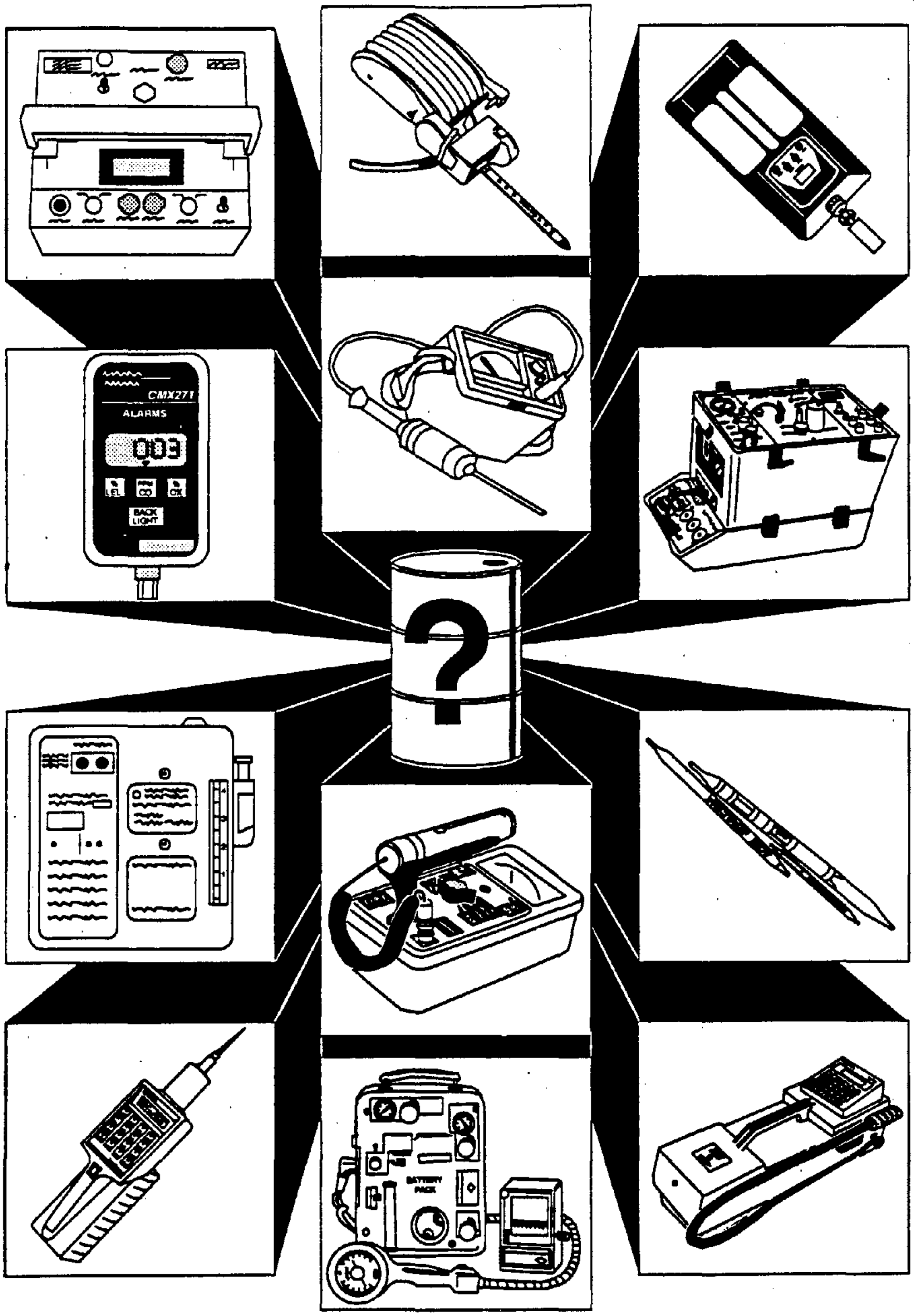
CHAPTER 6 AIR MONITORING



CHAPTER 6 AIR MONITORING

6.0 INTRODUCTION

The presence of hazardous materials at a site, as well as actions taken to address these materials, can cause the release of hazardous substances into the air. Chemical fires, transportation accidents, open or leaking containers, wind-blown dust, and site cleanup activities produce emissions that can rapidly affect the health and safety of response personnel and the public. Hazardous atmospheres can be:

- Explosive (characterized by the presence of ignitable or explosive vapors, gases, aerosols, and dusts);
- Toxic (characterized by the presence of vapors, gases, particulates, and aerosols);
- Oxygen-deficient (characterized by the displacement of breathable air); or
- Radioactive (characterized by the presence of radioactive materials).

The presence of one or more of these hazards is an important factor in determining subsequent actions that should be taken to protect people and the environment. Their presence may dictate operations that are necessary to mitigate the likelihood of an incident, and safety considerations for response personnel.

Airborne hazards can be predicted if the substance involved, its chemical and physical properties, and weather conditions are known. However, air monitoring is necessary to confirm predictions, to identify or measure contaminants, and to detect unknown air pollutants. Therefore, 29 CFR §1910.120(h) sets forth specific requirements for air monitoring. The remainder of this chapter describes the air monitoring requirements and outlines a number of practices that can be implemented to meet these requirements most effectively.

6.1 OBJECTIVES OF AIR MONITORING

The objectives of air monitoring during response operations are to:

- Identify and quantify airborne contaminants on- and off-site;
- Track changes in air contaminants that occur over the lifetime of the incident;
- Ensure proper selection of work practices and engineering controls;
- Determine the level of worker protection needed;
- Assist in defining work zones; and
- Identify additional medical monitoring needs in any given area of the site.

HAZWOPER requires air monitoring to be performed wherever the possibility of employee exposure to hazardous substances exists. Upon initial entry, representative air monitoring should be conducted to identify any IDLH conditions, exposure over PELs, exposure over a radioactive material's dose limits, or other dangerous conditions, such as flammable or oxygen-deficient environments. Air monitoring should also be conducted to confirm that the area considered for the Support Zone is clean (i.e., does not contain concentrations of hazardous substances that require worker protection). If there is any question that contaminants may have migrated into the area considered for the Support Zone, air and/or surface soil samples should be collected and compared with on-site and off-site background samples.

To determine whether additional monitoring is required to designate work zones, the site manager should evaluate the results of the initial air monitoring survey, the visual characterization of site hazards, the properties of on-site contaminants, and potential pathways of contaminant dispersion. During the site hazard evaluation, the site manager should use information from direct-reading instruments, visible indicators (signs, labels, placards, etc.), and other sources (manifests, inventories, government agency records, etc.) to evaluate the presence or potential for the release of contaminants into the air. Limited air sampling may also be conducted if time is available. Based on an assessment of this preliminary information, a more comprehensive air monitoring strategy should be developed and implemented.

During the response operation, (e.g., when soil or containers are moved or disturbed), employers should monitor those employees likely to have the highest exposures to hazardous substances (i.e., exposures above PELs). In accordance with 29 CFR §1910.120(h)(4), if any employee has been exposed to elevated levels of hazardous substances, extensive personal monitoring must be conducted, in conjunction with additional site control measures, to ensure employee health and safety.

6.2 IDENTIFYING AIRBORNE CONTAMINANTS

The two methods generally available for identifying and/or quantifying airborne contaminants are: (1) on-site use of direct-reading instruments (DRIs); and (2) laboratory analysis of air samples obtained by gas sampling bag, filter, sorbent, or wet-contaminant collection methods.

DRIs may be used to quickly detect flammable or explosive atmospheres, oxygen deficiency, certain gases and vapors, and ionizing radiation, as well as to identify changing site conditions. Because DRIs provide information at the time of sampling and allow for rapid decision-making, they are the primary tools of initial site characterization. All DRIs, however, have inherent limitations in their ability to detect hazards. DRIs detect and/or measure only specific classes of chemicals and usually are not designed to detect airborne concentrations below 1 ppm. In addition, many of the DRIs that have been designed to detect one particular substance also detect other substances and, consequently, may give false readings. DRIs must be operated, and their data interpreted, by qualified individuals using properly calibrated instruments. Additional monitoring should be conducted at any location where a positive instrument response occurs.

Because DRIs are available for only a few specific substances and are rarely sensitive enough to detect low concentrations of hazardous substances that may nonetheless present health risks, long-term or "full-shift" air samples must also be collected and analyzed in a laboratory. Full-shift air samples for some chemicals may be collected with passive dosimeters, or by means of a pump that draws air through a filter or sorbent.

Selection of the proper sampling media is determined by the physical state of the contaminants. Some chemicals, such as PCBs, may occur as both vapors and particulate-bound contaminants. In such cases, a dual-media system is needed to measure accurately for the chemical.

6.2.1 Direct Reading Instruments

During site operations, it is essential to monitor for the presence of, or changes in, the level of airborne contaminants. Changes in contaminant levels may occur when work is initiated in a different area of the site, new contaminants are discovered, or different types of operations are begun in a particular area (e.g., drum opening, as opposed to exploratory well drilling). DRIs can be used to provide approximate total concentrations of many organic chemicals and a few inorganic substances. If specific organics (and inorganics) have been identified, then DRIs calibrated to those materials can be used for more accurate on-site assessment.

To obtain air monitoring data rapidly at the site, monitoring personnel may use instruments with flame ionization detectors (FIDs), photo-ionization detectors (PIDs), and other similar instruments. These may be used as survey instruments (total concentration mode), or operated as gas chromatographs (gas chromatograph mode). As gas chromatographs, these instruments can provide real-time, qualitative/quantitative data when calibrated with standards of known air contaminants. Combined with selective laboratory analysis of samples, they provide an excellent tool for evaluating airborne organic hazards on a real-time basis, at a lower cost than analyzing all samples in a laboratory. **Exhibit 6-1** lists several direct-reading air monitoring instruments, and **Appendix D** presents more specific information on the characteristics of the PID and the organic vapor analyzer (OVA).

EXHIBIT 6-1
Summary of Direct-Reading Air Monitoring Instruments

Principle of Detection and Monitoring Need	Instrument	Features	Limitations
Wheatstone Bridge Filament *Monitoring Need:* ***Combustible Gas***	Combustible Gas Detector	• Nonspecific detector for combustible gases measures gas concentrations as a percentage of lower explosive limit (LEL) • Lightweight, portable, and easy to use • Visual and audible alarms • Probe provides remote sensing capabilities • 8- to 12-hour battery operating life for most models • Accuracy varies depending upon the model; accuracies of ± 2 to 3 percent are attainable	• Potential interferences from leaded gasoline and silicates, which are more strongly adsorbed on catalyst than oxygen or gas in question. Membranes are available to minimize these effects. • Most models do not measure specific gases • May not function properly in oxygen-deficient atmospheres ((10 percent)
Chemical Cell *Monitoring Need:* ***Oxygen Deficiency***	Oxygen Meter	• Direct readout in percent oxygen • Visual and audible alarm • Lightweight, portable, and easy to use • Probe provides remote sensing capabilities • Accuracies of ± 1 percent are attainable, but depend on the particular model • Generally 8- to 10-hour battery life	• High humidity may cause interference • Strong oxidants may cause artificially high readout
Chemical Sensor Wheatstone Bridge Filament *Monitoring Need:* ***Combustible Gas/Oxygen Deficiency***	Combination Oxygen Meter and Combustible Gas Detector	• Calibrated to Pentane or Hexane • Measure percent oxygen and gas concentration as a percentage of LEL • Both visual and audible alarm • Remote sensing capabilities • Lightweight, portable, and easy to use • Accuracies of ± 2 percent are attainable but may be as high as ± 10 percent, depending on the models	• Same limitation as oxygen meters and combustible gas detectors • In certain units, acid gases and high CO_2 concentrations shorten the life of oxygen sensor/cells • Certain units require conversion factor for true specific compound response readings • In certain units, oxygen calibration is altitude dependent
Optical, Electrical, Piezoelectric *Monitoring Need:* ***Aerosol/ Particulate***	Aerosol/ Particulate Monitor	• Selectable ranges • Particle size differentiation available • Certain units have data logging capabilities	• Factory recalibration required on certain units • Values represent total particulates: dust, mist, aerosols are all inclusive with no differentiation • Cold weather may have adverse effect on detector

EXHIBIT 6-1
Summary of Direct-Reading Air Monitoring Instruments

Principle of Detection and Monitoring Need	Instrument	Features	Limitations
Photoionization Ultraviolet Light *Monitoring Need:* ***Toxic Gas/ Vapors***	Photoionization Detector (PID)	• Nonspecific gas and vapor detection for organics and some inorganics • Not recommended for permanent gases • Lightweight (4 to 9 lbs) and portable • Sensitive to 0.1 ppm benzene. Sensitivity is related to ionization potential of compound • Remote sensing capabilities • Response time of 90 percent in less than 3 seconds • More sensitive to aromatics and unsaturated compounds that the flame ionization detector (FID) • 8-hour battery operating life; certain units with external interchangeable battery packs • Audible alarm is available • Certain units have data logging/computer interface capabilities • Certain units available with calibration libraries • Certain units available with interchangeable lamps	• Does not monitor for specific gases or vapors • Cannot detect hydrogen cyanide or methane • Cannot detect some chlorinated organics • High humidity and precipitation negatively affect meter response
Hydrogen Flame Ionization *Monitoring Need:* ***Toxic Gas/ Vapors***	Flame Ionization Detector (FID)	• In the survey mode, it functions as a nonspecific total hydrocarbon analyzer; in the gas chromatograph mode, it provides tentative qualitative/quantitative identification • Most sensitive to saturated hydrocarbons, alkanes, and unsaturated hydrocarbon alkanes • Lightweight (12 lbs) and portable • Remote sensing probe is available • Response time is 90 percent in 2 seconds • 8-hour battery operating life • Sounds audible alarm when predetermined levels are exceeded	• Not suitable for inorganic gases (e.g., Cl_2, HCN, NH_3) • Less sensitive to aromatics and unsaturated compounds than PID • Requires skilled technicians to operate the equipment in the GC mode and to analyze the results • Requires changes of columns and gas supply when operated in the GC mode in certain units • Because specific chemical standards and calibration columns are needed, the operator must have some idea of the identification of the gas/vapor • Substances that contain substituted functional group (e.g., hydroxide (OH-) or (Cl-) Chloride groups) reduce the detector's sensitivity

EXHIBIT 6-1
Summary of Direct-Reading Air Monitoring Instruments

Principle of Detection and Monitoring Need	Instrument	Features	Limitations
Infrared Radiation *Monitoring Need:* ***Toxic Gas/ Vapors***	Infrared Analyzer	• Overcomes the limits of most infrared (IR) analyzers by use of a variable filter; can be used to scan through a portion of the spectrum to measure concentration of several gases or can be set at a particular wavelength to measure a specific gas • Detects both organic and inorganic gases • Portable but not as lightweight (32 lbs.) as the photoionization or the flame ionization detectors	• Not as sensitive as PID or the FID • Less portable than other methods of gas/vapor detection • Requires skilled technicians to operate and analyze results when positive identification is needed • Interference by water vapor and carbon dioxide • Most require AC power source • Positive identification requires comparison of spectrum from strip chart recorder with published adsorption spectrum; infrared spectrum not available for all compounds
Chemical Reaction Producing a Color Change *Monitoring Need:* ***Toxic Gas/ Vapors***	Indicator Tubes	• Provides qualitative, semi-quantitative identification of volatile organics and inorganics • Accuracy of only about ± 25 percent • Simple to use, and relatively inexpensive • Real-time/semi-realtime results	• Low accuracy • Subject to leakage during pumping • Requires previous knowledge of gases/vapors in order to select the appropriate detector tube • Some chemicals interfere with color reaction to read false positive • Temperature and humidity may affect readings
Electrochemical Cell *Monitoring Need:* ***Toxic Gas/ Vapors Specific Atmospheres***	Toxic Atmosphere Monitor	• Ease of operation • Small, compact, lightweight • Audible alarm upon exceeding present action level or TLV • Certain units have digital readout • Generally compound-specific • Certain units interface with data logger	• Cross sensitivity • Slow response/recovery after exposure to high contamination levels • Limited number of chemicals detected
Metal-Oxide Semiconductor *Monitoring Need:* ***Toxic Gas/ Vapors***	Toxic Atmosphere Monitor	• Ease of operation • Small, compact, lightweight • Audible alarm upon exceeding present action level or TLV • Certain units have digital readout • Certain units interface with data logger • Nonspecific gas and vapor detection for some organics and inorganics	• Cross sensitivity • Slow response/recovery after exposure to high contamination levels

EXHIBIT 6-1
Summary of Direct-Reading Air Monitoring Instruments

Principle of Detection and Monitoring Need	Instrument	Features	Limitations
Scintillation Detector *Monitoring Need:* ***Radiation***	Radiation Meters	• Measures radiation in mR/hr (battery operated) • Probe provides remote sensing capabilities • Accuracy and sensitivity varies considerably with manufacturer and type of meter • A variety of meters are available. Some measure total ionizing radiation; others are specific for gamma, alpha, or a combination of two or more types	• Some meters do not determine type of radiation
Gold Film Sensor *Monitoring Need:* ***Mercury Vapor***	Mercury Vapor Analyzer	• Compound specific; has survey and sample modes • 0.001 mg/m^3 detection limit • Provides sensor saturation readout; saturated sensor cleaning capabilities • Can be used with dosimeters for on-site dosimetry • Microprocessor serves reading; automatically re-zeros • Certain units have data logging capabilities • 5-hour battery life	• Requires yearly factory recalibration • Short battery life • Requires AC power for Heat Cleaning Cycle

Sources: Mathamel, 1981; Spittler, 1980; McEnery, 1982; National Mine Service Company, 1980; Gas-Tech, 1980; Enmet Corporation, 1979; Foxboro Analytical, 1982; HNU Systems, 1982, 1991; Photovac International, Inc., 1989; Jerome, 1990; MIE, 1990.

6.2.2 Air Sampling

For more complete information about air contaminants, measurements obtained with DRIs should be supplemented with air samples. To assess air contaminants more thoroughly, air sampling devices equipped with appropriate collection media should be placed at various locations throughout the area. These samples provide air quality information, and can indicate the presence and concentrations of contaminants over the lifetime of site operations. As data are obtained (from the analysis of samples, DRIs, and site operations), adjustments should be made in the type and number of samples, frequency of sampling, and analysis required. In addition to air samplers, area sampling stations may also include DRIs equipped with recorders and operated as continuous air monitors. Area sampling stations should be placed in the following locations:

Upwind. Because many hazardous incidents occur near industries or highways that generate air pollutants, samples must be taken upwind of the site, and wherever there are other potential sources of contaminants, to establish background levels of air contaminants.

Support Zone. Samples must be taken near the command post or other support facilities to ensure that they are in fact located in a clean area, and that the area remains clean throughout operations at the site.

Contamination Reduction Zone. Air samples should be collected along the Contamination Control Line to ensure that personnel are properly protected and that on-site workers are not removing their protective gear in a contaminated area.

Exclusion Zone. The Exclusion Zone presents the greatest risk of exposure to chemicals and requires the most air sampling. The location of sampling stations should be based upon hot spots or source areas detected by DRIs, types of substances present, and potential for airborne contaminants. The data from these stations, in conjunction with intermittent walk-around surveys with DRIs, should be used to verify the selection of proper levels of PPE and to set Exclusion Zone boundaries, as well as to provide a continual record of air contaminants.

Fenceline/Downwind. Sampling stations should be located downwind from the site to determine whether any air contaminants are migrating from the site. If there are indications of airborne hazards in populated areas, additional samplers should be placed downwind.

In many instances, only air sampling and laboratory analysis are necessary for detection and quantification. Although accurate, the air sampling and laboratory analysis option has two disadvantages: cost and time. Analyzing large numbers of samples in laboratories is expensive, especially when results are needed quickly. On-site laboratories tend to reduce the turn-around time, but their cost may be prohibitive.

6.3 AIR SAMPLING EQUIPMENT AND MEDIA

A variety of air sampling equipment may be used to collect samples of potentially dangerous substances that may become airborne at hazardous waste sites. Sampling systems typically include a calibrated air sampling pump that draws air into selected collection media. Some of the most common types of sampling and collection media are described below:

Organic Vapors. Activated carbon is an excellent sorbent for most organic vapors. However, other solid sorbents (such as Tenax®, silica gel, and Florisil®) are routinely used to sample specific organic compounds or classes of compounds that do not adsorb or desorb well on activated carbon. The samples should be collected using an industrial hygiene personal sampling pump with either one sampling port or a manifold system capable of simultaneously collecting samples on several sorbent tubes. Individual pumps with varying flow rates may also be used to collect several samples at once. The sorbent tubes may contain:

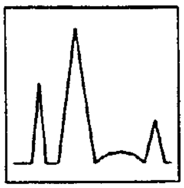
- Activated carbon, to collect vapors of materials with a boiling point above zero degrees centigrade. These materials include most solvent vapors.
- A porous polymer, such as Tenax® or Chromosorb® to collect substances that adsorb poorly onto activated carbon (e.g., high-molecular-weight hydrocarbons, organophosphorus compounds, and the vapors of certain pesticides). Some of these porous polymers also adsorb organic materials at low ambient temperatures more efficiently than carbon.
- A polar sorbent, such as silica gel to collect organic vapors that exhibit a relatively high dipole movement (e.g., aromatic amines).
- Any other specialty adsorbent selected for the specific site (e.g., a Florisil® tube, if PCBs are suspected).

Inorganic Gases. The inorganic gases present at a site would primarily be polar compounds such as the haloacid gases and ammonia. These gases can be adsorbed onto silica gel tubes and analyzed by ion chromatography. Impingers filled with selected liquid reagents can also be used.

Aerosols. Aerosols (solid or liquid particulates) that may be encountered at an incident include contaminated and non-contaminated soil particles, heavy-metal particulates, pesticide dusts, and droplets of organic or inorganic liquids. An effective method for sampling these materials is to collect them on a particulate filter, such as a glass fiber or mixed cellulose ester fiber membrane. A backup impinger filled with a selected absorbing solution may also be necessary.

Colorimetric detector tubes can also be used with a sampling pump when monitoring specific compounds. **Exhibit 6-2** lists several air collection and analytical methods.

6.4 SAMPLE COLLECTION AND ANALYSIS



Samples are analyzed to determine types and quantities of substances present at a site. Good sources of information on collecting and analyzing samples for a variety of chemical substances include: (1) EPA's *Compendium of Methods for Determination of Toxic Organic Compounds in Air*, (2) the National Institute for Occupational Safety and Health's (NIOSH) *Manual of Analytical Methods*, (Volumes 1-3, 4th Edition); and (3) *OSHA Analytical Methods*. These references may be consulted for specific procedures. This section provides additional guidance on sample collection and analysis.

Aerosols. Samples for aerosols should be taken at a relatively high flow rate (generally about 2 liters per minute) using a standard industrial hygiene pump and filter assembly. To collect total particulates, a membrane filter having a 0.8 micrometer pore size is common. The sample can be weighed to determine total particulates, then analyzed destructively or non-destructively for metals. If a non-destructive metals analysis is performed, or if the filter is sectioned, additional analyses (e.g., organics, inorganics, and optical particle sizing) can be performed.

Sorbent Samples. The sorbent material chosen, the amount used, and sample volume will vary according to the types and concentrations of substances anticipated at a particular site. Polar sorbent material such as silica gel will collect polar substances that are not adsorbed well onto activated carbon and some of the porous polymers. The silica gel sample can be split and analyzed for the haloacid gases and aromatic amines.

Activated carbon and porous polymers will collect a wide range of compounds. Exhaustive analysis to identify and quantify all the collected species is prohibitively expensive at any laboratory and technically difficult for a field laboratory. Therefore, samples should be analyzed for principal hazardous constituents (PHCs). The selection of PHCs should be based on the types of materials anticipated at a given site and on information collected during the initial site survey. To aid in the selection of PHCs, a sample could be collected on activated carbon or porous polymer during the initial site survey and exhaustively analyzed off-site to identify the major peaks within selected categories. This particular analysis, along with what is already known about a particular site, could provide enough information to select PHCs. Standards of PHCs could then be prepared and used to calibrate instruments used for field analysis of samples. Subsequent, routine, off-site analysis could be limited to scanning for only PHCs, saving time and resources. Special adsorbents and sampling conditions can be used for specific PHCs if desired while continued multi-media sampling provides a base for analysis of additional PHCs that may be identified during the course of cleanup operations.

Passive Dosimeters. A less traditional method of sampling is the use of passive dosimeters. The few passive dosimeters now available are for gases and vapors only. Although passive dosimeters are used primarily to monitor personal exposure, they also can be used to monitor areas. Passive monitors are divided into two groups:

- Diffusion samplers, in which molecules move across a concentration gradient, usually achieved within a stagnant layer of air, between the contaminated atmosphere and the indicator material.
- Permeation devices, which rely on the natural permeation of a contaminant through a membrane. A suitable membrane is selected that is easily permeated by the contaminant of interest and impermeable to all others. Permeation dosimeters, therefore, are useful in picking out a single contaminant from a mixture of possible interfering contaminants.

Some passive dosimeters may be read directly, as are DRIs and colorimetric length-of-stain tubes. Others require laboratory analysis similar to that conducted on solid sorbents.

EXHIBIT 6-2
Summary of Common Air Collection/Analytical Methods

Contaminant	Collection Media	Collection Method*	Analytical Method
Alcohols	Charcoal	NIOSH 1400 NIOSH 1401 NIOSH 1402	GC-FID
Aliphatic Amines	Silica Gel	NIOSH 2010	GC-FID
Aromatic Amines	Silica Gel	NIOSH 2002	GC-FID
Asbestos	25 mm 0.8 μm MCEF filter 25 mm 0.45 μm MCEF filter	NIOSH 7400 NIOSH 7402	PCM TEM
Cyanides	0.8 μm MCEF filter and impinger	NIOSH 7904	ISE
Dioxin	3" polyurethane foam plug/filter	EPA TO-9	GC/MS
Hydrocarbons: BP 36-126°C Aromatic Halogenated	Charcoal	NIOSH 1500 NIOSH 1501 NIOSH 1003	GC-FID EPA Modified GC/MS
Inorganic Acids	Washed Silica Gel	NIOSH 7903	IC
Mercury	Hopcolite/Hydrar	NIOSH 6009	AA
Metals (elements)	37 mm 0.8 μm MCEF filter	NIOSH 7300	ICP-AES
PCBs	Florisil® and 13 mm glass fiber filter	Lewis/McCleod Modified NIOSH 5503	GC-ECD
Pesticides/PCBs	3" polyurethane foam plug	EPA TO-4	GC-ECD
Polyaromatic Hydrocarbons (PAH)	Washed XAD-2, 37 mm PTFE filter w/support O-ring	NIOSH 5515	GC-PID
	2" x 1" Polyurethane Foam	NIOSH 5506	HPLC-UV
Volatile organics	Tenax®/carbonized molecular sieve (CMS)	EPA TO-1 EPA TO-2	GC-MS
Volatile organics	SUMMA® canister, SUMMA® canister w/critical orifice	EPA TO-14	GC-ECD, NPD or FID GC/MS

LEGEND:

AA:	Atomic Absorption
GC-ECD:	Gas Chromatography-Electron Capture Detector
GC-FID:	Gas Chromatography-Flame Ionization Detector
NPD:	Nitrogen-Phosphorus Detector
GC-MS:	Gas Chromatography
IC:	Ion Chromatography
ICP-AES:	Inductively Coupled Argon Plasma, Atomic Emission Spectroscopy
ISE:	Ion Specific Electrode
PCM:	Phase Contrast Microscopy
TEM:	Transmission Electron Microscopy
HPLC-UV:	High-Pressure Liquid Chromatography with UV Detector

* **Note:** The flow rates that appear in the NIOSH methods are often modified for outdoor ambient air sampling.

6.5 GENERAL MONITORING PRACTICES

Air sampling should be conducted using a variety of media to identify the major classes of airborne contaminants and their concentrations. The following sampling pattern can be used as a guideline. After visually identifying the sources of possible generation, air samples should be collected downwind from the designated source along the axis of the wind direction. Work should proceed upwind to a point as close as possible to the source. Level B protection (see Section 6.9.3) should be worn during this initial sampling. Levels of protection for subsequent sampling should be based upon the results obtained and the potential for an unexpected release of chemicals.

After reaching the source, or finding the highest concentration, samples should be collected along the cross-axis of the wind direction to determine the degree of dispersion. Smoke plumes, or plumes of instrument-detectable airborne substances, may be released as an aid in this assessment. To ensure that there is no background interference and that the detected substance(s) originate from the identified source, air samples also should be collected upwind from the source.

6.5.1 Perimeter Monitoring

Fixed-location monitoring at the "fenceline" or perimeter, where PPE is no longer required, measures contaminant migration away from the site and enables the Site Health and Safety Officer to evaluate the integrity of the site's clean areas. Because the fixed-location samples may reflect exposures either upwind or downwind from the site, wind speed and direction data are needed to interpret the sample results.

6.5.2 Periodic Monitoring

Site conditions and atmospheric chemical conditions may change following the initial characterization. Periodic monitoring should be conducted when the possibility of a dangerous condition has developed or when there is reason to believe that exposures may have risen above PELs since prior monitoring was conducted. The possibility that exposures have risen should be seriously considered when:

- Work begins on a different portion of the site;
- Different contaminants are being handled;
- A markedly different type of operation is initiated (e.g., barrel opening as opposed to exploratory well drilling); or
- Workers are handing leaking drums or working in areas with obvious liquid contamination (e.g., a spill or lagoon).

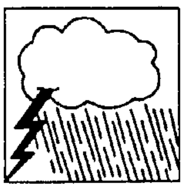
6.5.3 Personal Monitoring

The selective monitoring of high-risk workers (i.e., those who are closest to the source of contaminant generation) is required by 29 CFR §1910. 120(h). This requirement is based on the probability that significant exposure varies directly with distance from the source. If workers closest to the source are not significantly exposed, then other workers, presumably, are not significantly exposed and should not need to be monitored.

Because occupational exposures are linked closely with active material handling, personal air sampling is not necessary until site operations have begun. Thus, monitoring of those employees likely to have the highest exposures to hazardous substances and health hazards is not required until the actual cleanup phase commences (e.g., when soils, surface waters, or containers are moved or disturbed). Personal monitoring samples should be collected in the breathing zone and, if workers are wearing respiratory protective equipment, outside the facepiece. These samples represent the actual inhalation exposure of workers who are not wearing respiratory protection and the potential exposure of workers who are wearing respirators. Sampling should occur frequently enough to characterize employee exposures. If any employee is exposed to concentrations over PELs, monitoring must continue to ensure the safety of all employees likely to be exposed to concentrations above those limits.

Personal monitoring may require the use of a variety of sampling media. Unfortunately, single workers cannot carry multiple sampling media because of the added strain and because it is not usually possible to draw air through different sampling media using a single portable, battery-operated pump. Consequently, several days may be required to measure the exposure of a specific individual using each of the media. Alternatively, if workers are in teams, a different monitoring device can be assigned to each team member. Another method is to place multiple sampling devices on pieces of heavy equipment. While these are not personal samples, they can be collected very close to the breathing zone of the heavy equipment operator and thus would be reasonably representative of personal exposures. These multi-media samples can yield as much information as several personal samples.

6.6 METEOROLOGICAL CONSIDERATIONS



Meteorological information is an integral part of any air monitoring program. Data concerning wind speed and direction, temperature, barometric pressure, and humidity, singularly or in combination, are needed for selecting air sampling locations, calculating air dispersion, calibrating instruments, and determining population at risk of exposure from airborne contaminants.

Knowledge of wind speed and direction is necessary to effectively place air samplers. In source-oriented ambient air sampling, it is particularly important that samplers be located at varying distances downwind from the source. Similarly, it is important that background air samples be collected upwind from the source. Samplers should be relocated or adjusted to reflect shifts in wind direction. In addition, atmospheric simulation models for predicting contaminant dispersion and concentration need wind speed and direction as inputs for predictive calculations. Information may be needed concerning the frequency and intensity of winds from certain directions (windrose data). Consequently, wind direction must be monitored continually.

Air sampling systems need to be calibrated before use and corrections in the calibration curves made for temperature and pressure. After sampling, sampled air volumes should also be corrected for temperature and pressure variations. This requires data on air temperature and pressure during sampling.

Data may be collected from on-site meteorological stations or from government or private organizations that routinely collect meteorological data. The site manager should base data collection decisions on the availability of reliable data at the site, the resources needed to obtain meteorological equipment, the level of confidence required for the data, and the ultimate use of the data.

6.7 LONG-TERM AIR MONITORING PROGRAMS

A variety of long-term air monitoring programs can be designed to detect a wide range of airborne compounds. A number of factors should be considered before implementing any program, including type of equipment, costs, personnel, accuracy of analysis, time to obtain results (turn-around time), and availability of analytical laboratories.

One approach to air monitoring, developed and used by the ERT, is described here. This program achieves a reasonable balance between cost, accuracy, and time in obtaining data using a combination of DRIs and air sampling systems. The data is used to survey for airborne organic vapors and gases, to identify and measure organic vapors and gases, and to identify and measure particulates and inorganic vapors and gases. The ERT approach is based on:

- Using flame ionization detectors (FIDs) and/or photoionization detectors (PIDs) for initial detection of total organic gases and vapors and for periodic site surveys (for total organics). Equipped with strip chart recorders, the detectors are used as area monitors to record total organic concentrations and changes in concentration over a period of time. Calibrated to specific organic contaminants, they are used to detect and measure those substances.

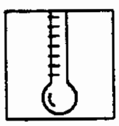
- Collecting area air samples using personal pumps and organic gas/vapor collection tubes. Samples are analyzed using the gas chromatograph (GC) capabilities of field instruments. Selected samples are also analyzed in laboratories accredited by the American Industrial Hygiene Association (AIHA).

- Using PIDs and/or FIDs (as a survey instrument or GC) to provide real-time data and to screen the number of samples needed for laboratory analysis.

- Sampling for particulates, inorganic acids, aromatic amines, halogenated pesticides, etc., when they are known to be present or when there are indications that these substances may be a problem.

6.8 VARIABLES IN HAZARDOUS WASTE SITE AIR MONITORING

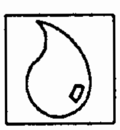
Complex environments involving numerous substances, such as those associated with hazardous waste sites, pose significant challenges to accurately and safely assessing airborne contaminants. Several independent and uncontrollable variables, most notably temperature and weather conditions, can affect airborne concentrations. These factors must be considered when developing an air monitoring program and when analyzing data. Some of the more important variables include:



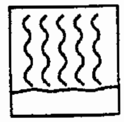
Temperature. An increase in temperature increases the vapor pressure of most chemicals.

Wind Speed. An increase in wind speed can affect vapor concentrations near a free-standing liquid surface. Dusts and particulate-bound contaminants are also affected.

Rainfall. Water from rainfall can essentially cap or plug vapor emission routes from open or closed containers, saturated soil, or lagoons, thereby reducing airborne emissions of certain substances.



Moisture. Dusts, including finely divided hazardous solids, are highly sensitive to moisture content. This moisture content can vary significantly with respect to location and time and can also affect the accuracy of many sampling results.



Vapor Emissions. The physical displacement of saturated vapors can produce short-term, relatively high, vapor concentrations. Continuing evaporation and/or diffusion may produce long-term low vapor concentrations and may involve large areas.

Work Activities. Work activities often require the mechanical disturbance of contaminated materials, which may change the concentration and composition of airborne contaminants.

6.9 USING VAPOR/GAS CONCENTRATIONS TO DETERMINE LEVEL OF PROTECTION

The objective of using total atmospheric vapor/gas concentrations is to determine a numerical criterion for selecting the appropriate level of PPE (e.g., Level A, B, or C). In situations where the presence of vapors or gases is not known, or if present, the individual components are unknown, personnel required to enter that environment must be protected. Total vapor/gas concentration can be used as a guide for selecting PPE until more definitive criteria can be determined (e.g., until the constituents and atmospheric concentrations of vapor, gas, or particulates can be determined, and until respiratory and body protection can be chosen that relate to the toxicological properties of these constituents.)

Although total vapor/gas concentration measurements are useful to a qualified professional for the selection of protective equipment, caution should be exercised in their interpretation. An instrument does not respond with the same sensitivity to several vapor/gas contaminants as it does to a single contaminant. Also, because total vapor/gas field instruments detect all contaminants in relation to a specific calibration gas, the concentration of unknown gases or vapors may be either overestimated or underestimated.

Suspected carcinogens, particulates, highly hazardous substances, infectious wastes, or other substances that do not elicit an instrument response may be known or suspected to be present. Therefore, the protection level should not be based solely on the total vapor/gas criterion. Rather, the level should be selected on a case-by-case basis, with special emphasis on potential exposure from the chemical and toxicological characteristics of the known or suspected material.

6.9.1 Factors for Consideration

A number of factors should be considered when using total atmospheric vapor/gas concentrations as a guide for monitoring a selected Level of Protection. First, the uses, limitations, and operating characteristics of the monitoring instruments must be recognized and understood. Instruments such as the photoionization detector (PID), flame ionization detector (FID), and others do not respond identically to the same concentration of a substance; nor do they respond to all substances. Therefore, experience, knowledge, and good judgement must be used to complement the data obtained with instruments.

Second, other hazards may exist such as gases not detected by the PID or FID (i.e., phosgene, cyanides, arsenic, chlorine), explosives, flammable materials, oxygen deficiency, liquid/solid particles, and liquid or solid chemicals. Vapors and gases with a very low Threshold Limit Value (TLV) or IDLH value could also be present. Total readings on instruments not calibrated to these substances may not indicate unsafe conditions.

The risk to personnel entering an area must be weighed against the need for entering. Although this assessment is largely a value judgment, it requires a conscientious balancing of the known and potential risks to personnel against the need to enter an unknown environment.

The knowledge that suspected carcinogens or extremely toxic substances are present requires an evaluation of a number of factors, such as the potential for exposure, chemical characteristics of the materials present, and the limitations of monitoring instruments and PPE relative to the tasks that must be done on-site.

On-site activities must be evaluated to choose the correct level of PPE. Based upon total atmospheric vapor concentrations, Level C protection may be judged adequate; however, tasks such as moving drums, opening containers, and bulking of materials, which increase the probability of liquid splashes or generation of vapors, gases, or particulates, will likely require a higher level of protection.

The following sections provide information on levels of protection (refer to **Chapter 5** for more information on selecting PPE).

6.9.2 Level A Protection (500 to 1,000 ppm)

Level A protection provides the highest degree of respiratory tract, skin, and eye protection if the inherent limitations of the PPE are not exceeded. Although Level A provides protection against air concentrations greater than 1,000 ppm for most substances, an operational restriction of 1,000 ppm is established as a warning flag to:

- Evaluate the need to enter environments with unknown constituents at concentrations greater than 1,000 ppm;
- Identify the specific chemical constituents contributing to the total concentration and their associated toxic properties;
- Determine more precisely the concentrations of constituent chemicals;
- Evaluate the calibration and/or sensitivity error associated with the instrument(s); and
- Evaluate instrument sensitivity to wind velocity, humidity, temperature, etc.

A limit of 500 ppm total vapors/gases in air was selected as the value at which to upgrade from Level B to Level A. This concentration was selected to fully protect the skin until the constituents can be identified and measured and substances affecting the skin are excluded. The range of 500 to 1,000 ppm is sufficiently conservative to provide a safe margin of protection if readings are low due to instrument error, calibration, and sensitivity; if higher than anticipated concentrations occur; and if substances highly toxic to the skin are present.

Ambient air concentrations approaching 500 ppm have not routinely been encountered on hazardous waste sites. Such high concentrations have been encountered only in closed buildings, when containers were being opened, when personnel were working in the spilled contaminants, or when organic vapors/gases were released in transportation accidents. A decision to require Level A protection should also consider the negative aspects: higher probability of accidents due to cumbersome equipment, and most importantly, the physical stress caused by heat buildup in fully encapsulating suits.

6.9.3 Level B Protection (5 to 500 ppm)

Level B protection is the minimum level of protection recommended for initially entering an open site where the type, concentration, and presence of airborne vapors are unknown. This level of protection provides a high degree of respiratory protection. Skin and eyes are also protected, although a small portion of the body (neck and sides of head) may be exposed. The use of a separate hood or hooded, chemical-resistant jacket would further reduce the potential for exposure to this area of the body. Level B impermeable protective clothing also increases the probability of heat stress.

A limit of 500 ppm total atmospheric vapor/gas concentration on portable field instruments has been selected as the upper restriction on the use of Level B. Although Level B PPE should be adequate for most commonly encountered substances at air concentrations higher than 500 ppm, this limit has been selected as a decision point for a careful evaluation of the risks associated with higher concentrations. The following factors should be considered when selecting Level B protection:

- The necessity for entering environments with unknown constituents at concentrations higher than 500 ppm wearing Level B protection;
- The probability that substance(s) present pose severe skin hazards;
- The work to be done and the increased probability of exposure;
- The need for qualitative and quantitative identification of the specific components;
- Inherent limitations of the instruments used for air monitoring; and
- Instrument sensitivity to winds, humidity, temperature, and other factors.

6.9.4 Level C Protection (Background to 5 ppm)

Level C provides skin protection identical to Level B, assuming the same type of chemical protective clothing is worn, but lesser protection against inhalation hazards. A range of background to 5 ppm above ambient background concentrations of vapors/gases in the atmosphere has been established as guidance for selecting Level C protection. Concentrations in the air of unidentified vapors/gases approaching or exceeding 5 ppm would warrant upgrading respiratory protection to a self-contained breathing apparatus.

A full-face, air-purifying mask equipped with an organic vapor canister (or a combined organic vapor/particulate canister) provides protection against low concentrations of most common organic vapors/gases. There are some substances against which full-face, canister equipped masks do not protect, for example, substances with very low Threshold Limit Values (TLV) or IDLH concentrations. Many of the latter substances are gases or liquids in their normal state. Gases would only be found in gas cylinders, while the liquids would not ordinarily be found in standard containers or drums.

Every possible effort should be made to identify the individual constituents (and the presence of particulates) contributing to such low total vapor readings. Respiratory protective equipment can then be selected accordingly. It is exceedingly difficult, however, to provide constant, real-time identification of all components with concentrations of less than 5 ppm in a vapor cloud at a site where ambient concentrations are constantly changing.

If highly toxic substances have been ruled out, but ambient levels of less than 5 ppm persist, it is unreasonable to assume only self-contained breathing apparatus should be worn. The continuous use of air-purifying masks in such low vapor/gas concentrations gives a reasonable assurance that the respiratory tract is protected, provided that the absence of highly toxic substances has been confirmed.

Full-face, air-purifying devices are capable of providing respiratory protection against most vapors at greater than 5 ppm; however, until definitive qualitative information is available, a concentration of greater than 5 ppm requires that a higher level of respiratory protection be used.

Also, unanticipated transient excursions may increase the concentrations in the environment above the limits of air-purifying devices. The increased probability of exposure due to the work being done may require Level B protection, even though ambient levels are low.

FURTHER GUIDANCE: For more information on air monitoring equipment and procedures, see:

1. *Standard Operating Guide for Air Sampling and Monitoring at Emergency Responses* (U.S. EPA, draft, Publication 9285.2-03A).

2. *Standard Operating Guide for the Use of Air Monitoring Equipment for Emergency Response* (U.S. EPA, draft, expected Summer 1992).

3. *Manual of Analytical Methods, (Volumes 1-3, 3rd Edition, with supplements)* (NIOSH, 1989, Publication 89-127).

4. *Compendium of Methods for Determination of Toxic Organic Compounds in Air* (U.S. EPA, 1987, EPA 600/4-87/006).

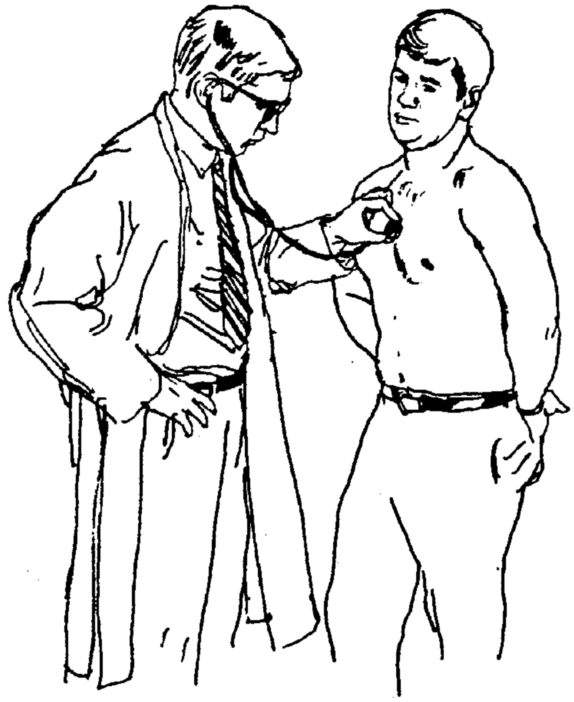
5. *OSHA Analytical Methods.* The OSHA Technical Center maintains an updated database of analytical testing methods. Printouts of analytical methods for individual chemicals are available by request. Contact the OSHA Technical Center, 1781 South 300 West, Salt Lake City, UT, 84115 (801) 524-5287.

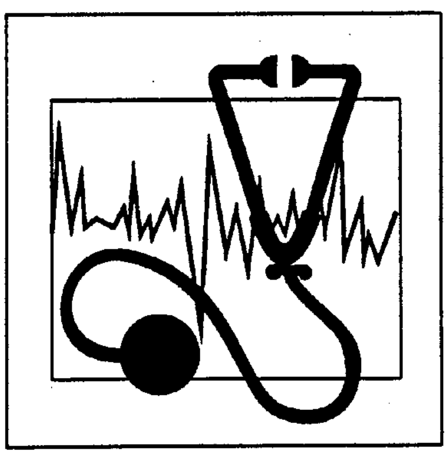
6. Air Methods Database. Available on the Cleanup Information electronic bulletin board (CLU-IN), formerly OSWER BBS. For further information, call (301) 589-8366. Communications: No Parity, 8 Databits, 1 Stopbit, F Duplex.

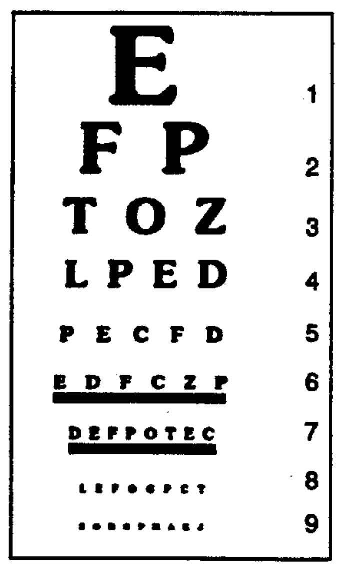
7. *Removal Program Representative Sampling Guidance: Air* (U.S. EPA, draft, expected Summer 1992).

8. *Respiratory Decision Logic* (NIOSH, 1987, Publication 87-108).

CHAPTER 7 MEDICAL SURVEILLANCE PROGRAM

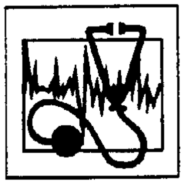






CHAPTER 7 MEDICAL SURVEILLANCE PROGRAM

7.0 INTRODUCTION



Workers engaged in hazardous waste operations and emergency response activities perform tasks that may expose them to a number of potential hazards, including: toxic chemicals; safety and biological hazards; and physical agents, such as heat stress and radiation. A medical program is essential for assessing and monitoring employee health, both prior to placement and during the course of work; for providing emergency and other treatment, as needed; and for keeping accurate records for future reference. A comprehensive medical surveillance program is required by §1910.120(f) of HAZWOPER. The standards contain provisions for baseline, periodic, and termination medical examinations.

The goal of a medical surveillance program, and of appropriate screening and monitoring in the workplace, is the protection of employees' health. Two factors are critical for achieving this goal:

- Detecting pre-existing disease or medical conditions that may place an employee performing certain tasks at an increased risk; and
- Minimizing individual exposures at the workplace, so that the disease process is never initiated.

Helping to place and maintain employees in work that is commensurate with their capabilities and, whenever possible, attempting to avoid certain exposure situations, will help achieve this goal of disease prevention.

An employer should develop a comprehensive medical program based on the specific needs, location, and potential exposures of its employees. The program should be designed by an experienced occupational health physician or other qualified occupational health consultant in conjunction with the employer's occupational health and safety professional. All occupational medical monitoring examinations and procedures should be performed by or under the direction of a physician who is board-certified in occupational medicine or a medical doctor who has had extensive experience managing occupational health services.

7.1 EMPLOYEES COVERED BY THE SURVEILLANCE PROGRAM

A medical surveillance program must include monitoring for four groups of employees:

- Employees who are, or may be, exposed to PELs of hazardous substances or health hazards for 30 or more days per year;
- Employees who wear a respirator for 30 or more days per year;
- Members of organized HAZMAT teams; and
- Employees who are injured as a result of overexposure during a site emergency, or who show symptoms of illness that may have resulted from exposure to hazardous substances.

OSHA standards represent only the minimum that is required by law and in no way preclude anyone from taking additional actions to ensure the well-being of their employees. For example, the medical surveillance policy for EPA employees (as outlined in the *OSWER Integrated Health and Safety Program Standard Operating Practice*) is more restrictive than the OSHA standards, and requires monitoring for employees who are potentially exposed to hazardous substances for 20 or more days per year.

7.2 FREQUENCY AND CONTENT OF MEDICAL EXAMINATIONS

All employees who are required by HAZWOPER to participate in a medical surveillance program must undergo a baseline medical examination prior to a field assignment. After this initial examination, employees must have a follow-up medical exam at least once per year, unless an attending physician believes a longer interval is appropriate. This longer interval, however, cannot exceed 2 years.

If the attending physician believes it is necessary by virtue of the nature of employees' potential exposure, more frequent medical examinations may be required. Irrespective of whether a baseline exam was performed, employees must also receive a medical examination as soon as possible if:

- The employee is injured or becomes ill from exposure to hazardous substances on-site; or

- The employee develops signs or symptoms indicative of possible overexposure to hazardous substances.

All potentially exposed employees must be trained to recognize symptoms that might be indicative of overexposure to chemicals or physical agents such as heat stress. These could include dizziness, rashes, shortness of breath, numbness, and fatigue.

In addition, employees who are reassigned or who terminate employment must receive a final examination. This examination is only required if the employee has not had an examination within the past 6 months. All required medical examinations must be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

The content of medical examinations should be determined by the attending physician and the site Health and Safety Officer, but certain key elements must be included. The physician must complete a medical and work history with emphasis on the symptoms related to handling hazardous substances. Further, the physician must determine the employee's fitness for the types of duties to be assigned, including whether the employee needs to wear personal protective equipment based on the anticipated conditions at the work site.

To ensure that the physician understands the OSHA and EPA medical surveillance requirements, the employer must provide a copy of the standard and its appendices to the physician. Substance-specific standards (e.g., for lead and asbestos) should also be provided, if appropriate. The employer is also responsible for describing to the physician each employee's duties relative to potential exposure levels. Additionally, the physician must be provided with information from the employee's previous medical exams and a complete description of the types of PPE that the employee will be expected to wear. This information is required so that the physician can adequately assess the employee's capacity to wear PPE and other required equipment.

Once an exam has been completed, the physician must submit a written opinion to the employer who then has the responsibility to provide that opinion to the employee. The opinion must contain:

- The results of the medical examination and tests;

- Any recommended work limitations; and

- The physician's opinion concerning the medical condition of the employee, including any conditions that need further examination and treatment, or that would place the employee at an increased risk of injury from respirator use or work in a hazardous substance environment.

Exhibit 7-1 outlines a recommended medical program with screening and examination protocols. These recommendations are based on known health risks for hazardous waste site personnel, a review of available data on their exposures, and an assessment of several established medical programs. Because conditions and hazards vary considerably at each site, only general guidelines are provided here.

7.2.1 Baseline Screening

Pre-placement or baseline screening has two major functions: (1) to determine an individual's fitness for duty, including the ability to work while wearing protective equipment; and (2) to provide baseline data for comparison with future medical data. To ensure that prospective employees are able to meet work requirements, the pre-placement screening should focus on the following areas:

<u>Occupational and Medical History</u>

- Require all personnel to fill out an occupational and medical history questionnaire, describing all prior occupational exposures to chemical and physical hazards.

EXHIBIT 7-1
Minimum Examination Types and Protocols

Examination Type	Baseline	Periodic	Termination	Unscheduled
History and Physical Exam				
Complete Medical History	X		X	X
Interval History		X		
Physical Examination by Physician	X	X	X	X
Visual Acuity	X	X	X	O
Routine Laboratory Tests/Procedures				
Pulmonary Function	X	X	X	O
Audiometry	X	X	X	O
Electrocardiogram	X	O	X	O
Chest X-ray*	X	O	X	O
Complete Blood Count	X	X	X	O
Routine Urinalysis	X	X	X	O
Blood Chemistry	X	X	X	O
Special Tests**				
Cholinesterase	X	O	O	O
Methemoglobin	O	O	O	O
Heavy Metal Screen	X	O	O	O
Urine and Sputum Cytology	O	O	O	O
Polychlorinated Biphenyl (PCB)	O	O	O	O
Cardiovascular Stress Test	X	O	-	-

X Recommended
O As indicated

* Chest X-rays not repeated more than once per year.

** Any special test which may be considered on a periodic basic should be included in the baseline test.

Source: *Occupational Medical Monitoring Program Guidelines for SARA Hazardous Waste Field Activity Personnel* (U.S. EPA, 1990, Publication 9285.3-04).

- Take note of past illnesses and chronic diseases, particularly atopic diseases such as eczema and asthma, lung diseases, and cardiovascular disease.
- Review symptoms, especially shortness of breath or labored breathing on exertion, other chronic respiratory symptoms, chest pain, high blood pressure, heat intolerance, or sensitivity to particular substances.
- Record relevant lifestyle habits (e.g., smoking, alcohol/drug use) and hobbies.

Physical Examination

- Conduct a comprehensive physical examination focusing on the pulmonary, cardiovascular, and musculoskeletal systems.

- Note conditions that could increase susceptibility to heat stroke or that could affect respirator use.

Ability to Work While Wearing PPE

- Disqualify individuals who are unable to perform based on the medical history and physical exam (e.g., those with severe lung disease, heart disease, or back or orthopedic problems).

- Note limitations concerning the worker's ability to use PPE.

- Provide additional testing for ability to wear PPE where necessary.

- Complete a written assessment of worker's capacity to perform while wear a respirator, if wearing a respirator is a job requirement. Note that the OSHA respirator standard (29 CFR §1910.134) states that no employee should be assigned to a task that requires the use of a respirator unless that person is physically able to perform under such conditions.

Pre-placement screening can be used to establish baseline data to verify the efficacy of protective measures and to determine whether exposures have adversely affected the worker. Baseline testing may include both medical screening tests and biologic monitoring tests. Given the problem in predicting significant exposures for these workers, there are no clear guidelines for prescribing specific tests.

7.2.2 Periodic Medical Examinations

Periodic medical examinations should be developed and used in conjunction with pre-placement screening examinations. Comparison of sequential medical reports with baseline data is essential for determining biologic trends that may mark early signs of adverse health effects, and thereby facilitate appropriate protective measures.

The frequency and content of examinations will vary, depending on the nature of the work and exposures. It is recommended that medical examinations be conducted at least annually; however, more frequent examinations may be necessary depending on the extent of potential or actual exposure, the type of chemicals involved, the duration of the work assignment, and the individual worker's profile. Periodic screening exams can include:

- Interval medical history, focusing on changes in health status, illnesses, and possible work-related symptoms;

- Physical examination; and

- Additional medical testing, depending on available exposure information, medical history, and examination results. Testing specific to possible medical effects of the worker's exposure can include pulmonary function tests, audiometric tests, vision tests, and blood and urine tests.

7.2.3 Termination Examination

At the end of employment as a hazardous waste site worker, all personnel should have a termination medical examination. A full examination is necessary at the termination of employment if any of the following criteria are <u>not</u> met:

- The last full medical examination was within the last 6 months;

- No exposure occurred since the last examination; and

- No symptoms associated with exposure occurred since the last examination.

7.3 EMERGENCY TREATMENT

Provisions for emergency treatment and acute non-emergency treatment should be made at each site. When developing plans, procedures, and equipment lists, the range of actual and potential hazards specific to the site should be considered, including chemical, physical, and biological hazards. Contractors, visitors, and other personnel may require emergency treatment in addition to site workers.

Emergency medical treatment should be integrated into the overall site emergency response program. **Exhibit 7-2** lists the recommended guidelines for establishing an emergency treatment program. Depending on the site's location and potential hazards, it may be important to identify additional medical facilities capable of sophisticated response to chemical or other exposures.

Non-emergency medical care should be arranged for hazardous waste site personnel who are experiencing health effects resulting from an exposure to hazardous substances. In conjunction with the medical surveillance program, off-site medical care should ensure that any potential job-related symptoms or illnesses are evaluated in the context of the employee's exposure. Off-site medical personnel should also investigate and treat non-job-related illnesses that may put the employee at risk because of task requirements.

7.4 CHEMICAL CONTAMINATION

Employees at hazardous waste sites may be exposed to a number of toxic chemicals with dangerous properties. Most sites contain a variety of chemical substances in gaseous, liquid, or solid forms that can enter the unprotected body. **Exhibit 7-3** lists some common chemicals found at hazardous waste sites, their potential health effects, and recommended medical procedures for monitoring employee exposure.

Preventing exposure to toxic chemicals is a primary concern at any site. Protective clothing and respirators help prevent the wearer from contamination, and good work practices and engineering controls help reduce contamination on protective clothing, instruments, and equipment.

EXHIBIT 7-2
Recommended Guidelines for Establishing an Emergency Treatment Program

- ✓ Train a team of site personnel in emergency first aid, including CPR and training that emphasizes treatment for explosion and bum injuries, heat stress, and acute chemical toxicity. This team should include an emergency medical technician if possible.
- ✓ Train personnel in emergency decontamination procedures in coordination with the Emergency Response Plan (see **Chapter 9**).
- ✓ Predesignate roles and responsibilities to be assumed by personnel in an emergency.
- ✓ Establish an emergency/first-aid station on-site, capable of providing stabilization for patients requiring off-site treatment and general first aid.
- ✓ Arrange for a physician who can be paged on a 24-hour basis.
- ✓ Set up an on-call team of medical specialists for emergency consultations (e.g., a toxicologist, dermatologist, hematologist, allergist, ophthalmologist, cardiologist, and neurologist).
- ✓ Establish a protocol for monitoring heat stress.
- ✓ Make plans in advance for emergency transportation to and contamination control procedures for treatment at a nearby medical facility.
- ✓ Post names, phone numbers, addresses, and procedures for contacting on-call physicians, medical specialists, ambulance services, medical facilities, emergency, fire, and police services, and poison control hotline.
- ✓ Provide maps and directions to medical facilities, and confirm that all managers and individuals involved in medical response know the location of the nearest emergency medical facility.
- ✓ Establish a radio-communication system for emergency use.
- ✓ Review emergency procedures daily with site personnel at safety meetings before beginning work shifts.

EXHIBIT 7-3
Common Chemical Toxicants Found at Hazardous Waste Sites, their Health Effects, and Medical Monitoring[a]

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Aromatic Hydrocarbons	Benzene Ethyl benzene Toluene Xylene	Commercial solvents and intermediates for synthesis in the chemical and pharmaceutical industries.	Blood Bone marrow CNS[b] Eyes Respiratory system Skin Liver Kidney	All cause: CNS[b] depression: decreased alertness, headache, sleepiness, loss of consciousness. Defatting dermatitis. Benzene suppresses bone-marrow function, causing blood changes. Chronic exposure can cause leukemia. Note: Because other aromatic hydrocarbons may be contaminated with benzene during distillation, benzene-related health effects should be considered when exposure to any of these agents is suspected.	Occupational/general medical history emphasizing prior exposure to these or other toxic agents. Medical examination with focus on liver, kidney, nervous system, and skin. Laboratory testing: CBC[c] Platelet count Measurement of kidney and liver function.
Asbestos (or asbestiform particles)		A variety of industrial uses, including: Building Construction Cement work Insulation Fireproofing Pipes and ducts for water, air, and chemicals Automobile brake pads and linings	Lungs Gastrointestinal system	Chronic effects: Lung cancer Mesothelioma Asbestosis Gastrointestinal malignancies Asbestos exposure coupled with cigarette smoking has been shown to have a synergistic effect in the development of lung cancer.	History and physical examination should focus on the lungs and gastrointestinal system. Laboratory tests should include a stool test for occult blood evaluation as a check for possible hidden gastrointestinal malignancy. A high quality chest X-ray and pulmonary function test may help to identify long-term changes associated with asbestos diseases; however, early identification of low-dose exposure is unlikely.
Dioxin (see Herbicides)					

[a] Source: *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH/OSHA/USCG/EPA, 1985).

[b] CNS = Central nervous system.
[c] CBC = Complete blood count.

EXHIBIT 7-3 (cont'd)
Common Chemical Toxicants Found at Hazardous Waste Sites, their Health Effects, and Medical Monitoring

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Halogenated Aliphatic Hydrocarbons	Carbon tetrachloride Chloroform Ethyl bromide Ethyl chloride Ethylene dibromide Ethylene dichloride Methyl chloride Methyl chloroform Methylene chloride Tetrachloroethane Tetrachloroethylene (perchloroethylene) Trichloroethylene Vinyl chloride	Commercial solvents and intermediates in organic synthesis.	CNS[a] Kidney Liver Skin	All cause: CNS[a] depression: decreased alertness, headaches, sleepiness, loss of consciousness. Kidney changes: decreased urine flow, swelling (especially around eyes), anemia Liver changes: fatigue, malaise, dark urine, liver enlargement, jaundice. Vinyl chloride is a known carcinogen; several others in this group are potential carcinogens.	Occupational/general medical history emphasizing prior exposure to these or other toxic agents. Medical examination with focus on liver, kidney, nervous system, and skin Laboratory testing for liver and kidney function; carboxyhemoglobin where relevant.
Heavy Metals	Arsenic Beryllium Cadmium Chromium Lead Mercury	Wide variety of industrial and commercial uses.	Multiple organs and systems including: Blood Cardiopulmonary Gastrointestinal Kidney Liver Lung CNS[a] Skin	All are toxic to the kidneys. Each heavy metal has its own characteristic symptom cluster. For example, lead causes decreased mental ability, weakness (especially in hands), headache, abdominal cramps, diarrhea, and anemia. Lead can also affect the blood-forming mechanism, kidneys, and the peripheral nervous system. Long-term effects[d] also vary. Lead toxicity can cause permanent kidney and brain damage; cadmium can cause kidney or lung disease. Chromium, beryllium, arsenic, and cadmium have been implicated as human carcinogens.	History-taking and physical exam: search for symptom clusters associated with specific metal exposure, e.g., for lead look for neurological deficit, anemia, and gastrointestinal symptoms Laboratory testing: Measurements of metallic content in blood, urine, and tissues (e.g., blood lead level; urine screen for arsenic, mercury, chromium, and cadmium) CBC[b] Measurement of kidney function, and liver function where relevant Chest X-ray or pulmonary function testing where relevant

[d] Long term effects generally manifest in 10 to 30 years

EXHIBIT 7-3 (cont'd)
Common Chemical Toxicants Found at Hazardous Waste Sites, their Health Effects, and Medical Monitoring (cont'd)

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Herbicides	Chlorophenoxy compounds: 2,4-dichloro-phenosyacetic acid (2,4-D) 2,4,5-trichloro-phenoxyacetic acid (2,4,5-T) Dioxin (tetrachloro-dibenzo-p-dioxin, TCDD), which occurs as a trace contaminant in these compounds, poses the most serious health risk.	Vegetation control.	Kidney Liver CNS[a] Skin	Chlorophenoxy compounds can cause chloracne, weakness or numbness of the arms and legs, and may result in long-term nerve damage. Dioxin causes chloracne and may aggravate pre-existing liver and kidney diseases.	History and physical exam should focus on the skin and nervous system. Laboratory tests include: Measurement of liver and kidney function, where relevant. Urinalysis.
Organochlorine Insecticides	Chlorinated ethanes: DDT Cyclodienes: Aldrin Chlordane Dieldrin Endrin Chlorocyclohexanes: Lindane	Pest control.	Kidney Liver CNS[a]	All cause acute symptoms of apprehension, irritability, dizziness, disturbed equilibrium, tremor, and convulsions. Cyclodienes may cause convulsions without any other initial symptoms. Chlorocyclohexanes can cause anemia. Cyclodienes and chlorocyclohexanes cause liver toxicity and can cause permanent kidney damage.	History and physical exam should focus on the nervous system. Laboratory tests include: Measurement of kidney and liver function. CBC[b] for exposure to chlorocyclohexanes.

EXHIBIT 7-3 (cont'd)
Common Chemical Toxicants Found at Hazardous Waste Sites, their Health Effects, and Medical Monitoring (cont'd)

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Organophosphate and Carbamate Insecticides	Organophosphate: Diazinon Dichlorovos Dimethoate Trichlorfon Malathion Methyl parathion Parathion Carbamate: Aldicarb Baygon Zectran	Pest control.	CNS[a] Liver Kidney	All cause a chain of internal reactions leading to neuromuscular blockage. Depending on the extent of poisoning, acute symptoms range from headaches, fatigue, dizziness, increased salivation and crying, profuse sweating, nausea, vomiting, cramps, and diarrhea to tightness in the chest, muscle twitching, and slowing of the heartbeat. Severe cases may result in rapid onset of unconsciousness and seizures. A delayed effect may be weakness and numbness in the feet and hands. Long-term, permanent nerve damage is possible.	Physical exam should focus on the nervous system. Laboratory tests should include: RBC[a] cholinesterase levels for recent exposure (plasma cholinesterase for acute exposures). Measurement of delayed neurotoxicity and other effects.
Polychlorinated Biphenyls (PCBs)		Wide variety of industrial uses.	Liver CNS[a] (speculative) Respiratory system (speculative) Skin	Various skin ailments, including chloracne; may cause liver toxicity; carcinogenic to animals.	Physical exam should focus on the skin and liver. Laboratory tests include: Serum PCB levels. Triglycerides and cholesterol. Measurement of liver function.

[a] RBC = Red blood count.

However, contamination can occur even with these safeguards. It is important to identify the chemical hazards that exist at a site, and to take steps to prevent contamination.

Chemical exposures are generally divided into two categories: acute and chronic. Symptoms resulting from acute exposures usually occur during and shortly after exposure to a high concentration of a contaminants. A chronic exposure usually occurs at a low concentration over a long period of time. Lethal concentrations vary with each chemical. The symptoms of an acute exposure for a given contaminant may be completely different from those resulting from a chronic exposure to the same contaminant.

For chronic and acute exposures, the toxic effect may be temporary and reversible or permanent (causing disability or death). Although some chemicals cause obvious symptoms (e.g., burning, nausea, rashes), others may causes health damage without any warning signs (e.g., cancer, respiratory disease). Some toxic chemicals may be colorless and/or odorless, may dull the sense of smell, or may not produce immediate or obvious physiological sensation. A worker's senses or feelings cannot be relied upon in all cases to warn of toxic exposures. **Exhibit 7-4** lists the signs and warning symptoms of potential chemical exposure.

The primary routes of chemical contamination are as follows:

Inhalation is an exposure route of concern because the lungs are extremely vulnerable to chemical agents. Respiratory protection should be used if there is any possibility that the site may contain hazardous substances that can be inhaled. Chemicals can also enter the respiratory tract through punctured eardrums.

Direct contact of the skin and eyes is another route of exposure to hazardous substances. Some chemicals will directly injure the skin; some may pass through the skin into the bloodstream where they are transported to vulnerable organs. This absorption is enhanced by abrasions, cuts, heat, and moisture. Workers can protect against direct contact of a hazardous chemical by wearing PPE, refraining from use of contact lenses in contaminated atmospheres, keeping hands away from the face, and minimizing contact with liquid and solid chemicals.

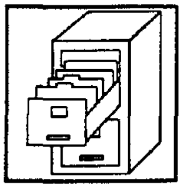
Ingestion occurs when chemicals are accidentally swallowed.

Injection can occur when chemicals are introduced into the body through puncture wounds, such as those caused by stepping or tripping or falling onto contaminated sharp objects. To protect against this type of exposure, the site should be prepared, and workers should wear safety shoes, avoid physical hazards, and take common sense precautions.

EXHIBIT 7-4
Signs and Symptoms of Chemical Contamination

- Behavioral changes
- Breathing difficulties
- Changes in complexion or skin color
- Coordination difficulties
- Coughing
- Dizziness
- Drooling, pupillary response
- Diarrhea
- Fatigue and/or weakness
- Irritability
- Irritation of eyes, nose, respiratory tract, skin or throat
- Headache
- Light-headedness
- Nausea
- Sneezing
- Sweating
- Tearing
- Blurred vision
- Cramps
- Tightness in the chest

7.5 MEDICAL RECORDS AND PROGRAM REVIEW



Medical records for employees must be maintained for at least 30 years after employment is terminated. These records must include the name and social security number of the employee, the physician's written opinions including recommended occupational limitations and results of examinations and tests, any employee medical complaints related to occupational hazardous substance exposure, and a copy of the material that the attending physician was provided before the examination. The employer is responsible for retaining the records if the employee or physician leaves the area, or if the company moves, is acquired, or goes out of business. In addition, employers who maintain 11 or more employees must keep injury and illness records for each establishment. Employers are also required to provide access to these records upon request by the employee or designated representative.

The medical surveillance program must be evaluated regularly to ensure its effectiveness.

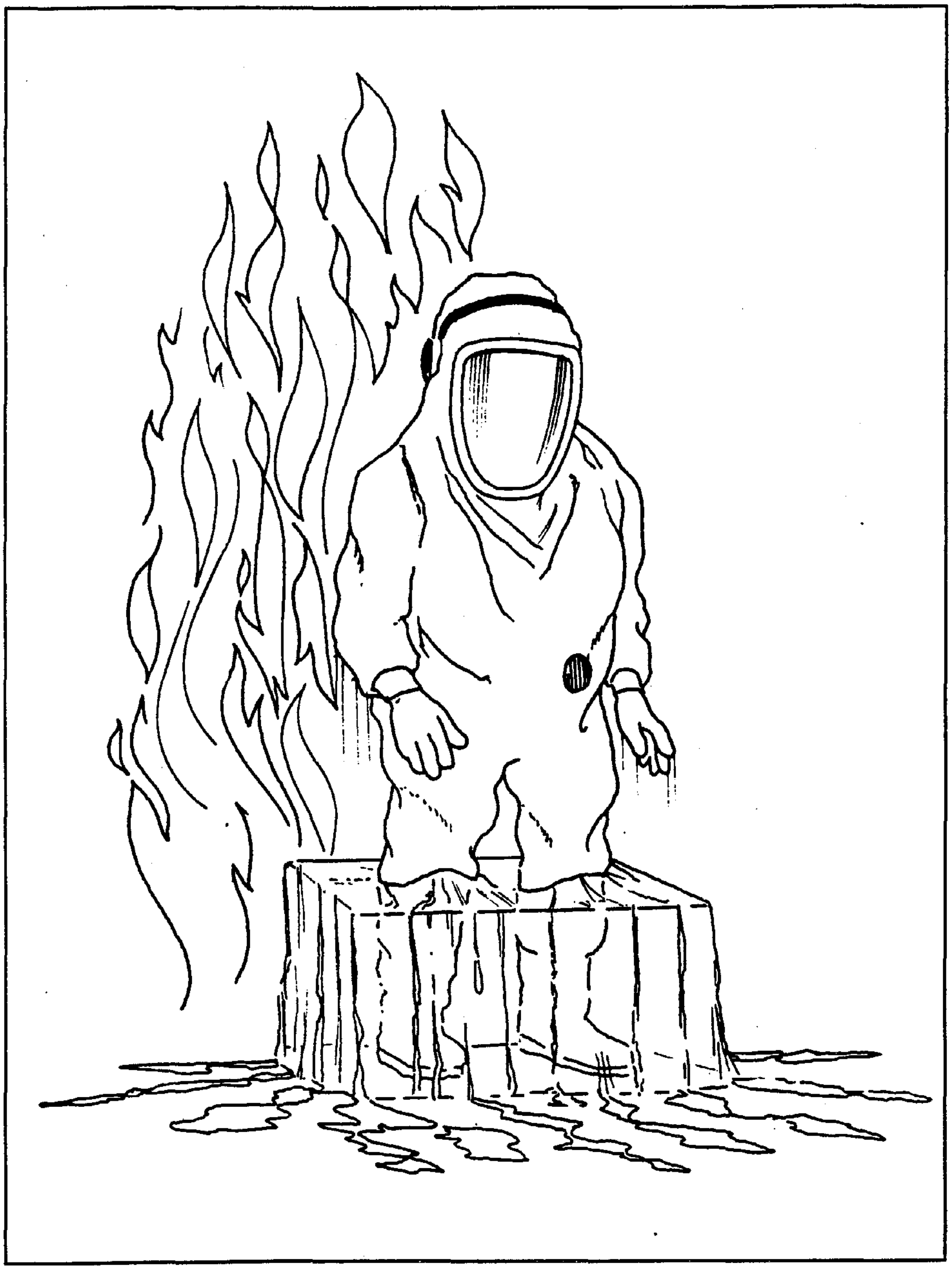
Maintenance and review of medical records and test results aid in assessing the effectiveness of the health and safety program. At a minimum, the Corporate Health and Safety Officer should perform the following record keeping activities annually:

- Ensure that each accident or illness was promptly investigated to determine the cause and make necessary changes in health and safety procedures;
- Evaluate specific medical testing to determine potential site exposures;
- Add or delete medical tests as suggested by current industrial hygiene and environmental data;
- Review potential exposures and the HASP at all sites to determine whether additional testing is required; and
- Review emergency treatment procedures and update lists of emergency contacts.
- Assure timely access upon employee request.

FURTHER GUIDANCE: For more information on developing a medical surveillance program, see:

1. *NIOSH Pocket Guide to Chemical Hazards* (NIOSH, 1991, Publication 90-117).
2. *Occupational Medical Monitoring Program Guidelines for SARA Hazardous Waste Field Activity Personnel* (U.S. EPA, 1990, Publication 9285.3-04).
3. *Occupational Safety and Health Guidelines for Chemical Hazards/Supplement II-OHG* (NIOSH, 1989, Publication 89-104).

CHAPTER 8 HEAT STRESS AND COLD EXPOSURE

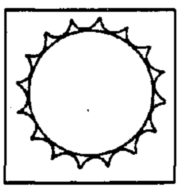


CHAPTER 8 HEAT STRESS AND COLD EXPOSURE

8.0 INTRODUCTION

Temperature extremes pose a hazard of particular concern to the health, safety, and comfort of personnel involved in hazardous waste site activities. Site health and safety personnel must consider the two most common dangers, heat stress and cold exposure, when making decisions regarding PPE selection and work mission duration, when establishing standard operating procedures for site activities, and when conducting medical monitoring.

8.1 HEAT STRESS



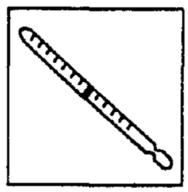
Heat stress is one of the most common and potentially serious illnesses at hazardous waste sites and, therefore, warrants regular monitoring and other preventive measures. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly -- within as little as 15 minutes -- and can pose as great a danger to worker health as chemical exposure. In its early stages, heat stress can cause rashes, cramps, and drowsiness. This can result in impaired functional ability that threatens the safety of both the individual and co-workers. Continued heat stress can lead to heat stroke and death.

8.1.1 Heat Stress and PPE

Heat stress is a major health hazard for workers wearing PPE because the same protective materials that shield the body from chemical exposure also limit the dissipation of body heat and moisture. Thus, personal protective clothing can create a hazardous condition.

Reduced work tolerance and the increased risk of excessive heat stress is directly influenced by the amount and type of PPE worn. The added weight and bulk of PPE severely reduces the body's access to normal heat exchange mechanisms and increases energy expenditure. When selecting PPE, therefore, each item's benefit should be carefully evaluated in relation to its potential for increasing the risk of heat stress. After PPE has been selected, the safe duration of work/rest periods should be determined based on the anticipated work rate, the ambient temperature and other environmental factors, the type of protective ensemble, and the individual worker characteristics and fitness.

8.1.2 Monitoring for Heat Stress



All workers, even those not wearing protective equipment, should be monitored, because the incidence of heat stress depends on a variety of factors and can affect any worker. Monitoring should be initiated before initial entry and should be continued during each break cycle. Some general guidelines include:

- For workers wearing permeable clothing, monitor for signs of heat stress and follow established work/rest schedules.
- For workers wearing semipermeable or impermeable encapsulating ensembles, workers should also be monitored when the temperature in the work area is above 70°F (21°C). Below 70°F, monitoring is considered on a case-by-case basis.

To conduct personnel monitoring, measure the heart rate and body temperature, as follows:

Heart Rate. Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same. If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.

Oral Temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking). If

EXHIBIT 8-1
Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK ENSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F (32.2°) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°- 90°F (30.8°- 32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°- 87.5°F (28.1°- 30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°- 82.5°F (25.3°- 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

[a] For work levels of 250 kilocalories/hour.
[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 X % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)
[c] A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Source: *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH/OSHA/USCG/EPA, 1985).

oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).

Initially, the length of the work cycle should be governed by the frequency of the required physiological monitoring. The frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see **Exhibit 8-1**, above).

8.1.3 Preventing Heat Stress

To protect against heat stress, it is important to choose the appropriate level of protection, to provide careful training for workers and site personnel, and to monitor frequently personnel who wear protective clothing. It is also important to ensure that work and rest periods are scheduled regularly, and that workers frequently replace lost fluids (it is not uncommon for workers to lose as many as 6 to 8 quarts of water in a hot shift).

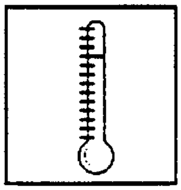
Proper training and preventive measures will help avert serious illness and loss of work productivity caused by heat stress. Preventing heat stress is particularly important because one incident of heat stress will increase the likelihood of future incidences. The site health and safety officer should take the following steps to prevent heat stress:

- Adjust work and rest schedules as needed;
- Provide shelter or shaded areas to protect personnel during rest periods;
- Maintain workers' body fluids at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must equal the approximate amount of water lost in sweat;
- Encourage workers to maintain an optimal level of physical fitness. Fit individuals may acclimatize more readily to temperatures;
- Provide cooling devices to aid natural body heat exchange during prolonged work or severe heat exposure. Effective devices

include field showers or hose-down areas, as well as cooling jackets, vests, or suits;

- Train workers to recognize and treat heat stress, and to identify the signs and symptoms of heat stress (e.g., muscle spasms, dizziness, lack of perspiration). Refer to **Exhibit 8-2** for more detail on the signs and symptoms of heat stress.

8.2 COLD EXPOSURE



Exposure to cold temperatures can cause frostbite and hypothermia as well as impair the ability to work. Extremely low temperatures are not necessary to suffer cold exposure -- a strong wind combined with a cold temperature can chill the body to the point where frostbite and hypothermia are a risk. Maintaining body temperature and recognizing the early signs and symptoms can help prevent illness and injury due to cold exposure.

Cold injury is generally classified as local (e.g., frostbite or frostnip) or general (e.g., hypothermia). The main factors contributing to cold injury are exposure to humidity and high winds, contact with wetness or metal, inadequate clothing, age, and general health. Physical conditions that worsen the effects of cold include allergies, vascular disease, excessive smoking and drinking, and use of specific drugs and medicines.

8.2.1 PPE And Cold Exposure

The correct PPE depends on the specific cold stress situation. It is important to preserve the air space between the body and the outer layer of clothing in order to retain body heat. The more air pockets each layer of clothing has, the better the insulation. However, the insulating effect is negated if the clothing interferes with the evaporation of sweat, or if the skin or clothing is wet.

The most important parts of the body to protect are the feet, hands, head, and face. Hands and feet are the farthest from the heart, and become cooled most easily. Keeping the head covered is important, because as much as 40 percent of body heat can be lost when the head is exposed.

Workers should wear several layers of clothing instead of a single heavy outer garment. In addition to offering better insulation, layers of clothing can be removed as needed to keep the worker from overheating. The outer layer should be windproof as well as waterproof, because body heat is lost quickly in even light winds.

8.2.2 Monitoring for Cold Exposure

Recognizing the early signs and symptoms of cold stress can help prevent serious injury. Described below are the most common types of cold injury and their monitoring signals.

Hypothermia. The first symptoms of hypothermia are uncontrollable shivering and the sensation of cold; the heartbeat slows and sometimes becomes irregular, the pulse weakens, and the blood pressure changes. Severe shaking or rigid muscles may be caused by bursts of body energy and changes in the body's chemistry. Uncontrollable fits of shivering, vague or slow slurred speech, memory lapses, incoherence and drowsiness are some of the symptoms that can occur. Other symptoms that can be seen before complete collapse are cool skin, slow and irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest.

As the core body temperature drops, the victim may become listless, confused, and make little or no attempt to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. Severe shivering must be taken as a sign of danger. If the body core temperature reaches about 85°F, significant and dangerous drops in blood pressure, pulse rate, and respiration can occur. In some cases, the victim may die.

Frostbite. Frostbite can occur without hypothermia when the extremities do not receive sufficient heat from central body stores. This can occur because of inadequate circulation and/or insulation. Frostbite occurs when there is freezing of the fluids around the cells of the body tissues due to extremely low temperatures. Frostbite may result in damage to and loss of tissue, and usually affects the nose, cheeks, ears, fingers, and toes. Damage from frostbite can be serious (e.g., scarring, tissue death resulting in amputation, and permanent loss of movement in the affected parts).

EXHIBIT 8-2
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbance	Treatment	Prevention
Temperature Regulation Heatstroke				
Heatstroke: (1) Hot, dry skin; usually red, mottled, or cyanotic; (2) rectal temperature 40.5°C (104°F) and over; (3) confusion, loss of consciousness, convulsions, rectal temperature continues to rise; fatal if treatment is delayed	(1) Sustained exertion in heat by unacclimatized workers; (2) lack of physical fitness and obesity; (3) recent alcohol intake; (4) dehydration; (5) individual susceptibility; and (6) chronic cardiovascular disease	Failure of the central drive for sweating (cause unknown) leading to loss of evaporative cooling and an uncontrolled accelerating rise in t_{re}; there may be partial rather than complete failure of sweating	Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning with cool dry air; avoid overcooling; treat shock if present	Medical screening of workers, selection based on health and physical fitness; acclimatization for 5-7 days by graded work and heat exposure; monitoring workers during sustained work in severe heat
Circulatory Hypostasis Heat Syncope				
Fainting while standing erect and immobile in heat	Lack of acclimatization	Pooling of blood in dilated vessels of skin and lower parts of body	Remove to cooler area; rest in recumbent position; recovery prompt and complete	Acclimatization; intermittent activity to assist venous return to heart
Water and/or Salt Depletion				
(a) <u>Heat Exhaustion</u>				
(1) Fatigue, nausea, headache, giddiness; (2) skin clammy and moist; complexion pale, muddy, or hectic flush; (3) may faint on standing with rapid thready pulse and low blood pressure; (4) oral temperature normal or low, but rectal temperature usually elevated (37.5-38.5°C or 99.5-101.3°F); water restriction type: urine volume small, highly concentrated; salt restriction type: urine less concentrated chlorides less than 3 g/L	(1) Sustained exertion in heat; (2) lack of acclimatization; and (3) failure to replace water lost in sweat	(1) Dehydration from deficiency of water; (2) depletion of circulating blood volume; (3) circulatory strain from competing demands for blood flow to skin and to active muscles	Remove to cooler environment; rest in recumbent position; administer fluids by mouth; keep at rest until urine volume indicates that water balances have been restored	Acclimatize workers using a breaking-in schedule for 5-7 days; supplement dietary salt only during acclimatization; ample drinking water to be available at all times and to be taken frequently during work day
(b) <u>Heat Cramps</u>				
Painful spasms of muscles used during work (arms, legs, or abdominal); onset during or after work hours	(1) Heavy sweating during hot work; (2) drinking large volumes of water without replacing salt loss	Loss of body salt in sweat, water intake dilutes electrolytes; water enters muscles, causing spasm	Salted liquids by mouth, or more prompt relief by IV infusion	Adequate salt intake with meals; for unacclimatized workers, supplement salt intake at meals.

EXHIBIT 8-2 (continued)
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbance	Treatment	Prevention
Skin Eruptions				
(a) Heat Rash (*miliaria rubra*, or "prickly heat")				
Profuse tiny raised red vesicles (blister-like) on affected areas; pricking sensations during heat exposure	Unrelieved exposure to humid heat with skin continuously wet from unevaporated sweat	Plugging of sweat gland ducts with sweat retention and inflammatory reaction	Mild drying lotions; skin cleanliness to prevent infection	Cool sleeping quarters to allow skin to dry between heat exposures
(b) Anhidrotic Heat Exhaustion (*miliaria profunda*)				
Extensive areas of skin which do not sweat on heat exposure, but present gooseflesh appearance, which subsides with cool environments; associated with incapacitation in heat	Weeks or months of constant exposure to climatic heat with previous history of extensive heat rash and sunburn	Skin trauma (heat rash; sunburn) causes sweat retention deep in skin; reduced evaporative cooling causes heat intolerance	No effective treatment available for anhidrotic areas of skin; recovery of sweating occurs gradually on return to cooler climate	Treat heat rash and avoid further skin trauma by sunburn; provide periodic relief from sustained heat
Behavioral Disorders				
(a) Heat Fatigue - Transient				
Impaired performance of skilled sensorimotor, mental, or vigilance tasks, in heat	Performance decrement greater in unacclimatized and unskilled worker	Discomfort and physiologic strain	Not indicated unless accompanied by other heat illness	Acclimatization and training for work in the heat
(b) Heat Fatigue - Chronic				
Reduced performance capacity; lowering of self-imposed standards of social behavior (e.g., alcoholic over-indulgence); inability to concentrate, etc.	Workers at risk come from temperate climates for long residence in tropical latitudes	Psychosocial stresses probably as important as heat stress; may involve hormonal imbalance but no positive evidence	Medical treatment for serious causes; speedy relief of symptoms on returning home	Orientation on life in hot regions (customs, climate, living conditions, etc.)

The freezing point of the skin is about 30°F (-1°C). As wind velocity increases, heat loss is greater and frostbite will occur more rapidly. If skin comes into contact with objects colder than freezing (e.g., tools or machinery), frostbite may develop at the point of contact, even in warmer environments.

There are three degrees of frostbite: first degree, which is freezing without blistering or peeling; second degree, which is freezing with blistering or peeling; and third degree, which is freezing with tissue death. **Exhibit 8-3** lists the symptoms of frostbite. It is important to remember that the victim is often unaware of the frostbite until someone else observes the symptoms.

EXHIBIT 8-3
Symptoms of Frostbite

- The first symptom of frostbite is an uncomfortable sensation of coldness, followed by numbness. There may be tingling, stinging, aching, or cramping.
- The skin changes color to white or grayish-yellow, then to reddish-violet, and finally turns black as the tissue dies.
- Pain may be felt at first, but subsides.
- Blisters may appear.
- The affected part is cold and numb.
- When frostbite of the outer layer of skin occurs, the skin has a waxy or whitish look and is firm to the touch.
- In cases of deep frostbite, the tissues are cold, pale, and solid. Injury is severe.

8.2.3 Preventing Cold Exposure

In preventing cold stress, health and safety professionals must consider factors relating both to the individual and to the environment. Acclimatization, water and salt replacement, medical screening, continuing medical supervision, proper work clothing, and training and education will contribute to the prevention of cold stress and injury related to working in a cold environment. Control of the environment involves engineering controls, work practices, work-rest schedules, environmental monitoring, and considerations of windchill temperature.

Acclimatization. Some degree of acclimatization may be achieved in cold environments. With sufficient exposure to cold, the body undergoes some changes that increase comfort and reduce the risk of cold injury. However, these physiological changes are usually minor and require repeated uncomfortably cold exposures to induce them. People who are physically unfit, older, obese, taking medication, or using alcohol or drugs may not acclimatize too readily.

Dehydration. Working in cold areas causes significant water losses through the skin and lungs as a result of the dryness of the air. Increased fluid intake is essential to prevent dehydration, which affects the flow of blood to the extremities and increased the risk of cold injury. Warm, sweet, caffeine-free, non-alcoholic drinks and soup should be available at the work-site for fluid replacement and caloric energy.

Salt. The body needs a certain amount of salt and other electrolytes to function properly. However, using salt tablets is not recommended. Salt tablets cause stomach irritation, which may include nausea and vomiting. A normal, balanced diet should take care of salt needs. Anyone with high blood pressure or who is on a restricted sodium diet should consult a physician for advice on salt intake.

Windchill. Air temperature alone is not sufficient to judge the cold hazard of a particular environment, because even a light wind can blow away the thin layer of air that insulates the body against the cold air temperature. The "windchill factor" is the cooling effect of any combination of temperature and air movement. The windchill index (**Exhibit 8-4**) should be consulted to estimate the equivalent temperature felt by personnel working in cold and windy environments. Remember, however, that the windchill index does not take into account: (1) the body part exposed to the cold; (2) the level of activity and the resulting heat produced; or (3) the amount of clothing worn.

Continuous exposure of skin should not be permitted when the windchill factor results in an equivalent temperature of -32°C (-26°F). Workers exposed to air temperatures of 2°C (35.6°F) or lower who become immersed in water or whose

EXHIBIT 8-4
Windchill Index[1]

	ACTUAL THERMOMETER READING (F)									
	50	40	30	20	10	0	-10	-20	-30	-40
Wind speed in mph	EQUIVALENT TEMPERATURE (F)									
calm	50	40	30	20	10	0	-10	-20	-30	-40
5	48	37	27	16	6	-5	-15	-26	-36	-47
10	40	28	16	4	-9	-21	-33	-46	-58	-70
15	36	22	9	-5	-18	-36	-45	-58	-72	-85
20	32	18	4	-10	-25	-39	-53	-67	-82	-96
25	30	16	0	-15	-29	-44	-59	-74	-88	-104
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116
Over 40 mph (little added effect)	Little Danger (for properly clothed person)				Increasing Danger			Great Danger		
					(Danger from freezing of exposed flesh)					

[1]Source: *Fundamentals of Industrial Hygiene, Third Edition.* Plog, B.A., Benjamin, G.S., Kerwin, M.A., National Safety Council, 1988.

clothing gets wet should be given dry clothing and be treated for hypothermia.

Special Considerations. Older workers and workers with circulatory problems need to be extra careful in the cold. Additional insulating clothing and reduced exposure time should be considered for these workers. Obese and chronically ill people need to make a special effort to follow preventive measures. Sufficient sleep and good nutrition are important for maintaining a high level of tolerance to cold. If possible, the most stressful tasks should be performed during the warmer parts of the day. Double shifts and overtime should be avoided. Rest periods should be extended to cope with increases in cold stress.

Workers should immediately go to warm shelter if any of the following symptoms are spotted: the onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, and/or euphoria. The outer layer of clothing should be removed when entering a heated shelter. If possible, a change of dry work clothing should be provided to prevent workers from returning to work with wet clothing. If this is not feasible, the remaining clothing should be loosened to permit sweat to evaporate.

Alcohol should not be consumed while in the warmer environment. Anyone on medication such as blood pressure control or water pills should consult a physician about possible side effects from cold stress. It is strongly recommended that workers suffering from diseases or taking medication that interferes with normal body temperature regulation, or that reduces tolerance of cold, not be permitted to work in temperatures of -1°C (30°F) or below.

To guard against cold exposure, provide workers with appropriate clothing, have warm shelter available at all times, carefully schedule work and rest periods, and monitor workers' physical conditions. Under no circumstances should a person be given an alcoholic beverage "to keep warm." Alcohol causes the body to release heat more quickly and will therefore increase the risk of cold exposure. Fruits can help warm the body by creating increased energy and metabolism.

8.2.4 A Control Program for Cold Stress

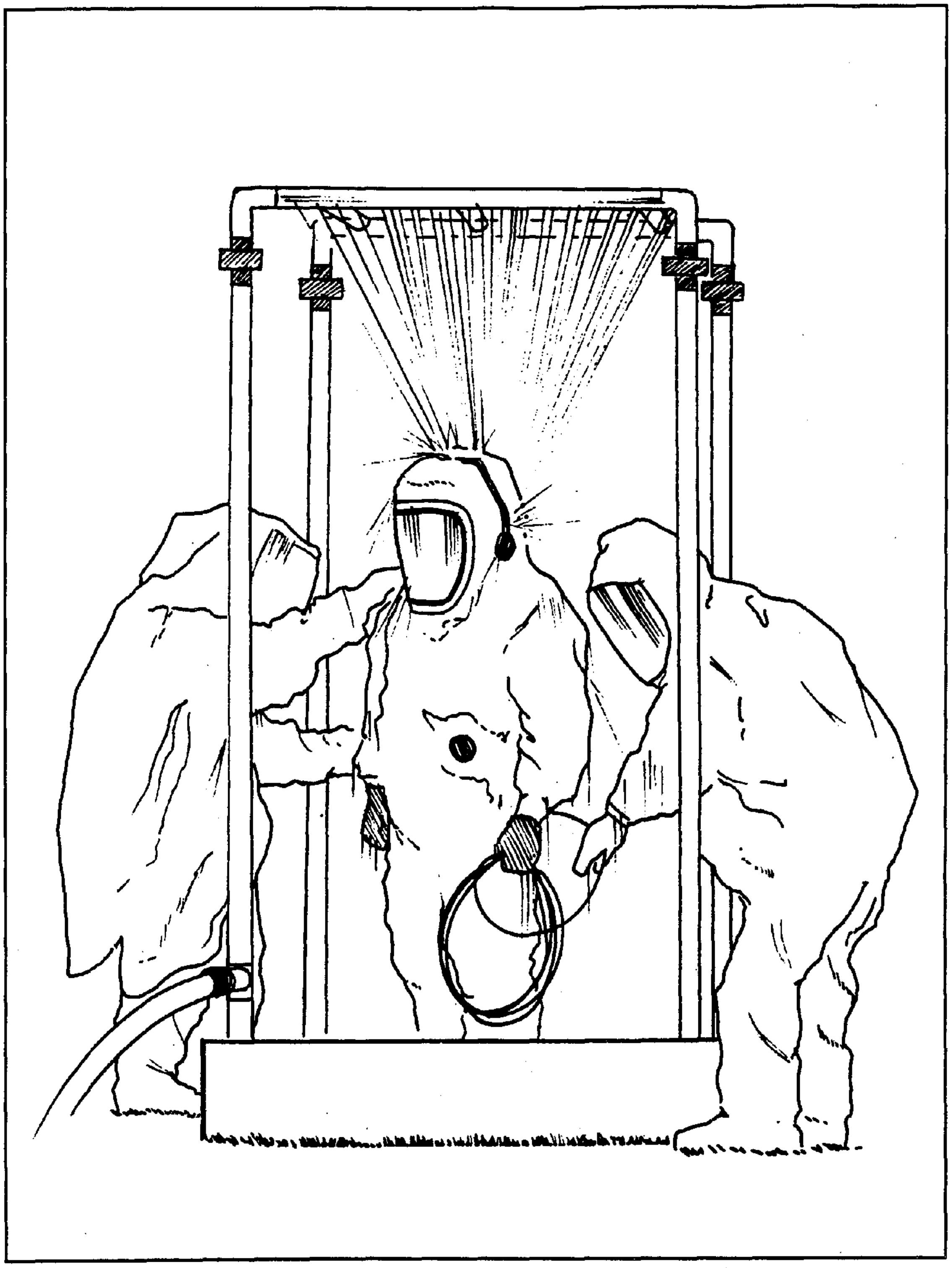
A control program for preventing cold stress at hazardous waste sites should include the following elements:

- **Medical supervision of workers** including pre-placement physicals that evaluate fitness, weight, the cardiovascular system, and other conditions that might make workers susceptible to cold stress. Medical evaluation during and after cold illnesses and a medical release for returning to work should be required.
- **Employee orientation and training** on cold stress, cold-induced illnesses and their symptoms, water and alt replacement, proper clothing, work practices, and emergency first aid procedures.
- **Work-rest regimens**, with heated rest areas and enforced rest breaks.
- **Scheduled drink breaks** for recommended fluids.
- **Environmental monitoring**, using the air temperature and wind speed indices to determine wind chill and adjust work/rest schedules accordingly.
- **Reduction of cold stress** through engineering and administrative controls, and the used of personal protective equipment.

FURTHER GUIDANCE: For additional information on recognizing, preventing, and controlling heat and cold stress, see:

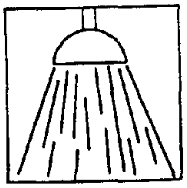
1. Plog, Barbara A., Benjamin, G.S., and M.A. Kerwin. *Fundamentals of Industrial Hygiene, Third Edition.* National Safety Council, 1988.
2. *Pocket Guide to Cold Stress.* National Safety Council, 1985.
3. *Pocket Guide to Heat Stress.* National Safety Council, 1985.
4. *1991-1992 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.* American Conference of Governmental Industrial Hygienists, 1991.

CHAPTER 9 DECONTAMINATION



CHAPTER 9 DECONTAMINATION

9.0 INTRODUCTION



Decontamination, the process of removing or neutralizing contaminants, is critical to health and safety at hazardous waste sites. Decontamination protects workers from hazardous substances that can eventually permeate protective clothing, respiratory equipment, tools, and vehicles. It protects site personnel by minimizing the spread of hazardous substances into clean areas on-site, prevents the mixing of incompatible wastes, and protects the community by preventing the migration of contaminants from the site. Personnel engaged in hazardous waste operations may become contaminated in a number of ways, including:

- Contacting vapors, gases, mists, or particulates in the air;
- Being splashed by materials while sampling or opening containers;
- Walking through puddles of liquids or sitting in contaminated soil; and
- Using contaminated instruments or equipment.

Protective clothing and respirators help prevent the wearer from becoming contaminated or inhaling hazardous substances, and good work practices help minimize contamination on PPE, instruments, and equipment. But even with these safeguards, contamination may occur. To prevent and minimize the severity of such incidences, the HAZWOPER regulations at 29 CFR §1910.120(k) require the development of a decontamination plan prior to site entry; the development of standard operating procedures (SOPs) to minimize contamination; full decontamination of employees and equipment; and the monitoring of decontamination procedures by the Site Health and Safety Officer.

Cross contamination from protective clothing to the wearer, from equipment to personnel, and from one area to another can be minimized by combining decontamination, the correct methods for removing contaminated PPE, and the use of site work zones. This chapter provides an overview of decontamination, provides general guidelines for designing and selecting decontamination procedures at a site, explains equipment for decontamination procedures, and discusses how decontamination and PPE are related.

9.1 THE DECONTAMINATION PLAN

Any site where hazardous waste cleanup operations occur must have a plan that outlines decontamination procedures (29 CFR §1910.120(k)). These procedures must be made available to employees and must be implemented before anyone enters areas on-site where there is suspected contamination. The plan must ensure that chosen decontamination methods are effective for the specific hazardous substances present, and that the methods themselves do not pose any health or safety hazards. The decontamination plan also should address:

- The number and placement of decontamination stations;
- The necessary decontamination equipment and methods;
- SOPs to prevent contamination of clean areas and to minimize worker contact with contaminants during removal of PPE; and
- Methods for disposing of clothing and equipment that may not be completely decontaminated.

9.2 DEVELOPING THE PLAN

The initial decontamination plan should be based on the assumption that all personnel and equipment leaving the Exclusion Zone ("hot zone") will be grossly contaminated. A personnel decontamination system should then be established to wash and rinse (at least once) all protective equipment used in contaminated areas. This should be done in combination with a sequential doffing of protective equipment, starting at the first decontamination station with the most heavily contaminated item and progressing to the last decontamination station with the least contaminated article (see Section 9.3).

An essential part of the plan should address SOPs for site operations, that is, methods to **prevent** the contamination of people and equipment. For example, using remote sampling techniques, not opening containers by hand, bagging monitoring instruments, using drum grapplers, watering down dusty areas, and not walking through areas of obvious contamination would reduce the probability of becoming contaminated and, therefore, would reduce decontamination time.

The initial decontamination plan should be based on a worst-case situation and should assume no information is available about on-site contaminants. The initial decontamination plan can be modified later, eliminating unnecessary stations or otherwise adapting it to site conditions, by considering the following factors:

Type of Contaminant. The extent to which personnel decontamination is required varies depending on the effects the contaminants have on the body. All contaminants do not exhibit the same degree of toxicity (or other hazard). Whenever it is known or suspected that personnel can become contaminated with highly toxic or skin-destructive substances, a full decontamination procedure should be followed. The procedure can be downgraded only if less hazardous materials are present at the site.

Amount of Contamination. The amount of contamination on protective clothing (and other objects or equipment) usually can be determined by visual inspection. If, after a visual inspection, the PPE appears grossly contaminated, a thorough decontamination is highly recommended. Gross material remaining on the protective clothing for any extended period of time may degrade or permeate it. This likelihood increases with higher air concentrations and greater amounts of liquid contamination. Gross contamination also increases the probability of personnel contact. Swipe tests may help determine the type and quantity of surface contaminants.

Type and Level of PPE. The level of protection and specific pieces of clothing worn can be used to determine the preliminary layout and decontamination stations needed for the decontamination line. Each level of protection presents different problems in decontamination and doffing of equipment. For example: decontamination of SCBA harness straps and backpack assembly often is difficult; however, a butyl rubber apron worn over the harness may make decontamination easier. Clothing variations and different levels of protection may require adding or deleting stations to the preliminary decontamination line.

Work Function. The work each person performs determines the potential for contact with hazardous materials. In turn, this should dictate the layout of the decontamination line. For example, observers, photographers, operators of air samplers, or others in the Exclusion Zone who are performing tasks that will not bring them in direct contact with contaminants may not need to have their garments washed and rinsed. Others in the Exclusion Zone with a potential for direct contact with the hazardous material will require more thorough decontamination. Different decontamination lines could be set up for different job functions, or certain stations in a line could be omitted for personnel performing certain tasks.

Location of Contamination. Contamination on the upper areas of protective clothing poses a greater risk to the worker because volatile compounds may generate a hazardous breathing concentration both for the worker and for decontamination personnel. There is also an increased probability of contact with skin when doffing the upper part of clothing.

Establishment of Procedures. Once decontamination procedures have been established, all personnel requiring decontamination must be given precise instructions (and practice, if necessary). Compliance must be checked frequently. The time it takes for decontamination also must be ascertained. Personnel wearing SCBA must leave their work area with sufficient air to walk to the Contamination Reduction Corridor and undergo decontamination.

9.3 THE CONTAMINATION REDUCTION CORRIDOR

Decontamination activities should be confined to a designated area within the Contamination Reduction Zone, known as the

Contamination Reduction Corridor. The Corridor controls access into and out of the Exclusion Zone and confines decontamination activities to a limited area. The size of the Corridor varies depending on the number of stations in the decontamination procedure, overall dimensions of work control zones, and amount of space available at the site. A Corridor of 75 feet by 15 feet is the minimum area for full decontamination. Stations should be separated physically to prevent cross contamination and should be arranged in order of decreasing contamination, preferably in a straight line. For example, outer, more heavily contaminated items (e.g., outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g., jackets and pants). Individual routes through the decontamination line should be developed for workers exposed to different contamination zones containing incompatible wastes. Entry and exit points should be marked clearly, and the entry and exit points into and out of the Exclusion Zone should be separate points. Dressing and redressing stations for entry and exit to the CRZ should also be separate. Personnel who wish to enter clean areas of the decontamination facility, such as locker rooms, should be completely decontaminated.

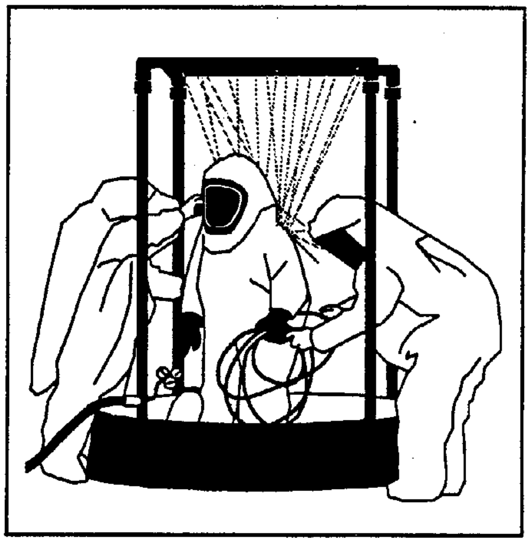
The decontamination Corridor boundaries should be conspicuously marked, with entry and exit restricted. The far end of the Corridor would be the Hotline, the boundary between the Exclusion Zone and the CRZ. Personnel exiting the Exclusion Zone must go through decontamination in the Corridor, and anyone in the Corridor should be wearing the level of protection designated for the decontamination crew. Another Corridor may be required for heavy equipment needing decontamination.

Within the Corridor, distinct areas should be set aside for decontamination of personnel, portable field equipment, removed clothing, etc. These areas should be marked and access should be restricted to personnel wearing the appropriate level of protection. All activities within the Corridor should be confined to decontamination. Personnel protective clothing, respirators, monitoring equipment, and sampling supplies should be stored and maintenanced outside of the Corridor. Personnel should not don their protective equipment in the Corridor.

9.4 DECONTAMINATION PROCEDURES AND EQUIPMENT

All personnel, clothing, equipment, and samples leaving the contaminated area of a site (the Exclusion Zone) must be decontaminated to remove any harmful chemicals or infectious organisms that may have adhered to them. Step-by-step procedures for decontamination of personnel wearing PPE Levels A through C are found in **Appendix E**.

Three general types of decontamination methods are commonly used: (1) physical removal of contaminants; (2) inactivation of contaminants by chemical detoxification or disinfection/sterilization; or (3) a combination of both physical and chemical means.



9.4.1 Physical Removal of Contaminants

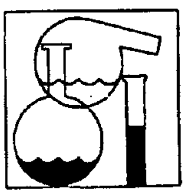
In many cases, contaminants may be removed by physical means; however, high pressure and/or heat should be used only as necessary and with caution because they can spread contamination and cause burns. Some contaminants that can be physically removed are described below.

Loose Contaminants. Soils or dusts that cling to equipment and personnel or that become lodged in PPE materials can be removed with water or a liquid rinse. Commercially available anti-static solutions may help to remove electrostatically attached particles.

Adhering Contaminants. Some contaminants adhere by forces other than electrostatic attraction. Adhesive qualities vary greatly with the specific contaminants and the temperature. For example, contaminants such as glues, cements, resins, and muds have great adhesive properties and, consequently, are difficult to remove by physical means. Adhesive contaminants can be removed using methods such as solidification, freezing (e.g., using dry ice or ice water), adsorption or absorption (e.g., with powdered lime or kitty litter), or melting.

Volatile Liquids. Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation (using steam jets) followed by a water rinse. This method should be used with caution because of the potential for employees to inhale the vaporized hazardous chemicals.

9.4.2 Chemical Removal of Contaminants



Physical removal of gross contamination should be followed by washing and rinsing with cleaning solutions. These solutions normally use one or more of the following methods:

Dissolving Contaminants. Chemical removal of surface contaminants can be accomplished by dissolving them in a solvent that must be chemically compatible with the equipment being cleaned. This is particularly important when decontaminating personal protective clothing constructed of organic materials that could be damaged or dissolved by organic solvents. In addition, any flammable or toxic organic solvents must be used and disposed of cautiously. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products.

Halogenated solvents are toxic and generally are incompatible with most types of PPE. They should be used only for decontamination in extreme cases where other cleaning agents will not remove the contaminant. Because of the potential hazards, decontamination using chemicals should be done only if recommended by an industrial hygienist or other qualified health professional.

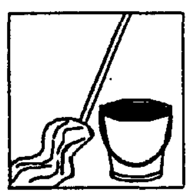
Surfactants. Surfactants supplement physical cleaning methods by minimizing adhesion between contaminants and the surface being cleaned and, therefore, prevent recontamination. Among the most common surfactants are household detergents, some of which can be used with organic solvents to improve the dissolving and dispersal of contaminants into the solvent.

Solidification. Solidifying liquid or gel contaminants can enhance their physical removal. Contaminants may be solidified by: (1) using absorbents such as grounded clay or powdered lime to remove moisture; (2) chemical reactions using polymerization catalysts and chemical reagents; and (3) freezing with ice water.

Rinsing. Rinsing removes contaminants through dilution, physical attraction, and solubilization. Multiple rinses with clean solutions remove more contaminants than a single rinse with the same volume of solution. Continuous rinsing with large volumes is the most effective way to remove contaminants.

Disinfection/Sterilization. Chemical disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization techniques are generally impractical for large equipment and PPE. For this reason, disposable PPE is recommended for use with infectious agents.

9.4.3 Decontamination Equipment



Decontamination equipment, materials, and supplies are generally selected based on availability. It is also necessary to consider whether the equipment itself can be decontaminated for reuse or can be easily disposed of. Most equipment and supplies needed for decontamination are easily procured (e.g., soft bristle and long handle brushes for scrubbing; buckets or garden sprayers for rinsing; large galvanized wash tubs or stock tanks for solutions; and large plastic garbage cans or other similar lined containers for storing contaminated clothing and equipment). Other decontamination gear includes paper or cloth towels for drying protective clothing and equipment. **Exhibits 9-1 and 9-2** list recommended equipment for decontaminating personnel and PPE, and heavy equipment and vehicles, respectively.

EXHIBIT 9-1
Recommended Equipment for Decontaminating Personnel and PPE

- Plastic drop cloths for storing heavily contaminated equipment and outer protective clothing.
- Drums or suitably lined trash cans for storing disposable clothing and heavily contaminated PPE that must be discarded, and for storing contaminated solutions.
- Lined boxes with absorbents for rinsing off solid or liquid contaminants.
- Washing and rinsing solutions selected to reduce contamination and the hazards associated with contaminants.
- Large galvanized tubs, stock tanks, or children's wading pools to hold wash and rinse solutions. These should be at least large enough for a worker to place a booted foot in, and should have either no drain or be connected to a collection tank or appropriate treatment system.
- Plastic sheeting, sealed pads with drains, or other appropriate methods for containing and collecting contaminated wash and rinse solutions spilled during decontamination.
- Long-handled, soft-bristled brushes to help wash and rinse off contaminants.
- Paper or cloth towels for drying protective clothing and equipment.
- Lockers and cabinets for storage of decontaminated clothing and equipment.
- Shower facilities for full body wash or, at a minimum, personal wash sinks (with drains connected to a collection tank or appropriate treatment system).

Currently, there are no available methods for immediately determining the effectiveness of decontamination procedures. Discolorations, stains, corrosive effects, and substances adhering to objects may indicate contaminants have not been removed. However, observable effects only indicate surface contamination and not permeation (absorption) into clothing, tools, or equipment. Also, many contaminants are not easily observed.

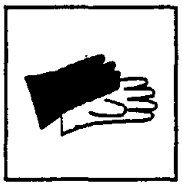
EXHIBIT 9-2
Recommended Equipment for Decontaminating Large Equipment and Vehicles

- Tanks for temporary storage and/or treatment of contaminated wash and rinse solutions.
- Drains or pumps for collecting contaminated wash and rinse solutions.
- Long-handled brushes, rods, and shovels for dislodging contaminated soil caught in tires and the undersides of vehicles and equipment and for general exterior cleaning.
- Washing and rinsing solutions selected to remove and reduce the hazards associated with contamination.
- Pressurized sprayers for washing and rinsing, particularly for hard-to-reach areas.
- Curtains, or spray booths to contain splashes from pressurized sprays.
- Containers to hold contaminated soil removed from tires and the undersides of vehicles and equipment.
- Wash and rinse buckets for use in the decontamination of operator areas inside vehicles and equipment.
- Brooms and brushes for cleaning the insides of vehicles and equipment.
- Containers for storage and disposal of contaminated wash and rinse solutions, damaged or heavily contaminated parts, and equipment to be discarded.

One method for determining effectiveness of surface decontamination is swipe testing. Cloth or paper patches are wiped over predetermined surfaces of the suspect object and analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be swipe tested. Positive indications of both sets of swipes would indicate surface contamination has not been removed and substances have penetrated or permeated through the garment. Determining permeation of contaminants into protective garments requires laboratory analysis of a piece of the material. Both swipe and permeation testing provide after-the-fact information. Along with visual observations, results of these tests can help evaluate the effectiveness of decontamination.

In many cases, depending on what substances are present at a site, chemical protective clothing (or naturally absorbable materials) may have to be discarded. In this case, all small equipment items (brushes, clothing, tools) should be collected, placed in containers, and labeled. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags, pending further decontamination and/or disposal.

9.5 PROTECTION OF DECONTAMINATION PERSONNEL



Decontamination workers are vital to the fulfillment of site decontamination procedures. It is their responsibility to monitor and aid the decontamination of personnel, PPE, and equipment. Decontamination workers must wear the appropriate level of protection to accomplish this task without exposing themselves to the contamination. This level of protection can be determined by:

- Expected or visible contamination on workers;
- Type of contaminant and associated respiratory and skin hazards;
- Total vapor/gas concentrations in the contamination reduction corridor;
- Particulates and specific inorganic or organic vapors in the Corridor; and
- Results of swipe tests.

Decontamination workers who initially come in contact with personnel and equipment leaving the Exclusion Zone will require more protection from contaminants than decontamination workers who are assigned to the last station in the decontamination line. In some cases, decontamination personnel should wear the same levels of PPE as workers in the Exclusion Zone. In other cases, decontamination personnel may be sufficiently protected by wearing protection of one level lower (e.g., wearing Level C protection while decontaminating workers who are wearing Level B). Level D is not acceptable in the CRZ for decontamination line personnel. All decontamination workers are in a contaminated area and must themselves be decontaminated before entering the clean Support Zone.

All decontamination personnel should be trained in the standard operating procedures for minimizing contact and maximizing worker protection, and these procedures should be enforced throughout site operations. In addition, standard operating procedures should be established that maximize worker protection. For example, proper procedures for dressing prior to entering the Exclusion Zone will minimize the potential for contaminants to bypass the protective clothing and escape decontamination. In general, all fasteners should be used; gloves and boots should be tucked under the sleeves and legs of outer clothing; hoods (if not attached) should be worn outside the collar; all junctures should be taped to prevent contaminants from running inside the gloves, boots, jackets, and suits.

9.6 HEALTH AND SAFETY HAZARDS

While decontamination is performed to protect health and safety, it can pose hazards under certain circumstances. Decontamination methods may:

- Be incompatible with the hazardous substances being removed (i.e., a decontamination method may react with contaminants to produce an explosion, heat, or toxic products).
- Be incompatible with the clothing or equipment being decontaminated (e.g., some organic solvents can permeate PPE).

- Pose a direct health hazard to workers (e.g., vapors from chemical decontamination solutions may be hazardous if inhaled).

The chemical and physical compatibility of the decontamination solutions or other decontamination materials must be determined before they are used. Any decontamination method that permeates, degrades, damages, or otherwise impairs the safe functioning of the PPE should not be used. Measures must be taken to adequately protect all workers and equipment from any decontamination method that does pose a direct health hazard.

Hazardous waste facilities should also have in place emergency decontamination procedures, in order to prevent the loss of life or severe injury to site personnel. In the case of threat to life, decontamination should be delayed until the victim is stabilized; however, decontamination should always be performed first, when practical, if it can be done without interfering with essential life-saving techniques or first aid, or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life. During an emergency, provisions must also be made for protecting medical personnel and disposing of contaminated clothing and equipment.

FURTHER GUIDANCE: For more information on decontamination procedures and equipment, see:

1. *Standard Operating Guidelines for Decontamination of Response Personnel* (U.S. EPA, draft, Publication 9285.2-02A).

2. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH/OSHA/USCG/EPA, 1985, NIOSH Publication 85-115).

CHAPTER 10 DRUM HANDLING

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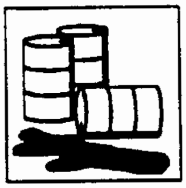
10.0 INTRODUCTION



Accidents may occur during handling of drums and other hazardous waste containers. Hazards include detonations, fires, explosions, vapor generation, and physical injury. The most significant ways to improve the safety of drum handling activities at a site are to keep the operation as remote from workers as possible, to avoid sudden releases of chemicals if the operation cannot be remote, and to provide adequate safety gear and equipment to protect the worker if spillage or contact with the drums is unavoidable. **Exhibit 10-1** outlines some basic safety precautions in drum handling.

Regulations defining practices and procedures for safe handling of drums and other hazardous waste containers include:

- OSHA regulations (29 CFR Part 1910. 120(j) and Part 1926) -- general requirements and standards for storing, containing, and handling chemicals and containers, and for maintaining equipment used for handling materials;

- EPA regulations (40 CFR Parts 264 and 265) -- requirements for types of hazardous waste containers, maintenance of containers and containment structures, and design and maintenance of storage areas; and

- DOT regulations (49 CFR Parts 171 through 178) -- requirements for containers and procedures for shipment of hazardous wastes.

During hazardous waste operations, containers are handled during inspection, drum opening, sampling, and characterization. This chapter provides guidance for safely performing these procedures when handling drums and other containers.

10.1 INSPECTION

Appropriate procedures for handling drums varies depending on the drum contents. Prior to handling, drums should be inspected visually to identify their contents. Information that may be helpful includes:

- Symbols, words, or other marks on the drum indicating that its contents are hazardous;

- Symbols, words, or other marks indicating that the drum contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume individual containers;

- Signs of deterioration such as corrosion, rust, and leaks;

- Signs that the drum is under pressure; and

- Configuration of the drumhead. For example, if the whole lid of the drum can be removed, then it was designed to contain solid material; if the lid has a bung, then the drum was intended for liquids. If the drumhead contains a liner, the drum may likely contain highly corrosive or otherwise hazardous materials.

Noting the type of drum also may be useful for identifying potential hazards. **Polyethylene** or **PVC-lined** drums often contain strong acids or bases. If the lining is punctured, the substance usually quickly corrodes the steel, and may cause a significant leak or spill. **Exotic metal** drums (e.g., aluminum, nickel, stainless steel) are very strong and expensive, and are often used to store extremely dangerous materials. **Single-walled drums used as a pressure vessel** have fittings for both the storage product and for an inert gas. These drums may contain reactive, flammable, or explosive substances.

Laboratory packs are used for disposal of expired chemicals and process samples from university laboratories, hospitals, and similar institutions. Individual containers within the lab pack often are not packed in absorbent material. They may contain incompatible materials, radioisotopes, or shock-sensitive, highly volatile, highly corrosive, or highly toxic exotic chemicals. Laboratory packs are a potential ignition source for fires at hazardous waste sites.

EXHIBIT 10-1
Safety Precautions for Drum Handling

ACTIVITY: LOCATING DRUMS AND CONDUCTING INVENTORY	
POTENTIAL SAFETY HAZARD: Unknown location and contents of drums can lead to unsuspected hazards	
Safety Tips	• Carefully review background data pertaining to the location and types of wastes on-site. • Conduct soil and ground-water sampling only after the geophysical survey is completed to minimize the possibility of puncturing drums. • During the random sampling of drums, which may be required for an inventory, spacing between drums should be adequate to allow for emergency evacuation if needed. • Use remotely operated, nonsparking tools for random sampling whenever possible. • Use direct-reading air monitoring equipment to detect hot spots where contamination may pose a risk to worker safety.

ACTIVITY: DETERMINING DRUM INTEGRITY	
POTENTIAL SAFETY HAZARD: The process of visual inspections requires close contact with drums of unknown content	
Safety Tips	• Approach drums cautiously. Conduct air monitoring to indicate levels of hazards that require withdrawal from the work area or use of additional safety equipment. • Any drum that is critically swollen should not be approached; it should be isolated using a barricade until the pressure can be relieved remotely. • Use of the grappler or other remotely operated equipment can eliminate the need for determining drum integrity prior to excavation, provided that rupture of the drum will not result in fire or unacceptable environmental impact.

ACTIVITY: DRUM EXCAVATION AND HANDLING	
POTENTIAL SAFETY HAZARD: Exposure to toxic/hazardous vapors; rupture of drums	
Safety Tips	• Where buried drums are suspected, conduct a geophysical survey before using any construction equipment in order to minimize the possibility of rupture. • Use a drum grappler where possible and cost-effective to minimize contact with drums. If a grappler is not available, pump or overpack drums of poor integrity before excavation. • Ground equipment prior to transferring wastes to new drums. • Use nonsparking hand tools and nonsparking bucket teeth on excavation equipment, and use plexiglass shields on vehicle cabs. • Where slings, yokes, or other accessories must be used, workers should back away from the work area after attaching the accessory and before the drum is lifted. • Critically swollen drums should not be handled until pressure can be relieved. • Use bars that fit over the teeth of excavation buckets to prevent drum puncture. • Where ionizing levels of radiation are detected, the Site Health and Safety Officer should be contacted; generally, the drum should be overpacked and isolated promptly. • Where explosive or shock-sensitive material is suspected, every effort should be made to handle the drum remotely. Gas cylinders should not be dragged during handling. • Use direct-reading air monitoring equipment when in close proximity to drums to detect any hot spots.

EXHIBIT 10-1 (cont'd)
Safety Precautions for Drum Handling

ACTIVITY: DRUM STAGING AND OPENING	
POTENTIAL SAFETY HAZARD: Release of toxic, hazardous vapors, rupture of drums	
Safety Tips	· Stage gas cylinders in a cool, shaded area. · Stage potentially explosive or shock-sensitive wastes in a diked, fenced area. · Use remote drum opening methods where drums are unsound. · Conduct remote-operated drum opening from behind a barricade or behind a plexiglas shield if backhoe-mounted puncture is being used. · Isolate drum opening from staging and other activities if possible to prevent a chain reaction if an explosion or reaction does occur. · If drum opening cannot be isolated from staging, drums should be staged so as to: (1) minimize the possibility of chain reactions in the event of a fire or explosion; and (2) provide adequate space for emergency evacuation. · Use only nonsparking hand tools if drums are to be opened manually. · Remotely relieve the pressure of critically swollen drums before opening. · Clean up spills promptly to minimize mixing of incompatible materials.

ACTIVITY: CONSOLIDATION AND RECONTAINERIZATION	
POTENTIAL SAFETY HAZARD: Mixing of incompatible wastes	
Safety Tips	· Perform on-site compatibility testing on all drums. · Segregate wastes according to compatibility class following compatibility testing. · Clean up spills promptly to avoid mixing of incompatible wastes. · Intentional mixing of incompatible wastes such as acids and bases should be performed under controlled conditions in a reaction tank where temperature and vapor release can be monitored. · Monitor for incompatible reactions during consolidation using direct-reading air monitoring equipment.

ACTIVITY: INTERIM STORAGE AND TRANSPORTATION	
POTENTIAL SAFETY HAZARD: Mixing of incompatible wastes	
Safety Tips	· Segregate incompatible wastes using dikes during interim storage. · Maintain a weekly inspection schedule. · Allow adequate aisle space between drums to allow rapid exit of workers in case of emergency. · Keep explosives and gas cylinders in a cool, shaded, or roofed area. · Prevent contact of water reactive wastes with water. · Clean up spills or leaks promptly. · Have fire fighting equipment readily available within the storage area. · Ensure adherence to DOT regulations regarding transport of incompatible wastes and drum integrity.

Source: *Drum Handling Practices at Hazardous Waste Sites* (U.S. EPA, 1986, EPA/500/2-86/013).

Conditions in the immediate vicinity of the drums may provide information about drum contents and associated hazards. In addition, air monitoring should be conducted around the drums. If buried drums are suspected, ground-penetrating systems can be used to estimate the location and depth of the drums.

After visual inspection, drums can be classified into preliminary hazard categories. They can be described as radioactive, leaking or deteriorated, bulging, and explosive or shock-sensitive. Until their contents are characterized, unlabelled drums should be handled in the same manner as drums that contain hazardous materials. It is also important to remember that drums are frequently mislabelled -- particularly drums that are reused. Therefore, a drum's label may not accurately describe its contents.

Results of the drum inspection can be used to determine: (1) whether any hazards are present and the appropriate response; and (2) which drums need to be moved before they are opened and sampled. A plan should be developed specifying the extent of handling necessary and the appropriate procedures for handling. Plans should be revised as new information is obtained during drum handling.

10.2 DRUM EXCAVATION AND REMOVAL EQUIPMENT

Drum excavation and removal equipment is used to perform several distinct and important functions, including:

- Excavating to the depth of buried drums and removing surface cover over buried drums.
- Excavating around buried drums to free them for removal.
- Removing (lifting) drums from exposed pits and trenches.
- Loading and transporting drums to onsite storage areas.
- Sampling, segregating, bulking, storing, and recontainerizing (e.g., overpacking) drums.
- Transporting offsite for appropriate storage, treatment, or disposal.

The choice of equipment for drum handling is based on the inherent capabilities and limitations of the equipment, site-specific conditions that affect equipment performance, the necessity to protect worker safety, and costs. Generally, a combination of equipment and accessories is required for a particular job.

10.3 DRUM HANDLING

The purpose of drum handling is to: (1) respond to obvious problems that might impair worker safety; (2) unstack and orient drums for sampling; and (3) if necessary, organize drums into different areas on-site to facilitate characterization and remedial action. Handling may or may not be necessary, depending on how the drums are positioned at a site.

To avoid accidents, drums should only be handled when necessary. Prior to handling, all personnel should be warned about the hazards of handling and instructed to minimize handling as much as possible. In all phases of handling, personnel should be alert for new information about potential hazards and should respond to new hazards before continuing with routine handling operations. Empty overpack drums (larger drums in which smaller leaking or damaged drums are placed for storage or shipment) and an adequate volume of absorbent should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm should be constructed prior to handling. If drum contents spill, personnel trained in spill response should isolate and contain the spill.

The following procedures can be used to maximize worker safety during drum handling and movement:

- Train personnel in proper lifting and moving techniques;
- Select vehicles with sufficient rated load capacity to handle anticipated loads, and ensure that vehicles can operate smoothly on available road surfaces;

- Air condition the cabs of vehicles to increase operator efficiency and protect the operator with heavy splash shields;

- Supply operators with appropriate respiratory protective equipment when needed;

- Prepare overpacks before any attempt is made to move drums;

- Before moving anything, determine the appropriate sequence for moving drums and other containers;

- Exercise extreme caution in handling drums that are not intact and tightly sealed; and

- Ensure that operators have a clear view of the roadway when carrying drums. Where necessary, have ground workers available to direct the operator's motion.

Drums containing **radioactive waste** should not be handled until experts in handling radioactive materials have been consulted. If a drum is suspected to contain **explosive** or **shock-sensitive waste**, specialized assistance should be sought before handling is initiated. If handling is necessary, extreme caution should be used and all non-essential personnel should remain a safe distance from the handling area. In addition, continuous communication with the Site Health and Safety Officer and/or the command post should be maintained until handling operations are complete.

Drums that may be under internal pressure can be identified by **bulging or swelling**. If a pressurized drum must be moved, whenever possible, the drum should be handled with a grappler unit constructed for explosive containment. Either move the bulged drum only as far as necessary to allow seating on firm ground, or carefully overpack the drum. Exercise extreme caution when working with or adjacent to potentially pressurized drums.

Laboratory packs (lab packs) should be considered to hold explosive or shock-sensitive wastes until otherwise characterized. Prior to handling or transporting lab packs, all non-essential personnel should move a safe distance from the handling area. If handling is required, continuous communication with the Site Health and Safety Officer and/or the command post should be maintained until handling operations are complete. Once a lab pack has been opened, it should be inspected and classified according to the hazards of the wastes to ensure safe segregation of the lab packs' contents.

If a **drum containing a liquid** cannot be moved without rupture, its contents should be immediately transferred to a sound drum. **Leaking drums** that contain sludges or semi-solids, open drums that contain liquid or solid waste, and deteriorated drums that can be moved without rupture should be placed in overpack containers.

Prior to initiating **subsurface** excavation, ground-penetrating systems should be used to confirm the location and depth of drums. Soil should be removed with caution to minimize the potential for drum rupture. In addition, a dry chemical fire extinguisher should be available to control small fires.

10.4 DRUM OPENING

Drums are usually opened and sampled in place during site investigations. However, remedial and emergency operations may require a separate drum opening area. Procedures for opening drums are the same, regardless of where the drums are opened. To maximize worker safety during drum opening, the following procedures should be instituted:

- If a supplied-air respiratory protection system is used, place a bank of air cylinders outside the work area and supply air to the operators via airlines and escape SCBAs;

- Keep personnel at a safe distance from the drums being opened; place explosion-resistant plastic shields between personnel and the drums for protection in case of detonation; locate controls for drum opening equipment, monitoring equipment, and fire suppression equipment behind the explosion-resistant plastic shield;

- Conduct air monitoring during drum-opening activities;

- Use non-sparking bronze-beryllium tools when possible;

- Use remote-controlled devices for opening drums, when feasible;
- Hang or balance the drum opening equipment to minimize worker exertion;
- If the drum shows signs of swelling or bulging, perform all steps slowly and relieve excess pressure prior to opening;
- Open exotic metal drums and polyethylene or polyvinyl chloride-lined drums through the bung by removal or drilling;
- Do not open or sample individual containers within laboratory packs;
- Reseal open bungs and drill openings as soon as possible; and
- Decontaminate equipment after each use to avoid mixing incompatible wastes.

Exhibit 10-2 provides a summary assessment of several drum opening techniques, **Exhibit 10-3** presents a sample drum characterization sheet, and **Exhibit 10-4** illustrates two common examples of drum opening equipment.

10.5 DRUM SAMPLING

Drum sampling can be hazardous to worker health and safety because it can involve direct contact with unidentified wastes. Prior to collecting samples, a sampling plan should be developed, including: (1) research about the waste; (2) identification of drums to be sampled; (3) selection of appropriate sampling device(s) and container(s); (4) determination of the number, volume, and locations of samples to be taken; and (5) development of procedures for opening drums, sampling, and sample packaging and transportation. A trained health and safety professional should determine the appropriate personal protection to be used during sampling, decontamination, and packaging of the sample.

To maximize worker safety during manual sampling from a drum, the following techniques should be used:

- Keep sampling personnel at a safe distance while drums are being opened and sample only after opening operations are complete;
- Do not lean over other drums to reach the drum being sampled, unless absolutely necessary;
- Cover drum tops with plastic sheeting or other suitable uncontaminated materials;
- Never stand on drums -- use mobile steps or another platform to achieve the height necessary to safely sample from the drums; and
- Obtain samples with glass rods or vacuum pumps.

10.6 CHARACTERIZATION

The goal of characterization is to obtain data necessary to determine how to safely and efficiently package and transport the wastes for treatment and/or disposal. If wastes are bulked, they must be sufficiently characterized to determine which of them can be safely combined. Standard compatibility tests are simple, rapid, and cost-effective procedures used to segregate wastes into broad categories, including water reactive, oxidative, and radioactive. By identifying broad waste categories, compatible waste types can be safely bulked on-site without the risk of fore or explosion, and disposal options can be determined without exhaustive and costly analysis of each drum. In some cases, however, further analysis may be necessary to identify the waste materials more precisely.

During the compatibility testing process, each drum is scanned for radioactivity as it is opened. If the scan is negative, a sample is taken to perform the compatibility test. (Solid samples should be taken from several different areas within the drum.) In addition, the contents of all drums should be described on the drum data sheet in terms of physical state, viscosity, and number of phases. A sample should be taken for each phase. **Exhibit 10-5** provides a sample HAZCAT checklist for recording screening data.

There are a number of published compatibility testing protocols; however, procedures must be tailored for site-specific conditions. **Exhibit 10-6** presents a thorough protocol developed by the Chemical Manufacturers' Association (CMA). Based on the CMA protocol, wastes can be segregated into the following broad waste categories:

EXHIBIT 10-2
Summary Assessment of Drum Opening Techniques

Recommended Drum Opening Applications (for Sample Acquisition or Recontainerization)

Technique	# of Drums to be Opened			Physical Condition of Drums		Waste Content of Drum			Restrictions/Disadvantages
	<100	100-500	>500	Damaged or Bulging	Structurally Sound	Unknown	Shock Sensitive/ Explosive	Non-Hazardous	
Bung Wrenches (Nonsparking)	X				X			X	Not recommended for unknown waste contents; full protective gear for worker.
Manual Drum Deheader	X				X			X	Only if bung is impossible to open; used mainly for recontainerization vs. sample acquisition; unsafe if waste contents are unknown.
Self-Propelled Drum Deheader (Electric or Pneumatic)	X				X			X	May require use of a dekinker or readjustment of the deheader if the chime is dented.
Remotely Operated Pneumatic Wrench	X	X		X	X	X	X		Requires direct contact with the drum during attachment of the wrench. Time-consuming setup.
Remote Hydraulic Plunger									Only in controlled area with spill containment.
• Portable	X			X	X	X	X[1]	X	Most time-consuming hydraulic plunger methods. Requires direct contact with the drum to set up the plunger.
• Self-Propelled (Electric or Pneumatic)	X	X			X	X	X	X	Only suitable if the chime is free of dents.
• Backhoe attached			X	X	X	X	X[1]	X	Use long boom-dipper arms (12 meters or 40 feet).
• Conveyor			X	X	X	X	X[1]	X	Has not been used in the field to date.
Backhoe Spike (Nonsparking)	X	X		X		X	X	X	May damage drum; use long backhoe boom (>40 feet).
Tube and Spear device for venting	X	X	X	X			X		Method applicable for venting of pressure, but not for drum sampling.

[1] Plunger may be of nonsparking bronze or of stainless steel, which is more durable.

Source: *Drum Handling Practices at Hazardous Waste Sites* (U.S. EPA, 1986, EPA/500/2-86/013).

EXHIBIT 10-3
Sample Drum Characterization Sheet

SITE: ________________ **DRUM #:** ______________ **SAMPLE #:** __________

Drum Size:

0 unknown ___
1 55 gal. ___
2 30 gal. ___
3 other ___
specify ___

Drum Opening:

0 unknown ___
1 ring top ___
2 closed top ___
3 open top ___
4 other ___
specify ___

Drum Type:

0 unknown ___
1 metal ___
2 plastic ___
3 fiber ___
4 glass ___
5 other ___
specify ___

Drum Color: PRI SEC

0 unknown ___ ___
1 cream ___ ___
2 clear ___ ___
3 black ___ ___
4 white ___ ___
5 red ___ ___
6 green ___ ___
7 blue ___ ___
8 brown ___ ___
9 pink ___ ___
10 orange ___ ___
11 yellow ___ ___
12 gray ___ ___
13 purple ___ ___
14 amber ___ ___
15 green-blue ___ ___

Drum Contents Color:

PRI SEC
0 unknown ___ ___
1 cream ___ ___
2 clear ___ ___
3 black ___ ___
4 white ___ ___
5 red ___ ___
6 green ___ ___
7 blue ___ ___
8 brown ___ ___
9 pink ___ ___
10 orange ___ ___
11 yellow ___ ___
12 gray ___ ___
13 purple ___ ___
14 amber ___ ___
15 green-blue ___ ___

Drum Condition:

0 unknown ___
1 good ___
2 fair ___
3 poor ___

Drum Marking Keywords:

#1 ______________
#2 ______________
#3 ______________

Drum Contents State:

PRI SEC
0 unknown ___ ___
1 solid ___ ___
2 liquid ___ ___
3 sludge ___ ___
4 gas ___ ___
5 trash ___ ___
6 dirt ___ ___
7 gel ___ ___

Drum Content Amount:

0 unknown ___ ___
1 full ___ ___
2 part ___ ___
3 empty ___ ___

Chemical Analysis:

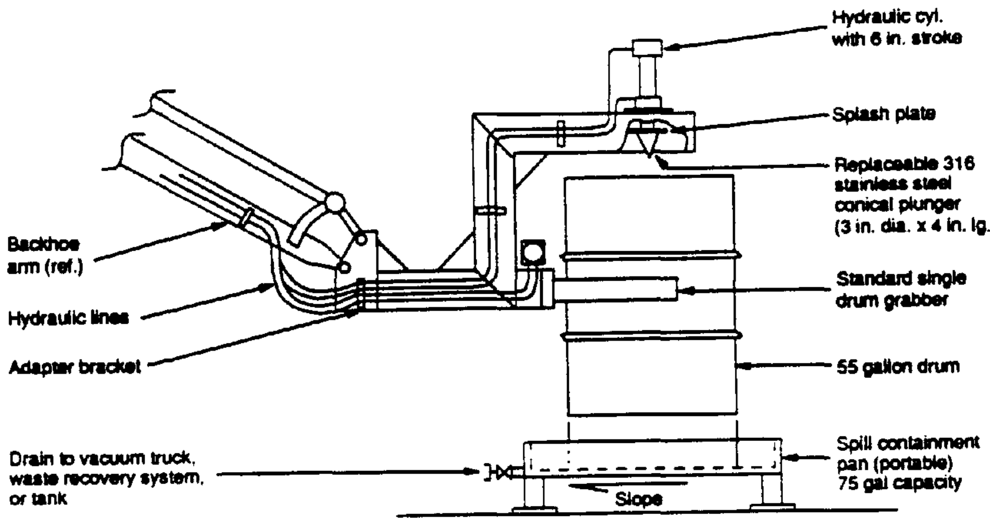
YES NO
radiation ___ ___
ignitable ___ ___
water reactive ___ ___
cyanide ___ ___
oxidizer ___ ___
organic vapor ___ ___ ppm
pH ___ ___

Real-time Instrument Readings

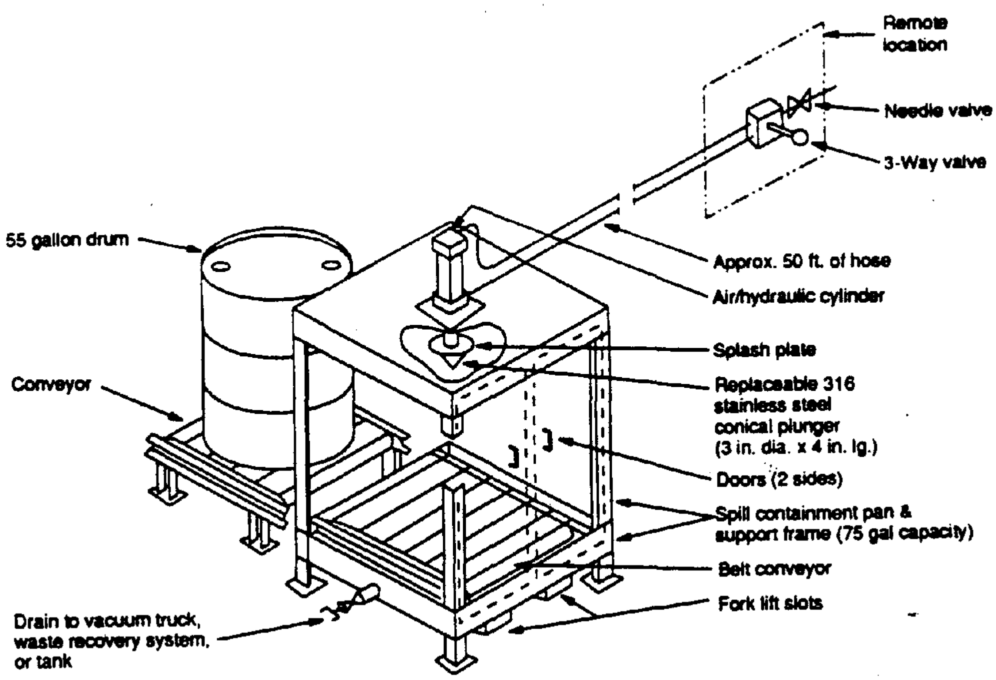
Colorimetric tube _____
Radiation ________
PID ________
FID ________

Source: EPA Region VII Emergency Planning and Response Branch

EXHIBIT 10-4
Examples of Drum Opening Equipment



Hydraulic Backhoe Drum Plunger Arrangement



Conveyor Belt System for Remote Hydraulic Puncturing of Large Number of Drums

EXHIBIT 10-5
HAZCAT Checklist: Characterization Screening Data

Screening Data	YES	NO	Criteria
RADIOACTIVE	☐	☐	≥1 mR over background
ACIDIC	☐	☐	pH ≤ 3
CAUSTIC	☐	☐	pH ≥ 12
AIR REACTIVE	☐	☐	Reaction of ≥ 10°F temp. change
WATER REACTIVE	☐	☐	Reaction of ≥ 10°F temp. change
WATER SOLUBLE	☐	☐	Dissolves in water
WATER BATH OVA	☐	☐	Reading = _____ ≥10 ppm = Yes
COMBUSTIBLE	☐	☐	Catches fire when torched in water bath
HALIDE	☐	☐	Green flame when heated with copper
INORGANIC	☐	☐	WATER BATH OVA and COMBUSTIBLE = No
ORGANIC	☐	☐	INORGANIC = No
ALCOHOL/ALDEHYDE	☐	☐	WATER BATH OVA, WATER SOLUBLE, and COMBUSTIBLE = Yes
CYANIDE	☐	☐	Draeger tube over water bath ≥ 2 ppm
FLAMMABLE	☐	☐	Combustible = Yes, and SETA flashpoint ≤ 140°F
OXIDIZER	☐	☐	Starch iodine paper shows positive reaction
INERT OR OTHER	☐	☐	Everything "No" except INORGANIC or ORGANIC
PCB SCREEN (Chlor-N-Oil)	☐	☐	
	☐		> 50 ppm
	☐		< 50 ppm
	☐		100%

Source: EPA Region VII Emergency Planning and Response Branch. This chart is provided only as an example; values may need to be modified as appropriate.

Liquids: Radioactives, Peroxides and oxidizing agents, Reducing agents, and Water-reactive compounds.

Water Insolubles: Low halogen/low PCB, Mixed halogen/high PCB, and High halogen/low PCB.

Acids: Strong (pH<2), Weak (pH 2-7).

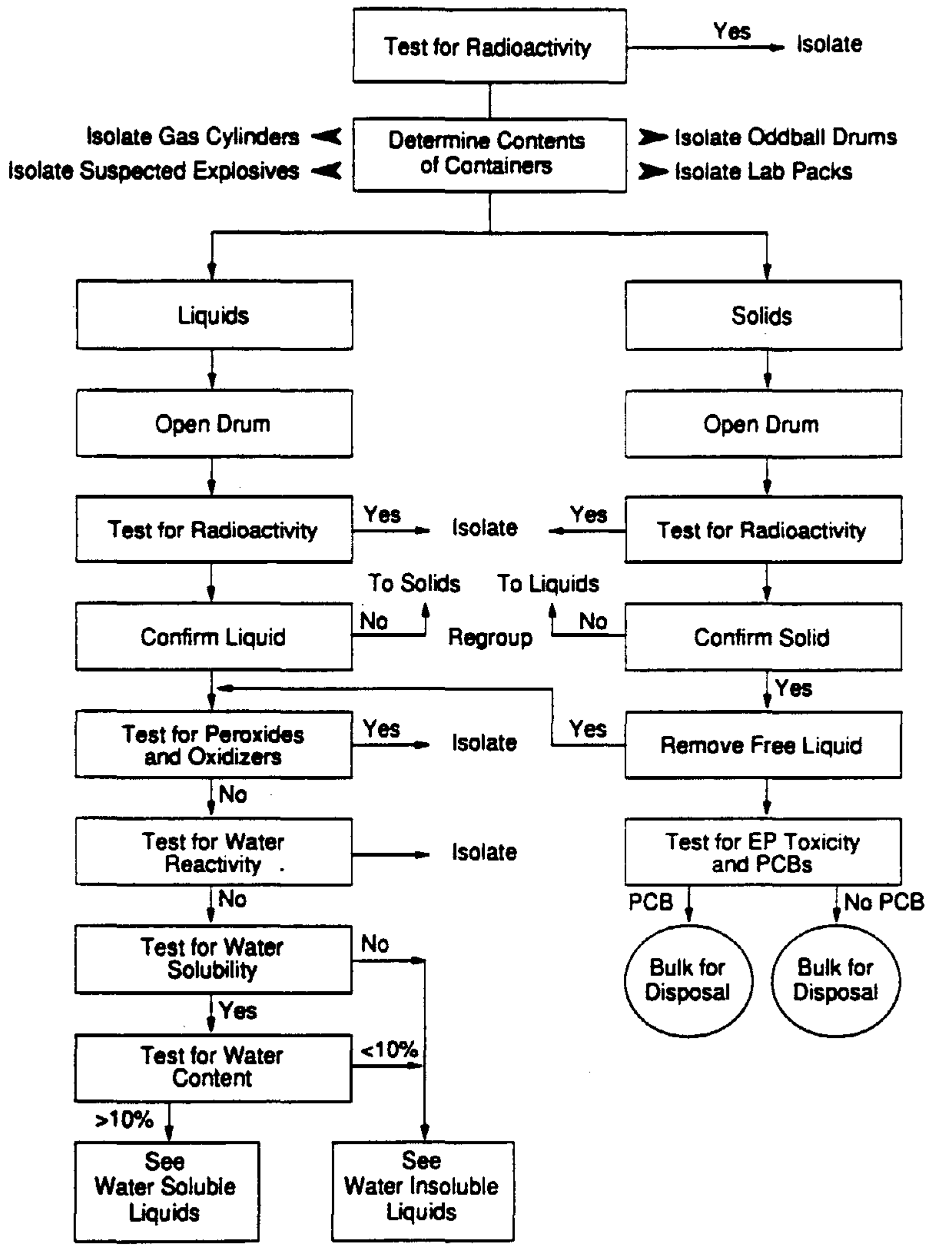
Bases: Strong (pH>12) with or without cyanides or sulfides, and Weak (pH 7-12) with or without cyanides or sulfides.

Solids: Radioactive and Non-radioactive.

This protocol also requires that a compatibility test be performed by mixing small samples of wastes that are intended to be bulked, making visual observations for precipitation, temperature changes, or phase separation.

When possible, materials should be characterized using an on-site laboratory to minimize the time before appropriate action can be taken to handle any hazardous materials. If samples must be analyzed off-site, samples should be packaged on-site in accordance with DOT regulations (49 CFR Parts 171-178) and shipped to the laboratory for analysis.

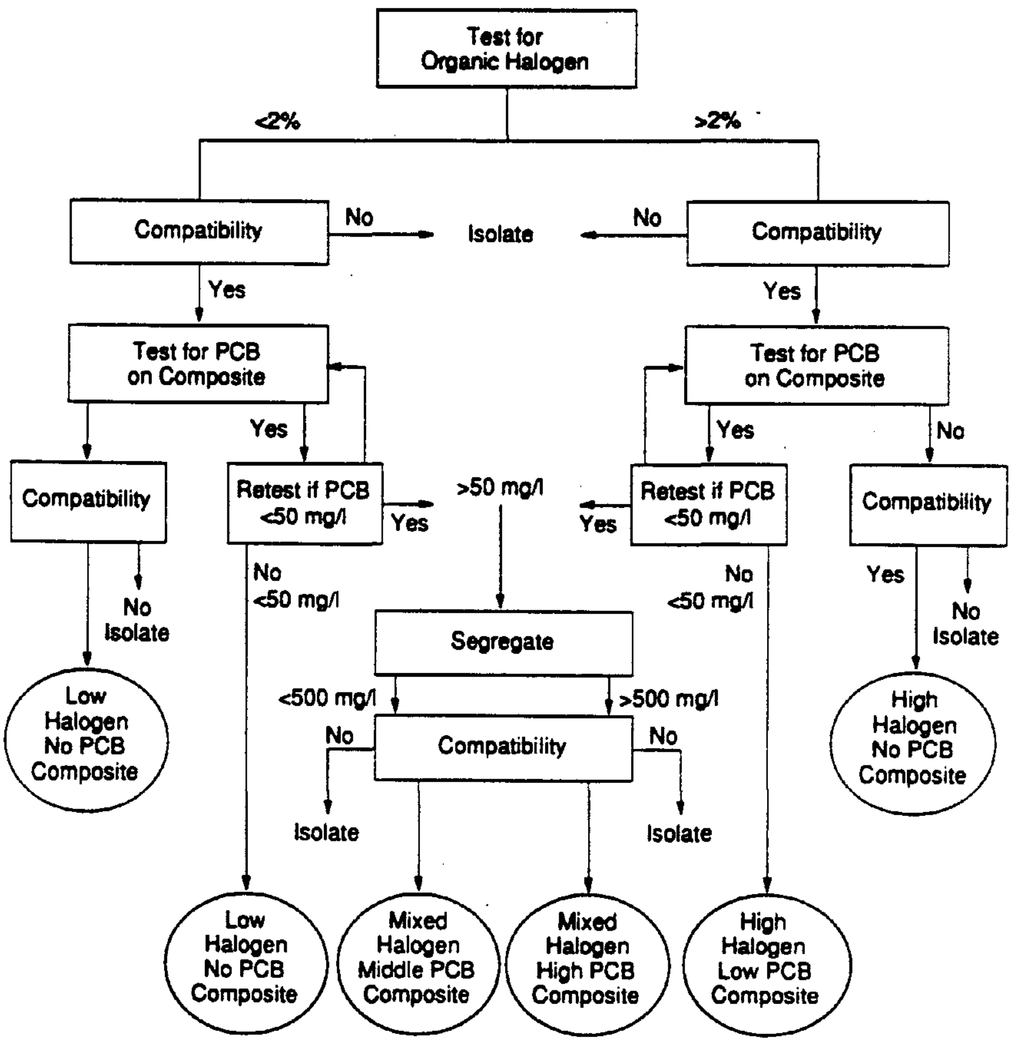
EXHIBIT 10-6
CMA COMPATIBILITY TESTING PROTOCOL



Source: *Drum Handling Practices at Hazardous Waste Sites* (U.S. EPA, 1986, EPA/500/2-86/013).

EXHIBIT 10-6 (cont'd)
CMA COMPATIBILITY TESTING PROTOCOL

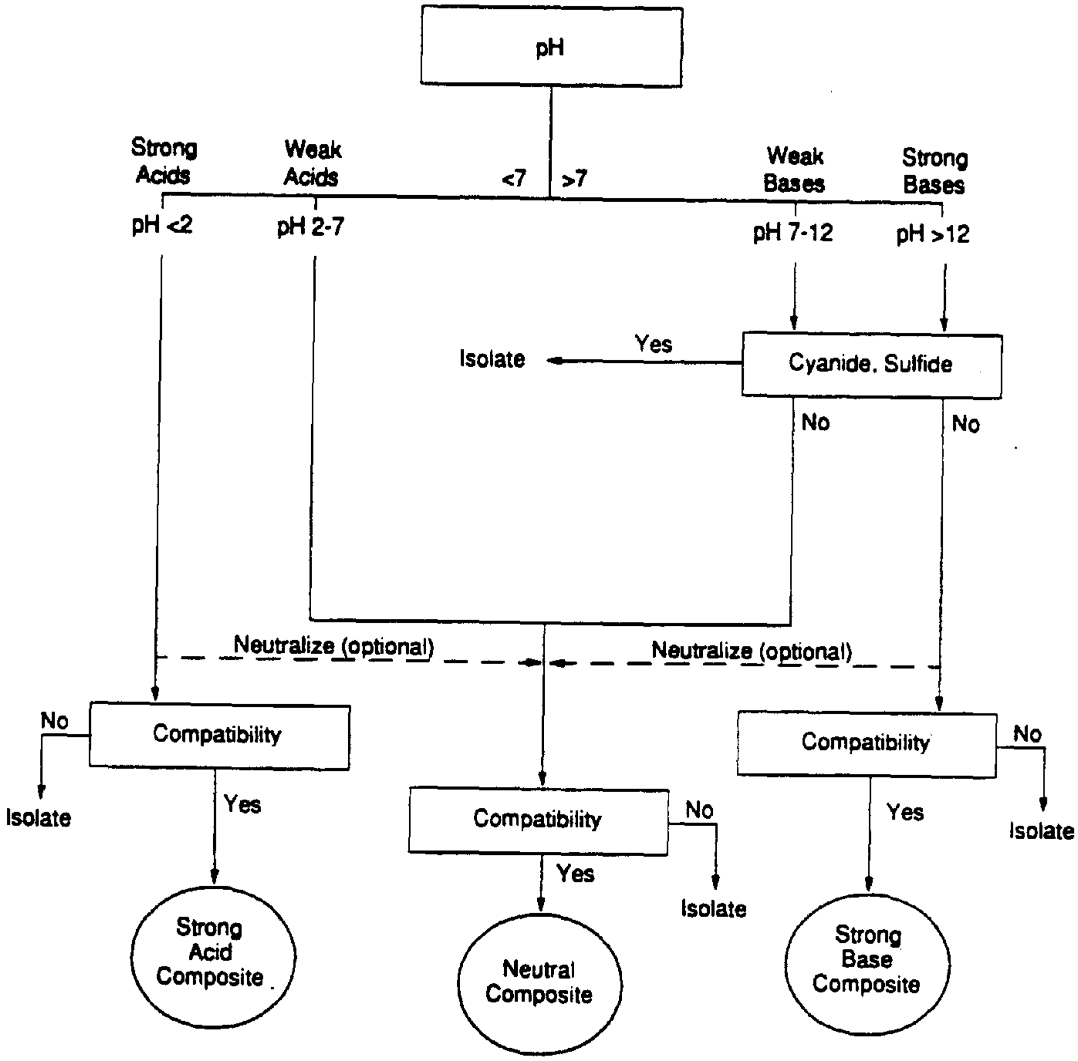
Water Insoluble Liquids Testing



Source: *Drum Handling Practices at Hazardous Waste Sites* (U.S. EPA, 1986, EPA/500/2-86/013).

EXHIBIT 10-6 (cont'd)
CMA COMPATIBILITY TESTING PROTOCOL

Water Soluble Scan



Source: *Drum Handling Practices at Hazardous Waste Sites* (U.S. EPA, 1986, EPA/500/2-86/013).

FURTHER GUIDANCE: For more information on drum handling, see:

1. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.* (NIOSH/OSHA/USCG/EPA, 1985, NIOSH Publication 85-115).

2. *Drum Handling Practices at Hazardous Waste Sites* (U.S. EPA, 1986, EPA 500/2-86/013).

3. *Guidance Document for Cleanup of Surface Tank and Drum Sites* (U.S. EPA, Publication 9380.0-3).

CHAPTER 11 OTHER REQUIREMENTS AND SAFETY CONSIDERATIONS

C24085-2

CHAPTER 11 OTHER REQUIREMENTS AND SAFETY CONSIDERATIONS

11.0 INTRODUCTION

This chapter provides information on three other important HAZWOPER requirements and on specific hazards that employees may face in hazardous waste operations:

- Emergency response and prevention requirements;
- Confined space entry procedures;
- Information and new technology programs;
- Specific hazards, including chemical contamination, explosion and fire, oxygen deficiency, ionizing radiation, biological hazards, and noise and safety hazards.

11.1 EMERGENCY RESPONSE AND PREVENTION

Site emergencies are characterized by their potential for complexity; uncontrolled toxic chemicals may be numerous and unidentified, and their effects may be synergistic. Rescue personnel attempting to remove injured workers may themselves become victims. This variability means that advance planning, including anticipation of different emergency scenarios and thorough preparation for contingencies, is essential to protect worker and community health and safety.

One of the most important components of the HASP is the written site-specific emergency response plan. The emergency response plan should be designed as a separate section of the HASP, and must be compatible and integrated with the disaster, fire, and/or emergency response plans of local, state, and federal agencies. The plan must include a description of how anticipated emergencies would be handled at the site and how the risks associated with a response would be minimized. <u>The emergency response plan must be developed and implemented prior to commencing operations at a site</u>.

The requirements for an emergency response plan at an uncontrolled hazardous waste site are listed in **Exhibit 11-1** and are codified at 29 CFR §1910.120(l)(2). Employers must develop emergency response plans to protect workers in emergencies resulting from the release of all kinds of hazardous substances, including Extremely Hazardous Substances (EHSs), CERCLA hazardous substances, RCRA hazardous wastes, and any substance listed by the U.S. Department of Transportation as a hazardous material.

EXHIBIT 11-1
Required Elements of an Emergency Response Plan at an Uncontrolled Hazardous Waste Site
(29 CFR §1910.120(l)(2))

- Pre-emergency planning.
- Personnel roles, lines of authority, and communication.
- Emergency recognition and prevention.
- Safe distances and places of refuge.
- Site security and control.
- Evacuation routes and procedures.
- Decontamination procedures.
- Emergency medical treatment and first aid.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- PPE and emergency equipment.
- Site topography, layout, and prevailing weather conditions.
- Procedures for reporting incidents to local, state, and federal governmental agencies.

In addition to these elements, the emergency response plan must include information relevant for conducting emergency operations at the site, such as information on site topography, layout, and prevailing weather conditions, and procedures for reporting incidents to local, state, and federal agencies. As part of the overall training program for site operations, the emergency response plan also must be rehearsed regularly and reviewed periodically to ensure that it accounts for new or changing site conditions or new information on potential hazards at the site. The plan must be in writing and available for inspection and copying by employees, their representatives, OSHA personnel, and other government agencies with relevant responsibilities.

An employee alarm system must be installed at all sites in accordance with 29 CFR §1910.165 to notify employees of an emergency situation, to stop work activities if necessary, to lower background noise in order to speed communications, and to begin emergency procedures. Based on the information available at the time of the emergency, the employer should evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the site emergency response plan.

In lieu of preparing an emergency response plan, site managers may prepare an emergency action plan in accordance with 29 CFR §1910.38(a). This plan may only be developed in lieu of the emergency response plan if employees are evacuated from the site when an emergency occurs, and are not permitted to assist in responding to the emergency. An emergency action plan includes an evacuation plan in which persons responsible for an orderly exit are identified. These designated individuals would direct employees to leave the site and maintain a safe distance, and would also call the appropriate emergency response organization.

If an emergency action plan is prepared, arrangements must be made with the local response community (e.g., fire department or other local response services) for them to respond to emergencies that may occur during site operations. The local response community must be provided with sufficient information regarding site activities, including the types of operations being conducted at the site, the type and degree of contamination at the site, the location of work zones, and any other relevant information that may be necessary for an appropriate response. Such information must be provided prior to the commencement of site operations. Regardless of whether an emergency action plan or an emergency response plan is prepared, local response officials should be notified of site operations prior to the commencement of any site activities. As an additional good operating practice, the site manager may choose to provide local officials with a copy of the plan to review and concur upon.

11.1.1 Prevention

On a day-to-day basis, individual personnel should be constantly alert for indicators of potentially hazardous situations and for signs and symptoms in themselves and others that warn of hazardous conditions and exposures. Rapid recognition of dangerous situations can avert an emergency and prevent injuries and loss of life. Regular health and safety meetings with employees should address:

- Tasks to be performed;
- Time constraints (e.g., rest breaks, air tank changes);
- Hazards that may be encountered, including their potential effects, how to recognize symptoms or monitor them, concentration limits, or other danger signals; and
- Emergency procedures.

After daily work assignments, a debriefing session should be held to review work accomplished, problems observed, and suggestions for future improvement.

11.1.2 Communications

In an emergency, crucial messages must be conveyed quickly and accurately. Site staff must be able to communicate information, such as the location of injured personnel, orders to evacuate the site, and information on safe evacuation routes to employees, even through noise and confusion. Outside support sources must be reached and measures for public notification must be ensured, if necessary. To accomplish this, a separate set of internal emergency signals should be developed and rehearsed daily. External communication systems and procedures should be clear and accessible to all workers.

11.1.3 Site Mapping

Detailed information about the site is essential for advance planning. For this purpose, a site map is a valuable tool. It serves as a graphic record of the locations and types of hazards, a reference source, and a method of documentation. The map should focus on potential areas where emergencies may develop, and should be sure to highlight:

- Hazard areas, especially potential IDLH conditions;
- Site terrain: topography, buildings, barriers;
- Evacuation routes;
- Site accessibility by land, sea, and air; and
- Off-site populations or environments at risk.

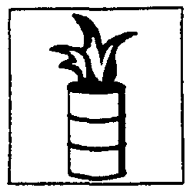
It is recommended that maps be prepared to scale in a professional manner so that the map can be used as a basis for planning and training, as well as for developing potential emergency scenarios and alternative response strategies. When an emergency occurs, the problem areas should be pinpointed on the map. Pertinent information (e.g., weather and wind conditions, temperature, and forecast) should be added. The map can then be used to design the emergency response plan. When using the map for such purposes, the accuracy of the data obtained and the potential for over- or under-estimating a hazard should be considered. Even if the emergency develops so fast that the map cannot be used for on-the-spot planning, prior familiarity with it will aid in making informed decisions.

11.2 HAZARDS

Although the medical program is essential for assessing and monitoring employee health and fitness before the employee begins activities and during the course of employment, employees should be aware of specific hazards in the workplace.

The following sections describe the specific hazards that site personnel face during hazardous waste operations. It is important to remember that no two sites are alike, and that each site may present unique hazards to employees based on the contaminants present, site conditions, site geography and location, and weather.

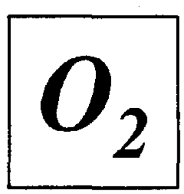
11.2.1 Explosion and Fire



Explosions and fires at a hazardous waste site may occur for a variety of reasons. Accidentally mixing incompatible chemicals could cause an intense exothermic reaction. A spark or flame could be introduced into an oxygen enriched or flammable atmosphere. The movement or removal of tanks and drums could agitate shock-sensitive compounds or could release materials stored under high pressure.

Explosions and fires may arise spontaneously, although they more commonly result from site activities. In addition to the normal dangers of intense heat, open flame, smoke inhalation, and flying objects, an explosion or fire at a hazardous waste site poses the additional threat of potentially releasing hazardous substances into the atmosphere. Such releases can threaten both personnel on-site and members of the general public living or working nearby. The following precautions should be taken to protect against the hazard: (1) have qualified personnel monitor for explosive atmospheres and flammable vapors; (2) keep all potential ignition sources away from an explosive or flammable environment; (3) use nonsparking, explosion-proof equipment; and (4) follow safe practices when performing any task that might result in the agitation or release of chemicals.

11.2.2 Oxygen Deficiency

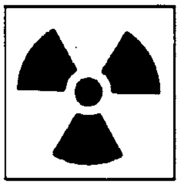


The oxygen content of normal air at sea level is approximately 21 percent. Physiological effects of oxygen deficiency are readily apparent when the oxygen concentration in air decreases to 16 percent. These effects include impaired attention, judgment and coordination, and increased breathing and heart rate. Oxygen concentrations lower than 16 percent can result in nausea and vomiting, brain damage, heart damage, unconsciousness, and death.

For individual physiological responses and errors in measurement, precautions should be taken when the ambient oxygen level is 19.5 percent or lower.

Oxygen deficiency may result from the displacement of oxygen by another gas, or the consumption of oxygen by a chemical reaction. Confined spaces or low-lying areas are particularly vulnerable to oxygen deficiency and should always be monitored prior to entry. Qualified field personnel should always monitor oxygen levels and should use atmosphere-supplying respiratory equipment when oxygen concentrations drop below 19.5 percent.

11.2.3 Ionizing Radiation



Radioactive materials emit one or more of three types of harmful radiation: alpha, beta, and gamma. **Exhibit 11-2** presents the characteristics of these three types of radiation. Alpha radiation has limited penetration ability and is usually stopped by clothing and the outer layers of the skin. Alpha radiation poses little threat outside the body. Beta radiation can cause harmful "beta burns" to the skin and damage the subsurface blood system. Both alpha and beta radiation can be hazardous if radioactive materials emitting alpha or beta radiation are introduced into the body. Use of protective clothing combined with scrupulous personal hygiene and decontamination provides good protection against alpha and beta radiation. Gamma radiation passes easily through clothing and human tissue and can also cause serious permanent damage to the body. Chemical-protective clothing affords no protection against gamma radiation itself; however, use of respiratory and other protective equipment can help keep radioactive materials from entering the body.

If levels of radiation above natural background levels are discovered, a health physicist should be consulted. At levels greater than 1 millirem per hour, all site activities should cease until the site has been assessed by health physicists.

11.2.4 Biological Hazards

Wastes from hospitals and research facilities may contain disease-causing organisms that could infect site personnel. Like chemical hazards, pathogens may be dispersed in the environment via water and wind. Other biologic hazards that may be present include poisonous plants, insects, animals, and

EXHIBIT 11-2
Radiation Characteristics

	Form	Relative Mass	Velocity	Path Length	Number of Ionizations/ cm in Air	Biological Hazard
ALPHA (α)	Particle	4 Atomic Mass Units	1/10 C (C = Speed of Light)	< 1 inch	Hundreds of Thousands	Internal
BETA (β)	Particle	.000001	99% C	1 meter	Hundreds	Internal/ External
GAMMA (γ)	Electro-magnetic Energy	0	C	Several Meters to Kilometers	1	External

indigenous pathogens. Protective clothing and respiratory equipment, and identification of toxic plants, animals, and insects in the area can help reduce the chances of exposure. Thoroughly washing any exposed body parts and equipment will also help protect against infection.

11.2.5 Safety Hazards

Hazardous waste sites may contain a variety of safety hazards, including holes, ditches, precariously positioned or sharp objects, slippery surfaces, steep grades, uneven terrain, and unstable surfaces. In addition to those safety hazards that are a function of the site, many safety hazards are a function of the work itself. Heavy equipment creates an additional hazard for workers in the vicinity of the operating equipment. PPE can impair workers' vision, hearing, or agility. Removal of wastes can create physical hazards at the site that were not present prior to the beginning of operations.

Accidents involving physical hazards can directly injure workers and can create additional hazards such as increased exposure to chemicals due to damaged protective equipment. Site personnel should constantly be aware of potential safety hazards, and should immediately inform a supervisor of any new hazards so that mitigative action can be taken.

One potential hazard that results from a variety of sources is electrocution. Overhead power lines, downed electrical wires, and buried cables all pose a danger of shock or electrocution if workers come into contact with or sever them during site operations. Electrical equipment used on-site may also pose a hazard to workers. Low-voltage equipment with ground-fault interrupters and water tight, corrosion-resistant connecting cables should be used on-site to minimize electrical hazards. Lightning is a hazard during outdoor operations, particularly for workers handling metal containers or equipment. To eliminate this hazard, weather conditions should be monitored and work should be suspended during electrical storms. The OSHA standards at 29 CFR §1910.136 describe proper clothing and equipment for protection against electrical hazards.

11.2.6 Noise Hazards

At many sites, different activities (e.g., drilling operations, heavy equipment operations) may result in appreciable noise levels. It is important that area and personal noise surveys be conducted to categorize noise levels appropriately. A sound level meter that has the capability to integrate and average the sound levels throughout the work day is required to monitor employee exposure to noise levels. **Exhibit 11-3** provides OSHA's Permissible Noise Exposures. These values represent noise levels over which workers may not be exposed without risking adverse hearing effects. These values should be used as guides and should not be regarded as fine lines between safe and dangerous levels.

EXHIBIT 11-3
Permissible Noise Exposures

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

NOTE: When daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 ... C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

Continuous and Intermittent Noise. Currently, the OSHA-Permissible Exposure Limit (PEL) for an 8-hour work day, 40-hour work week is 90 decibels, as recorded on a sound level meter on the A weighted scale (dBA). If the 8-hour time weighted average noise exposures equal or exceed

85 dBA, the site manager must implement a hearing conservation program. If feasible administrative and engineering controls do not reduce sound levels to within acceptable limits, employees should use appropriate PPE to reduce personal exposure.

Impulsive or Impact Noise. Exposure to impulsive or impact noise should not exceed the limits given in **Exhibit 11-4**. No exposures in excess of 140 dB peak sound pressure level are permitted. Impulsive or impact noise is considered to be a variation in noise levels that involves maxima at intervals of greater than one per second. Where the intervals are less than one second, exposure should be considered continuous and should be integrated into the time weighted average.

EXHIBIT 11-4
Threshold Limit Values for Impulsive or Impact Noise

Sound Level dB*	Permitted Number of Impulses or Impacts per Day
140	100
130	1000
120	10,000

* Decibels peak sound pressure level

11.2.7 Work Hazards

The nature of the work done at a hazardous waste site can contribute to the health and safety risks at the site. **Trench excavation** can increase the instability of the site and increase the risk of a "cave in" or collapse. Moving chemical **drums** may injure a worker if the drum ruptures, spilling chemicals in higher quantity than the protective clothing was designed to accommodate. Drums also pose the threat of back injury or a hernia if those workers moving them do not take proper precautions.

Confined spaces, discussed in detail below, often present a major health and safety hazard to workers involved in hazardous waste site operations. In accidents involving confined spaces, a potential rescuer frequently becomes a victim because he or she rushes into the space without taking proper precautions such as a self-contained breathing apparatus. Therefore, it is important that rescuers recognize the atmospheric hazards of a confined space and take proper precautions.

11.3 CONFINED SPACE ENTRY

The proposed Confined Space Standards at 29 CFR §1910.146 may provide the basis upon which to develop a program for entry into confined spaces that pose potential health or safety risks. A confined space is defined as any location that, by design, has limited openings for entry and egress, is not intended for continuous employee occupancy, and is so enclosed that natural ventilation may not reduce air contaminants to levels below the threshold limit value (TLV). Entry into confined spaces without the proper precautions could result in injury and/or impairment due to:

- An atmosphere that is flammable or explosive;
- Lack of oxygen to support life;
- Toxic materials that upon contact or inhalation could cause injury, illness, or death; or
- General safety hazards such as steam, high pressure materials, or other work area hazards that could result in injuries.

Examples of confined spaces include: manholes, stacks, pipes, storage tanks, trailers, tank cars, pits, sumps, hoppers, and bins. It is important to note that even some buildings might be considered a confined space (e.g., an abandoned chemical laboratory with no open doors or windows).

The following elements of confined site entry should be addressed at each site:

- Hazards information and control;
- Employee training and information;
- Prevention of unauthorized entry;
- Equipment;

- Emergency rescue;
- Protection from external hazards;
- Training and duties of authorized entrants, attendants, and individuals authorizing or in charge of entry.

Before entry could be made into a confined space, a confined space entry checklist should be completed and signed. **Exhibit 11-5** provides the proposed Confined Space Entry Permit. To insure that all areas of the confined space are safe for work, the following situations should be evaluated by competent personnel:

Flammable or Explosive Potential. Technically competent personnel trained in testing methods using an explosive gas detector should test the atmosphere within the confined space. If combustible gases are present, entry should not be allowed until the source has been isolated and the space flushed or purged so that the test indicates less than 5 percent of the lower explosive limit.

Oxygen Deficiency. Technically competent personnel should use approved oxygen testing equipment to test the atmosphere within the confined space to determine whether the air is respirable and contains sufficient oxygen to support normal consciousness. If the air is found to be oxygen deficient (less than 17 percent by volume), positive ventilation techniques, including fans and blowers, may be used to increase the oxygen content. If, after further testing, the oxygen concentration is still deficient, SCBA or another proven air supply should be provided and used.

Toxic or Corrosive Materials. When toxic or chemical materials that could result in injury by contact or inhalation by persons entering the confined space are detected or suspected, several actions should be taken by on-site personnel. First, any piping that conveys hazardous materials to the confined space should be isolated. Second, the space should be emptied of the hazardous substance until safe limits are reached. Third, adequate ventilation equipment, as well as all other appropriate protective equipment for protection of the eyes, face, and arms should be provided if the work to be done in the confined space includes welding, burning, or heating, which may generate toxic fumes and gases. Finally, all employees entering a confined space that has contained corrosive materials should wear eye and other appropriate protective equipment to prevent possible contact with any remaining corrosive material.

A hazard evaluation should be conducted before any work in a confined space is started, to identify existing or potential work area hazards that have the potential to cause injuries, illness, or property damage. Examples of work area hazard control items include unguarded openings, high or low temperatures, poor illumination, sharp edges, steam, compressed gases and liquids, flammable or combustible materials, and mechanical or electrical exposures. When dealing with hazards that cannot be eliminated or controlled, adequate PPE should be used.

Prior to entry into a confined space, consideration should be given to how life support systems would function in the event of a power failure. For example, in the event of electrical failure, air supply pumps, lights, warning systems, and other electrically powered devices would be inoperative. Site personnel should have an emergency plan of action that provides alternate life support systems and a means of escape from the confined space. The Site Health and Safety Officer should have communicated this plan to all employees engaged in work in confined spaces.

Each employee entering a confined space should wear a safety belt equipped with a life-line for evacuation purposes in case of an emergency. If the entry is through a top opening, the safety belt should be of the harness type that will suspend a person in an upright position. Emergency equipment such as life-lines, safety harnesses, fire extinguishers, breathing equipment, and other devices appropriate to the situation should be ready and immediately available. All persons engaged in the activity should be trained in the use of the life support system, rescue system, and emergency equipment. In keeping with the buddy system, at least one person, trained in first aid and respiration, should be immediately available outside the confined space to provide assistance if needed, utilizing a planned and immediately available communications means.

EXHIBIT 11-5
OSHA's Proposed Confined Space Entry Permit

☐ CONFINED SPACE ENTRY PERMIT ☐ HAZARDOUS AREA ENTRY PERMIT

1

LOCATION and DESCRIPTION of Confined Space ______________ Date ________

PURPOSE of Entry ______________ Time ________ M

DEPARTMENT ______________ Expiration ________ M

PERSON in Charge of Work ______________

2

SUPERVISOR (S) in Charge of Crews	Type of Crew	Phone

3

SPECIAL REQUIREMENTS	Yes	No		Yes	No
Lock Out - De-energize			Escape Harness		
Lines Broken - Capped or Blanked			Tripod emergency escape unit		
Purge - Flush and vent			Lifelines		
Ventilation			Fire Extinguishers		
Secure Area			Lighting		
Breathing Apparatus			Protective Clothing		
Resuscitator - Inhalator			Respirator		

4

TEST(S) TO BE TAKEN (Valid for one 8-hour turn entry)	P.E.L.*	YES	NO	DATE M	DATE M	DATE M	DATE M	DATE M	DATE M	DATE M	DATE M
% of Oxygen	.19.5% +21%										
% of L.E.L.*	Any % over 10										
Carbon Monoxide	50 ppm										
Aromatic Hydrocarbon	10 ppm										
Hydrocyanic Acid	10 ppm										
Hydrogen Sulfide	10 ppm										
Sulfur Dioxide	5 ppm										
Ammonia	25 ppm										

GAS TESTER Name ______________

Note: Continuous/periodic tests shall be established before beginning job. Any questions pertaining to test requirements contact certified division gas tester, Plant Gas Coordinator or the Industrial Hygienist

5

INSTRUMENTS USED Name	Type	Ident. No.

	SAFETY STANDBY PERSON(S) Name	Ck. No.
Yes ☐		
No ☐		

Supr. authorizing all above conditions satisfied ______________

AMBULANCE * P.E.L. Permissible Entry Level

FIRE * L.E.L. Lower Explosion Level

Orig. to Dept.
Copy to Safety

11.4 INFORMATION AND NEW TECHNOLOGY PROGRAMS

Two additional programs that must be developed, implemented, and included as part of the employer's health and safety program are information and new technology programs (29 CFR §1910.120(i) and (o)). The information program must be developed and implemented to inform employees, contractors, and subcontractors engaged in hazardous waste operations of the nature, level, and degree of exposure that may result from performing hazardous waste operations. In developing this informational program, the employer should consult the Hazard Communications Standard (HCS) (29 CFR §1910.1200 and 29 CFR §1926.59), which may contain information that would be useful to incorporate into the informational program or emergency response plan for a site. Employees, contractors, and subcontractors working outside of the operational part of a site are not covered by this standard.

In addition to developing an informational program, the employer must include as part of the health and safety program procedures for introducing new and innovative technologies into the work area. The purpose of the new technology program is to ensure that new and improved technologies and equipment are developed and introduced to provide for the improved protection of employees engaged in hazardous waste cleanup operations. As part of the new technology program, the employer must carefully evaluate new technologies, equipment, and control measures, such as absorbents and neutralizers, as they are introduced and made available on the market. This evaluation, which must be completed prior to using the new technology on a large scale at the site, must assess the effectiveness of the new equipment, method, or material. Any data or information obtained during the evaluation must be made available to OSHA upon request.

11.5 CONSTRUCTION REQUIREMENTS

In addition to the worker protection standards at 29 CFR §1910.120, OSHA has a number of regulations at 29 CFR Part 1926 that set forth safety and health standards specifically applicable to the construction industry. These standards establish workplace requirements for the following, among others:

- Subpart C: General Health and Safety Provisions;
- Subpart D: Occupational Health and Environmental Controls, for providing adequate illumination and ventilation;
- Subpart F: Fire Protection and Prevention, for storing flammable and combustible liquids;
- Subpart G: Signs, Signals, and Barricades, for posting adequate accident prevention signs and tags;
- Subpart I: Tools -- Hand and Power; and
- Subpart P: Excavations.

Appendix B provides a detailed description of these and other common applicable OSHA standards.

FURTHER GUIDANCE: For more information on emergency response and safety considerations, see:

1. HAZMAT Team Planning Guidance (U.S. EPA, 1990, EPA 540/G-90/003).

2. NIOSH Pocket Guide to Chemical Hazards (NIOSH, 1991, Publication 90-117).

3. Occupational Safety and Health Guidelines for Chemical Hazards/Supplement II-OHG (NIOSH, 1989, Publication 89-104).

4. 1991-1992 Threshold Limit Values for Chemical Substances and Physical Agents, and Biological Exposure Indices. American Conference of Governmental Industrial Hygienists, 1991.

5. Criteria Document -- Working in Confined Spaces (NIOSH, 1980, Publication 80-106).

6. NIOSH Alert: Request for Assistance in Preventing Occupational Fatalities in Confined Spaces (NIOSH, 1986, Publication 86-110).

ACRONYMS

ANSI	American National Standards Institute
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CPC	Chemical Protective Clothing
CPR	Cardiopulmonary Resuscitation
CRZ	Contamination Reduction Zone
DOT	U.S. Department of Transportation
DRI	Direct Reading Instrument
EHS	Extremely Hazardous Substance
EPA	US Environmental Protection Agency
ERT	US EPA Environmental Response Team
FID	Flame Ionization Detector
FR	Federal Register
GC	Gas Chromatography
HASP	Site-Specific Health and Safety Plan
HAZCOM	Hazard Communication Standard (HCS)
HAZMAT	Hazardous Material
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCS	Hazard Communication Standard (HAZCOM)
IDLH	Immediately Dangerous to Life or Health
IR	Infrared
LEL	Lower Explosive Limit
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NPRM	Notice of Proposed Rulemaking
OSHA	U.S. Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PA/SI	Preliminary Assessment and Site Investigation
PCB	Polychlorinated Biphenyls
PE	Preliminary Investigation
PEL	Permissible Exposure Limit
PHC	Principal Hazardous Constituent
PID	Photoionization Detector
PPE	Personal Protective Clothing and Equipment
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit
RI/FS	Remedial Investigation and Feasibility Study
SAR	Supplied-Air Respirator
SARA	Superfund Amendments and Reauthorization Act of 1986
SCBA	Self-Contained Breathing Apparatus
SOP	Standard Operating Procedure
SOSG	Standard Operating Safety Guides
TLV	Threshold Limit Value
TSD	Treatment, Storage, and Disposal
TWA	Time-Weighted Average
USCG	U.S. Coast Guard

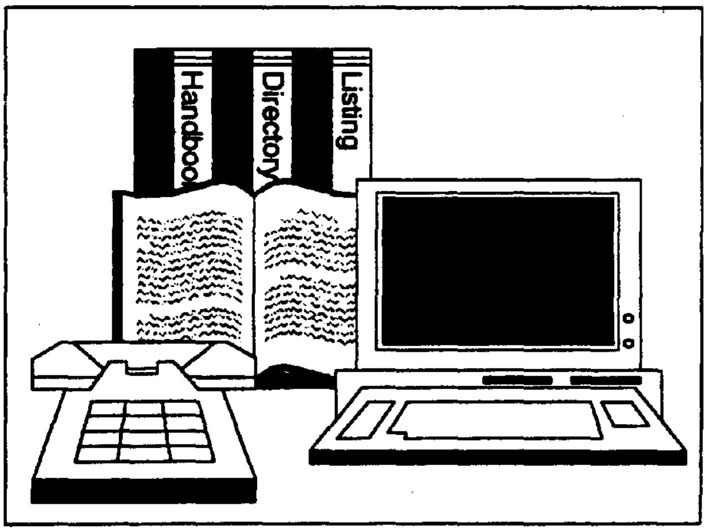
ABBREVIATIONS

cm^3	cubic centimeter
CO_2	carbon dioxide
dBA	decibels on A-weighted scale
ft	foot
g	gram
hr	hour
l	liter
lb	pound
m^3	cubic meter
mg	milligram
ml	milliliter
mrem	milliroentgen equivalent in man
O_2	oxygen
ppb	parts per billion
ppm	parts per million
ta	ambient air temperature
ta adj	adjusted ambient air temperature

APPENDIX A

SOURCES OF INFORMATION AND RESPONSE ASSISTANCE

This Appendix provides a short bibliography of technical manuals and sources of response information. It includes basic chemical and emergency response reference documents, toll-free hotlines and other telephone information sources, and private organizations that offer emergency response assistance and information.



SOURCES OF INFORMATION AND RESPONSE ASSISTANCE

A. INTRODUCTION

Many reference texts and organizations can provide response personnel with technical data and physical assistance regarding both the hazards associated with an incident and methods to deal with them. Because of the variety of activities encountered in hazardous waste field operations, it is necessary to be aware of available resources, to determine their applicability to a project, and to know how to use them.

The information, which may include data on sites, topography, meteorology, physical/chemical properties of the material, applicable treatment methods, and available cleanup resources, can be provided by various agencies, maps, reference books, and manuals. It is advisable to get data from at least two sources and use the latest edition of any reference, especially when searching for hygienic standards or toxicological data.

Access to on-line computer files may be possible at the site if a telephone, portable terminal, and 120-volt outlet are available. Aerial photographs can also provide useful information when properly interpreted.

NOTE: **References are not presented in any particular order.**

B. BASIC REFERENCES

1. *A Compendium of Superfund Field Operations Methods* (U.S. EPA, 1987, EPA/540/P-87/001).

   The compendium was developed by the U.S. EPA Office of Emergency and Remedial Response primarily to assist the manager as he/she conducts site investigations and assessments. It discusses recordkeeping, site safety, sampling, laboratories, geology, hydrology, quality assurance and a number of other important topics. The information is presented in an easy to understand format, but is not arranged for quick reference (an index is not included).

2. *CHRIS: Chemical Hazard Response Information System* developed by the U.S. Coast Guard. Access through the National Response Center, telephone (800) 424-8802.

   CHRIS consists of four manuals, a regional contingency plan, a Hazard Assessment Computer System (HACS), and an organizational entity at Coast Guard Headquarters. Volume 1 (CG-446-1) is designed to be used by the first responders at an incident. Volumes 2, 3, and 4 (CG-446-2), CG-446-3, and CG-446-4, respectively) are intended for use by the On-Scene Coordinator's (OSC) office along with Regional and National Response Center. Main Coast Guard stations will usually have these manuals.

   a. Volume 1: *Condensed Guide to Chemical Hazards*

      Volume 1 is intended for use by the first responders on the scene of an incident. The chemicals involved must be known, however, before the appropriate information can be obtained from the manual. This volume also contains a list of questions needed to access Volume 3. All information in this volume can be found in Volume 2.

b. Volume 2: *Hazardous Substance Data Manual* (also available from the U.S. Government Printing Office, Washington, DC 20402, GPO stock number 050-012-00147-2)

Volume 2 is probably the most useful in responding to spills/waste sites. It contains information on hazardous chemicals shipped in large volume by water and is intended to be used by port security personnel and others who may be first to arrive at the scene. The easily understood information regarding chemical, physical, and toxicological properties can help quickly determine the actions to be taken immediately to safeguard life, property, and the environment.

c. Volume 3: *Hazard Assessment Handbook*

Volume 3 describes methods of estimating the quantity of chemicals that may be released during an incident, their rate of dispersion, and the methods for predicting any potential toxicity, fire, and explosive hazards.

Volumes 2 and 3 are designed to be used together. The hazard assessment code in Volume 2 for each chemical is used in Volume 3 to select the appropriate procedures for estimating degree of hazard.

d. Volume 4: *Response Methods Handbook*

Volume 4 contains information on existing methods for handling spills of hazardous materials. The appendix lists manufacturers of equipment which may be useful. It also describes methods of spill containment (primarily oil). This volume is intended for use by Coast Guard OSCs with some training or experience in hazard response.

3. *Condensed Chemical Dictionary*, Gessner G. Hawley, Van Nostrand Reinhold Co., 135 W. 50th Street, New York, NY 10020.

This book, a compendium of technical data and descriptive information covering many thousands of chemicals and reactions, is designed for use in industrial situations and can be helpful in assessing a hazardous waste site or spill. However, information pertaining to environmental behavior of chemicals is limited and can be misleading. Three distinct types of information are presented:

a. Technical descriptions of compounds, raw materials, and processes.

b. Expanded definitions of chemical entities, phenomena, and terminology.

c. Description or identification of a wide range of trade-name products used in the chemical industry.

4. *Dangerous Properties of Industrial Materials*, edited by N. Irving Sax, Van Nostrand Reinhold, Co., 135 W. 50th Street, New York, NY 10020.

This book provides a single source of concise information on the hazards of nearly 13,000 common industrial and laboratory materials. Descriptive information and technical data are given in the three sections of the book. The main section "General Information" is designed to expedite retrieval of hazard information. The three sections are:

a. "General Information" -- synonyms, description, formula, physical constants.

b. "Hazard Analysis" -- toxicity, fire hazard, explosive hazard.

c. "Countermeasures" -- handling, storage, shipping, first aid, fire-fighting, personnel protection.

This book is not intended for use on-site. It can be useful later, however, to verify hazards associated with the emergency.

5. *Documentation of the Threshold Limit Values (TLV®)*, ACGIH Publications Office, 6500 Glenway Avenue, Building D-5, Cincinnati, OH 45211.

   This reference includes pertinent scientific information about each substance with references to literature sources used to determine each TLV. Each documentation also describes the type of toxic response for which the limit is used. This book should be consulted for a better understanding of TLVs.

6. *Emergency Response Guidebook*: developed under the supervision of the Office of Hazardous Materials Transportation, Research and Special Programs Administration, U.S. Department of Transportation. The guidebook is available through UNZ&CO, 190 Baldwin Avenue, Jersey City, NJ 07306.

   The guidebook is intended to assist first responders in making informed judgments during the initial phases of a transportation incident involving hazardous materials. It lists the UN/NA numbers designated for hazardous materials, identifies potential hazards associated with the materials and recommends emergency actions to be taken following a spill. It also makes recommendations as to when areas should be evacuated or isolated in the event of a spill.

7. *Handbook of Environmental Data on Organic Chemicals.* Karel Verschueren, published by Van Nostrand Reinhold Company, Inc., 115 Fifth Avenue, New York, NY 10003.

   This handbook provides information to: properties of organic chemicals; air pollution factors; water pollution factors; and biological effects. Where entries are not complete, it may be assumed that no reliable data were provided by the references utilized. The author uses numerous abbreviations which are explained in the first section of the book. Individuals who are not familiar with the abbreviations will find themselves referring to the first section frequently in order to understand listings of specific chemicals.

8. *Hazardous Materials Injuries: A Handbook for Pre-Hospital Care*, Bradford Communications Corp., 7500 Greenway Center Drive, Greenbelt, MD 20770.

   This reference provides information on pre-hospital care. The handbook is set-up similar to the US DOT Guidebook.

9. *The Merck Index*, Merck and Company, Inc., Rahway, NJ 07065.

   The Merck Index is a comprehensive, interdisciplinary encyclopedia of chemicals, drugs, and biological substances. It describes 9,856 chemicals in a structured format. An extensive index and cross-index make the manual easy to use. It is designed to serve a variety of purposes. For response personnel, it provides information on physical/chemical properties of chemicals and their toxicity.

10. National Institute of Occupational Safety and Health/Occupational Safety and Health Administration Resources.

    a. *NIOSH Pocket Guide to Chemicals Hazards*, U.S. Government Printing Office, 1991, Washington, DC 20402.

       Information in this pocket guide comes from the NIOSH/OSHA Occupational Health Guidelines. Presented in a tabular format, it is a reference for industrial hygiene and medical surveillance practices. Included are chemical names and synonyms, permissible exposure limits, chemical and physical properties, signs and symptoms of overexposure, environmental and medical monitoring procedures, recommended respiratory and personal protective equipment, and procedures for treatment.

    b. *NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards*, U.S. Government Printing Office, Washington, DC 20402.

       This three-volume document provides technical data for most of the substances listed in the "NIOSH/OSHA Pocket Guide." The information is much more detailed and is designed primarily for use by industrial hygienists and medical surveillance personnel. In addition to the information found in the "Pocket Guide," "Occupational Health Guidelines" includes recommended medical surveillance practices, air monitoring and measurement procedures, protective equipment, and spill and disposal techniques.

11. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*: developed by NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985, Washington, DC 20402.

    This manual is a guidance document for managers responsible for occupational safety and health programs at inactive hazardous waste sites. It is intended for federal, state, and local officials and their contractors. It may be used: as a planning tool by government or private individuals; as a management tool by upper level or field managers; as an educational tool to provide a comprehensive overview of all aspects of safety and health protection at hazardous waste sites; or as a reference document for site personnel who need to review important aspects of health and safety.

12. *OHMTADS: Oil and Hazardous Materials Technical Assistance Data System*, developed by the U.S. EPA. Access through U.S. EPA Regional Offices.

    OHMTADS is a computerized data retrieval system available in the form of a computer print-out, manuals, or microfiche. For each of more than 1,000 oil and hazardous substances, there are 126 possible information segments on, for example, toxicity and associated hazards, personnel safety precautions, cleanup and disposal methods, materials handling, and fire fighting. However, not all information is available for all materials.

13. *Registry of Toxic Effects of Chemical Substances*, U.S. Government Printing Office, Washington, DC 20402.

    This annual publication is sponsored by NIOSH and contains toxic dose data with references to source documents and major standards and regulations for 35,000 chemicals.

14. *Farm Chemicals Handbook 1991*, edited by Charlotte Sine, Meister Publishing Company, Willoughby, Ohio, 1991.

    This handbook/dictionary provides information on the properties of common pesticides and herbicides utilized in the farming industry.

C. TOLL-FREE AND OTHER TELEPHONE INFORMATION SOURCES

1. Federal Information Sources

a. Chemical Emergency Preparedness Program (CEPP) Information: Continental US (Toll Free) (800) 535-0202, DC Metropolitan Area (202) 479-2449.

Contact: Chemical Emergency Preparedness Program (CEPP), Office of Solid Waste and Emergency Response (WH-548A), U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460. EPA established the toll-free technical assistance hotline in 1985.

b. Coast Guard National Strike Force. Access through the National Response Center, telephone (800) 424-8801.

The National Strike Force (NSF) is a part of the National Response Team established under the authority of the Federal Water Pollution Control Act as amended in 1977.

c. Environmental Response Team (ERT). Telephone (908) 321-6740.

The National Contingency Plan directed EPA to establish the ERT to advise OSCs and Regional Response Teams on environmental issues related to spill containment, cleanup, and damage assessment. The team, established in October 1978, provides expertise in biology, chemistry, and engineering for environmental emergencies, as well as special equipment to control and clean up chemical discharges.

The ERT makes it possible for EPA to provide around-the-clock support to the Regional Offices through personnel whose sole responsibility is to respond to environmental emergencies. The Team is EPA's focal point for technical assistance to the Regions and Program Offices during emergency episodes involving toxic and hazardous wastes. The Team has two locations: Edison, NJ, and Cincinnati, OH. Usually, request for help from the Team comes from each Region's Emergency Coordinator, once the conclusion has been reached that technical assistance is needed. The Team consists of 23 individuals with long experience in dealing with various types of environmental emergencies and in responding to requests for assistance at uncontrolled hazardous waste sites.

The Team is responsible for coordinating the Response, Analytical and Engineering Contract (REAC), a cooperative effort between the Team, the Office of Research and Development's Oil and Hazardous Materials Spill Branch, and contractor personnel. Services available through the Response Unit include prototype spill control equipment such as the mobile physical/chemical treatment system, a mobile flocculation/ sedimentation system, contract laboratory analytical services, and pilot plant treatment studies.

d. Department of Transportation (DOT) Hotline. Telephone (202) 426-2075.

This telephone service was established by the Standards Division of the Materials Transportation Bureau, Office of Hazardous Materials Regulations, to provide informational assistance to those interpreting DOT regulations, as defined in 49 CFR.

e. Hazard Assessment Computer System (HACS). Telephone (800) 424-8802.

HACS, the computerized counterpart of Volume 3 of the CHRIS manuals, makes it possible to obtain very detailed hazard evaluations through the computer at Coast Guard Headquarters. The system is intended primarily for use by the OSC.

2. Private Information Sources

a. Bureau of Explosives. Association of American Railroads (AAR), telephone (202) 835-9500.

This 24-hour emergency number can be used for assistance for hazardous materials incidents involving railroads. This office is often contacted through CHEMTREC.

b. Chemical Referral Center (CRC). Telephone (800) 262-8200, Monday through Friday, 8 a.m. to 9 p.m. EST.

Contact: Chemical Manufacturers Association (CMA), 2501 M Street, NW, Washington, DC 20037. CMA makes this toll-free telephone number available for the general public to use to gain access to non-emergency health and safety information about chemicals.

When the Center receives an inquiry about a chemical, the operator first must determine that the call is not an emergency. Emergencies are immediately routed to CMA's Chemical Transportation Emergency Center (CHEMTREC), which gives emergency personnel detailed information on how to handle the incident (see below). If the inquiry is not on emergency, the operator finds out the name of the company that manufactures the product in question. Working from a computerized index of over 110,000 trade name products, the operator gives the caller the address and phone number of the company person to call. That person will provide the specific health and safety information asked for. For more information about the CRC, contact (202) 887-1318.

c. CHEMTREC. Chemical Manufacturers Association, (800) 424-9300. Alaska, Hawaii, and DC (202) 483-7616.

Contact: Chemical Manufacturers Association, 2501 M Street, NW, Washington, DC 20037. CMA established CHEMTREC to provide immediate assistance to those at the scene of accident, 24 hours a day, seven days a week. CHEMTREC maintains an on-line librarian. Other requests will be referred back to the appropriate states for handling. When the situation requires an immediate response and the manufacturer is unable to respond promptly, CHEMTREC can activate CHEMNET. CHEMNET is an industry-wide mutual aid program established to provide chemical expertise at the scene of a chemical emergency. The program currently includes more than 77 chemical producers, their response teams, and more than 50 private contractor emergency response teams.

CHEMTREC can also provide emergency respondents with a "hard copy" of the information which they have stored on the product during emergencies. The HIT (Hazardous Information Transmission) program requires that response personnel be preregistered and have access to a personal computer, a modem, and a printer. For additional information on the HIT program, contact R. Jay Chezem at the address listed above, or at (202) 887-1255.

d. CHLOREP (Chlorine Emergency Plan). Access through CHEMTREC.

CHLOREP was established by the Chlorine Institute to handle chlorine emergencies in the U.S. and Canada. The system operates through CHEMTREC. Upon receiving an emergency call, CHEMTREC notifies the nearest manufacturer in accordance with a mutual aid plan. This manufacturer then contacts the emergency scene to determine if a technical team should be sent to assist. Each participating manufacturer has trained personnel and equipment available for emergencies.

e. TEAP (Transportation Emergency Assistance Plan). Canadian Chemical Producers Association. Access 24 hours a day through three regional control centers:

-- British Columbia, (604) 929-3341

-- Prairie Provinces, (403) 477-8339

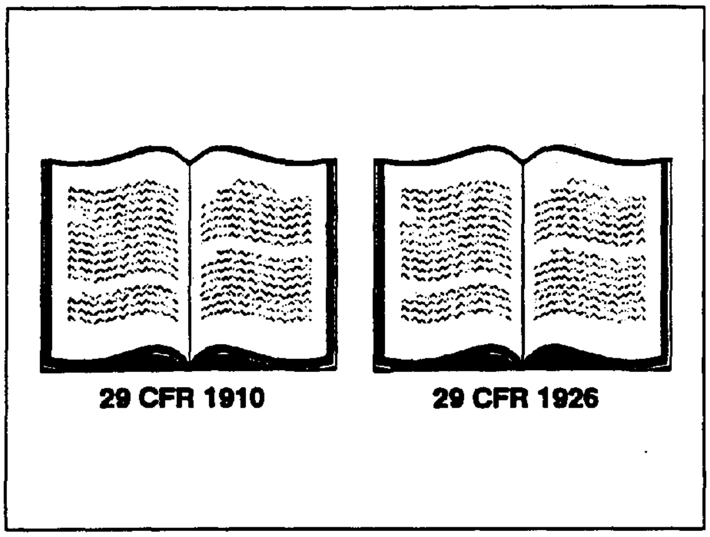
-- Northern Ontario, (705) 682-2881

TEAP functions in Canada in a similar fashion to CHEMTREC in the U.S. It provides emergency advice, gets knowledgeable personnel (usually the manufacturer) in touch with responsible people at the scene of the emergency, and sees that on-the-scene assistance is provided if needed. When the regional control center receives a call, the attendant records basic information, obtains a call-back number, and perhaps gives preliminary information from standard references if the name of the product is known. The attendant then calls one of the center's technical advisors, who calls the scene of the accident to get as much detail as possible and perhaps provides additional advice on coping with the emergency. The advisor then tries to contact the producer. If the producer cannot be reached, or if distances are great, the regional control center contacts a company familiar with the product. The center is also prepared to send personnel and equipment to the scene if necessary. Once contact has been established between producers and local authorities on the scene, the technical advisor assumes a follow-up role and notifies the Canadian Chemical Producers Association of the accident.

APPENDIX B

OTHER COMMON APPLICABLE OSHA STANDARDS

This Appendix presents some common health and safety requirements that are not part of 29 CFR §1910.120 that may need to be addressed prior to initiating hazardous work activities. For sites at which any of these safety requirements are applicable, the information from the regulation should be provided in sufficient detail within the Health and Safety Plan (HASP) to provide adequate protection of employees working on-site. The following are some of the more common OSHA standards that should be considered for site activities, although the list does not reflect all components of the OSHA General Industry (1910) or Construction (1926) standards.



OTHER COMMON APPLICABLE OSHA STANDARDS

OSHA Act, Section 5(a)(1): GENERAL DUTY CLAUSE

Under the "General Duty" clause of the Occupational Safety and Health Act of 1970, section 5(a)(1) states that each employer "shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

29 CFR §1904.2: LOG AND SUMMARY OF OCCUPATIONAL ILLNESSES AND INJURIES

This regulation requires that each employer maintain a log of all recordable occupational injuries and illnesses and that the information be recorded in the log within 6 working days of the receipt of the information. Form OSHA No. 200 or its equivalent is to be used for this purpose.

29 CFR §1910.20: ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

An employer must provide exposure and medical records to an employee or designated representative within 15 days after the request for access to records. If the employee requests copies of this information, the employer must make the copies available to the employee at no cost. All employee medical records must be maintained for the duration of employment plus 30 years by the employer.

29 CFR §1910.24: FIXED INDUSTRIAL STAIRS

This section contains specifications for the safe design and construction of fixed general industrial stairs. This classification includes interior and exterior stairs around machinery, tanks, and other equipment, and stairs leading to or from floors, platforms, or pits.

Requirements include stair strength, stair width, angle of stairway rise, stairway platforms, railings and handrails, and vertical clearance. The requirements regarding stairs are very specific. For instance, 29 CFR §1910.24(h), Railings and Handrails, references 29 CFR §1910.23, which requires two standard rails (one set on each open side) if the stairway is more than four feet in height from ground level.

29 CFR §1910.27: FIXED LADDERS

This regulation includes information on design requirements, specific features, appropriate clearances, special requirements (e.g., use of cages for ladder heights greater than 20 feet), and appropriate pitch when using a fixed ladder.

29 CFR §1910.28: SAFETY REQUIREMENTS FOR SCAFFOLDING

This regulation provides safety requirements for the construction, operation, maintenance, and use of the approximately 20 types of scaffolding.

29 CFR §1910.38: EMPLOYEE EMERGENCY PLANS AND FIRE PREVENTION PLANS

This regulation applies to all emergency action plans and fire prevention plans required by particular OSHA standards. With the exception of employers with 10 or fewer employees, both the emergency action plan and the fire prevention plan are required in writing. The required elements of each of these plans are provided in the regulation. If the employer has 10 or fewer employees, the elements of both types of plans must be provided orally to the employees. The employer shall also perform housekeeping and maintenance of equipment and systems as part of the fire prevention plan.

29 CFR §1910.95: OCCUPATIONAL NOISE EXPOSURE

On many sites, different site activities (e.g., drilling operations, heavy equipment operations) may result in appreciable noise levels. It is important that area and personal noise surveys be conducted to categorize noise levels appropriately. A sound level meter that has the capability to integrate and average sound levels over the course of a work day is required. Currently, the OSHA-Permissible Exposure Limit for an 8-hour work day, 40-hour work week, is 90 decibels as recorded on a sound level meter on the A weighted scale (dBA). An employer shall implement a hearing conservation program if 8-hour time weighted average noise exposures equal or exceed 85 dBA. Continuous intermittent and impulsive sound levels of 80 dBA or greater shall be integrated into the time weighted average.

29 CFR §1910.96: IONIZING RADIATION

This regulation covers employee protection measures related to the possession, use, or transfer of ionizing radiation. The regulations set limitations on employee exposure to ionizing radiation and provide methods for establishing precautionary procedures and personnel monitoring, including surveys of radiation hazards, monitoring equipment, marking of radiation areas, emergency evacuation warning signals, and personnel instruction. The regulations require notification of incidents of releases, overexposure, or excessive levels or concentrations of radiation, and specify that employers must keep records of employee exposure and disclose the information upon request from a former employee.

29 CFR §1910.101: COMPRESSED GASES

To the extent possible, each employer should determine, through a visual inspection, that compressed gas cylinders under his/her control are in safe condition. Other inspections are prescribed in the DOT Hazardous Materials Regulations. Specific safety requirements for handling compressed gases are found in 29 CFR §252(b).

29 CFR §1910.133: EYE AND FACE PROTECTION

Eye and face protection is required when there is the potential for on-site injury. Particular information on goggles, spectacles, and face protection is included in this regulation. Design, construction, testing, and use of such devices must be in accordance with ANSI Z87.1-1968 specifications.

29 CFR §1910.134: RESPIRATORY PROTECTION

Prior to wearing a respirator, an employee should be certified as medically able to wear one. Each employer should have a written respiratory protection plan for selection and use of respirators. All employees must receive training in the proper use of a respirator.

29 CFR §1910.135: OCCUPATIONAL HEAD PROTECTION

On-site situations requiring head protection include: presence of overhead objects, on-site operation of heavy equipment, potential for flying objects in the work area, and possible electric shock hazard. In addition to protecting workers from falling or flying objects, head protection affords limited protection from electric shock and burn. Head protection must meet ANSI Z89.1-1969 specifications.

29 CFR §1910.136: OCCUPATIONAL FOOT PROTECTION

Safety toe footwear for employees must meet ANSI Z41.1-1967 specifications for Men's Safety Toe Footwear. In general, workers at hazardous waste sites must wear leather or rubber boots with steel toes and steel shanks.

29 CFR §1910.141: SANITATION

Specifications concerning appropriate housekeeping, waste disposal, vermin control, water supply, toilet and washing facilities, showers, change rooms, waste disposal containers, sanitary storage, and food handling for permanent places of employment are provided in this regulation.

29 CFR §1910.151: MEDICAL SERVICES AND FIRST AID

If a medical facility is not located in proximity to the workplace, there shall be a person or persons on-site with adequate first-aid training. First-aid supplies approved by a consulting physician shall be available on-site. If there is the potential for corrosive materials on-site, suitable facilities shall be available for drenching of eyes and skin.

29 CFR §1910.165: EMPLOYEE ALARM SYSTEMS

The employee alarm system shall be recognizable to all on-site employees. The signal from the employee alarm system shall be audible to employees in the event of a need to warn employees of an evacuation from work areas.

29 CFR §1910.181: DERRICKS

Derricks attached to drill rigs must be periodically inspected. This regulation defines nine different types of derricks. Specific information is provided on inspection; frequency of inspection; lead ratings; rope use and inspection; fire extinguisher use; operation near power lines; and operating enclosures.

29 CFR §1910.252: WELDING, CUTTING, AND BRAZING

Detailed regulations exist for various types of welding, cutting, and brazing operations. There regulations provide specific information on types of gases, gas pressures, operations and maintenance, and safety procedures.

29 CFR §1910.307: HAZARDOUS LOCATIONS

Electrical equipment used in hazardous locations must be intrinsically safe and suitable for use in the appropriate classified environment. Specified definitions of classifications and further information can be found in §1910.307 and §1910.399.

Subpart Z, 29 CFR §1910.1000: TOXIC AND HAZARDOUS SUBSTANCES

There are other applicable OSHA standards that refer to particular air sampling procedures for chemical contaminants, PPE requirements, and recordkeeping for a variety of compounds. These compounds and their accompanying OSHA regulations are as follows:

Compound	OSHA Reference
Asbestos	29 CFR §1910.1001
Coal tar pitch volatiles	29 CFR §1910.1002
4-nitrobiphenyl	29 CFR §1910.1003
Alpha-naphthylamine	29 CFR §1910.1004
Methyl chloromethyl ether	29 CFR §1910.1006
3,3'-dichlorobenzidine	29 CFR §1910.1007
bis-chloromethyl ether	29 CFR §1910.1008
beta-napthylamine	29 CFR §1910.1009

Benzidine	29 CFR §1910.1010
4-aminodiphenyl	29 CFR §1910.1011
Ehthyleneimine	29 CFR §1910.1012
beta-propiolactone	29 CFR §1910.1013
2-acetylaminofluorene	29 CFR §1910.1014
4-dimethylaminoazobenzene	29 CFR §1910.1015
N-nitrosodimethylamine	29 CFR §1910.1016
Vinyl Chloride	29 CFR §1910.1017
Inorganic arsenic	29 CFR §1910.1018
Lead	29 CFR §1910.1025
Benzene	29 CFR §1910.1028
Coke oven emissions	29 CFR §1910.1029
1,2-dibromo-3-chloropropane	29 CFR §1910.1044
Acrylonitrile	29 CFR §1910.1045
Ethylene oxide	29 CFR §1910.1047
Formaldehyde	29 CFR §1910.1048

29 CFR §1910.1200: HAZARD COMMUNICATION

The employer will establish a hazard communication program to ensure that hazards associated with chemical usage are communicated to employees. The hazard communication program does not apply to hazardous wastes. There are training, labeling, and material safety data sheet (MSDS) requirements for known chemicals. Employers are required to develop a written hazard communication program that will include:

- List of known chemicals on-site;
- Methods for informing employees of chemical hazards associated with non-routine tasks;
- Methods for informing both employees and subcontractors about chemical hazards (e.g., chemical hazard training, distribution of MSDSs).

29 CFR §1926.56: ILLUMINATION

General work areas shall have a minimum illumination intensity of 5 foot-candles. Other specifications for minimum illumination intensities for different work areas and operations are provided in this regulation.

29 CFR §1926.57: VENTILATION

Whenever dust, fumes, mists, vapors, or gases exist or are produced in the course of construction work, their concentrations must not exceed limits specified in 29 CFR §1926.55(a). When ventilation is used, the system must be installed and operated according to the requirements of this section.

29 CFR §1926.59: HAZARD COMMUNICATION

29 CFR §1926.151(a)(3): FIRE PREVENTION

Electrical equipment and wiring for light, heat, or other power purposes must be installed in accordance with the National Electrical Code requirements, NFPA 70-1971; and ANSI CI-197. Also, smoking is prohibited at or in the vicinity of operations which constitute a fire hazard. "No Smoking" or "Open Flame" signs must be posted. In general, smoking should be limited to a designated area within the "support zone" at a hazardous waste site. This will minimize the fire hazard, as well as the transfer of contaminants to smokers' mouths.

29 CFR §1926.152: FLAMMABLE AND COMBUSTIBLE LIQUIDS

Information on appropriate containers and appropriate storage for flammable and combustible liquids is contained in this reference. Note that no more than 25 gallons of liquid may be stored indoors unless located within an approved storage cabinet.

29 CFR §1926.200: ACCIDENT PREVENTION SIGNS AND TAGS

This regulation contains specific information on color, size, shape, and placement of danger, caution, exit, safety instruction, directional, accident prevention, and traffic signs.

29 CFR §1926.301: HAND TOOLS

Special attention should be paid to the use of safe hand tools. For example, wooden tool handles must be kept free of splinters or cracks, and impact tools, such as wedges and chisels, must be kept free of mushroomed heads. Also, wrenches must not be used when jaws are sprung to the point that slippage occurs.

29 CFR §1926.651: SPECIFIC EXCAVATION REQUIREMENTS

Specific information on locating underground utilities; using support systems; securing sides, slopes, and faces; using seals, benches, rock bolts, and wire meshes; taking precautions for work adjacent to previously backfilled areas; diverting water flows from excavated areas; using explosives appropriately; using dust control techniques; and using ladders and ramps is provided in this regulation.

29 CFR §1926.652: TRENCHING REQUIREMENTS

Shoring is needed when the sides of a trench are more than 5 feet deep and unsuitable ground or soft material is present. Also, sides of trenches in hard or compact soil must be shored when the trench is more than 5 feet deep and 8 feet long.

29 CFR Part 1926: Safety and Health Regulations for Construction

29 CFR Part 1926 is divided into twenty-four specific areas addressing safety and health standards for the construction industry, some of which are described in more detail above:

Subpart A	General
Subpart B	General Interpretations
Subpart C	General Safety and Health Provisions
Subpart D	Occupational Health and Environmental Controls
Subpart E	Personal Protective and Life Saving Equipment
Subpart F	Fire Protection and Prevention
Subpart G	Signs, Signals, and Barricades
Subpart H	Materials Handling, Storage, Use, and Disposal
Subpart I	Tools -- Hand and Power
Subpart J	Welding and Cutting
Subpart K	Electrical
Subpart L	Ladders and Scaffolding
Subpart M	Floors and Wall Openings, and Stairways
Subpart N	Cranes, Derricks, Hoists, Elevators, and Conveyors
Subpart O	Motor Vehicles, Mechanized Equipment, and Marine Operations
Subpart P	Excavations
Subpart Q	Concrete and Masonry Construction
Subpart R	Steel Erection
Subpart S	Underground Construction
Subpart T	Demolition
Subpart U	Blasting and Use of Explosives
Subpart V	Power Transmission and Distribution
Subpart W	Rollover Protective Structures; Overhead Protection
Subpart X	Effective Dates

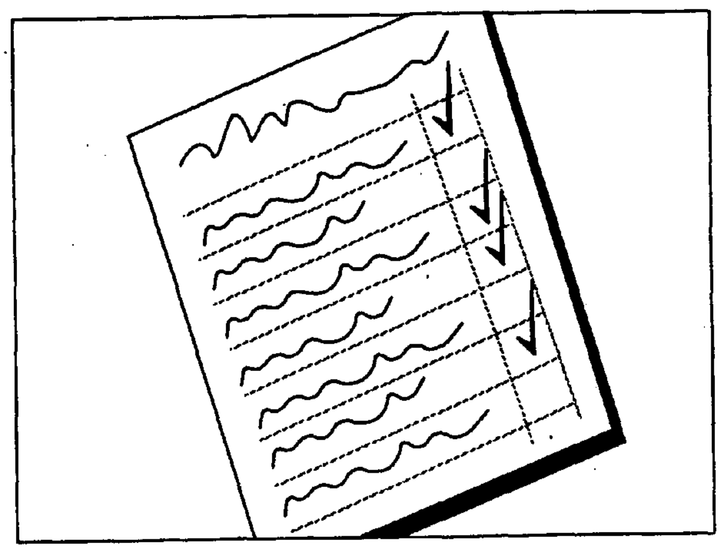
APPENDIX C

INCIDENT SAFETY CHECK OFF LIST

The Incident Safety Check Off List, when completed correctly, fulfills the requirements for performing Preliminary Evaluations under 29 CFR §1910.120. The checklist is divided into two sections.

Section I, which includes the basic preliminary evaluation criteria, must be completed prior to leaving the office for field activities. If the answers provided are not applicable to your particular site, you may write in the appropriate information and any necessary explanations. Section I must be reviewed and signed by a first line supervisor or a health and safety officer before field operations may begin.

Upon returning from the response action, fill out Section II to reflect what actually happened at the site. Section II must also be dated and reviewed by an appropriate supervisor or officer.



Adapted from the *OSWER Integrated Health and Safety Standard Operating Practice for Field Activities* (U.S. EPA, January 1992, Publication 9285.3-02).

INCIDENT SAFETY CHECK OFF LIST

I. BEFORE FIELD ACTIVITY

_______________________ Employee

1. **Incident:** Site ______________ City ______________ State ______________
2. **Activity Description:** Site Evaluation ____ Containment ____ Well Drilling ____ Facility Inspection ____
   Sampling - Air ______ Water ______ Drum ______ Soil ______ Residential ______ Other ______
3. **Type of Response:** Spill ______ Fire ______ Site ______ Train ______ Other ______
4. **Site Topography:** Moutains ______ Rivers ______ Valley ______ Rural ______
   Suburban ______ Level ______ Slopes ______ Unknown ____
5. **Incident Safety Plan:** Region ______________ Reviewed ______________
   ERT ______________ Briefed ______________
   Facility ______________ Not Developed ______________
6. **Site Accessibility:** Road: Good ______________ Air: Good ______________
   Fair ______________ Fair ______________
   Poor ______________ Poor ______________
7. **Suspected chemical(s) and pathway with source(s) involved:** (A) ______________
   (B) ______________ (C) ______________ (D) ______________
8. **Emergency Response Teams Present for First Aid, etc.** Yes __________ No __________
9. **Protective Level(s) Selected:** (A) ________ (B) ________ (C) ________ (D) ________
   (a) If Level "C" - 1, Identify Canister ______________________________
   (b) If Level "D", JUSTIFY:
10. **SCBA Identify Buddy System:** Office/Name ______________________________
11. **Last Response:** (a) Level Used: (A) ________ (B) ________ (C) ________ (D) ________
    (b) Medical Attention/Exam Performed: Yes __________ No __________

II. AFTER RESPONSE

1. **Protective Level Used:** (A) ________ (B) ________ (C) ________ (D) ________
   (a) If Level "C", Identify Canister ______________________________
   (b) If Level "D", JUSTIFY:
   (c) Level B or C skin protection: Tyvek ___ Tyvek/Saran ___ Acid/Rain ___ Other _____
2. **List possible chemical exposure:** Same as above: ________ (A) ______________
   (B) ______________ (C) ______________ (D) ______________
3. **Equipment Decontamination:**

	(a) clothing	(b) respirator	(c) monitoring
Disposed:	________	________	________
Cleaned:	________	________	________
No Action:	________	________	________

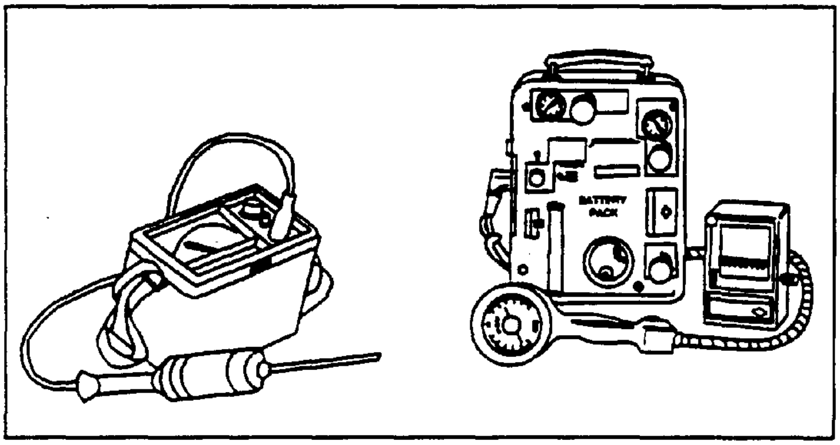
4. **Approximate time in exclusion area:** __________ hours per day for ________ days
5. **Was medical attention/exam required for this response:** Yes __________ No __________

Part I: DATE PREPARED: ______________ **Reviewed by:** ______________ **Date:** __________

Part II: DATE PREPARED: ______________ **Reviewed by:** ______________ **Date:** __________

APPENDIX D

CHARACTERISTICS OF THE PHOTOIONIZATION DETECTOR (PID) AND THE FLAME IONIZATION DETECTOR (FID)



CHARACTERISTICS OF THE PHOTOIONIZATION DETECTOR (PID) AND THE FLAME IONIZATION DETECTOR (FID)

I. INTRODUCTION

The HNU® Photoionizer* and the Foxboro® Organic Vapor Analyzer* (OVA) are two of the most widely used hand-held real-time instruments used in the field to detect a variety of compounds in air. The two instruments differ in their modes of operation and in the number and types of compounds they detect (**Table D-1**). Both instruments can be used to detect leaks of volatile substances from drums and tanks, determine the presence of volatile compounds in soil and water, make ambient air surveys, and collect continuous air monitoring data. If personnel are thoroughly trained to operate the instruments and to interpret the data, these instruments can be valuable tools for helping to decide the levels of protection to be worn, assist in determining other safety procedures, and determine subsequent monitoring or sampling locations.

II. ORGANIC VAPOR ANALYZER (OVA)

The OVA operates in two different modes. In the survey mode, it can determine approximate total concentration of all detectable species in air. With the gas chromatograph (GC) option, individual components can be detected and measured independently, with some detection limits as low as a few parts per million (ppm).

In the GC mode, a small sample of ambient air is injected into a chromatographic column and carried through the column by a stream of hydrogen gas. Contaminants with different chemical structures are retained on the column for different lengths of time (known as retention times) and hence are detected separately by the flame ionization detector. A strip chart recorder can be used to record the retention times, which are then compared to the retention times of a standard with known chemical constituents. The sample can either be injected into the column from the air sampling hose or injected directly with a gas-tight syringe.

In the survey mode, the OVA is internally calibrated to methane by the manufacturer. When the instrument is adjusted to manufacturer's instructions it indicates the true concentration of methane in air. In response to all other detectable compounds, however, the instrument reading may be higher or lower than the true concentration. Relative response ratios for substances other than methane are available.

To correctly interpret the readout, it is necessary to either make calibration charts relating the instrument readings to the true concentration or to adjust the instrument so that it reads correctly. This is done by turning the ten-turn gas-select knob, which adjusts the response of the instrument. The knob is normally set at 3.00 when calibrated to methane. Calibration to another gas is done by measuring a known concentration of a gas and adjusting the gas select knob until the instrument reading equals that concentration.

The OVA has an inherent limitation in that it can detect only organic molecules. Also, it should not be used at temperatures lower than about 40 degrees Fahrenheit because gases condense in the pump and column. It has no column temperature control, (although temperature control kits are available) and since retention times vary with ambient temperatures for a given column, determinations of contaminants are difficult. Despite these limitations, the GC mode can often provide tentative information on the identity of contaminants in air without relying on costly, time-consuming laboratory analysis.

III. HNU

The HNU portable photoionizer detects the concentration of organic gases as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. Every molecule has a characteristic ionization potential

Note: The use of any trade names does not imply their endorsement by the U.S. Environmental Protection Agency.

TABLE D-1 COMPARISON OF THE OVA AND HNU		
Action	**OVA**	**HNU**
Response	Responds to many organic gases and vapors	Responds to many organics and some inorganic gases and vapors.
Application	In survey mode, measures total concentration of detectable gases and vapors. In GC mode, identifies and measures specific compounds.	In survey mode, measures total concentration of detectable gases and vapors.
Detector	Flame ionization detector (FID)	Photoionization detectors (PID)
Limitations	Does not respond to inorganic gases and vapors. Kit available for temperature control.	Does not respond to methane. Does not detect a compound if probe has a lower energy than compound's ionization potential.
Calibration gas	Methane	Isobutylene
Ease of operation	Requires experience to interpret correctly, especially in GC mode.	Fairly easy to use and interpret.
Detection limits	0.1 ppm (methane)	0.1 ppm (benzene)
Response time	Two - three seconds (survey mode) for CH_4	Three seconds for 90% of total concentration of benzene.
Maintenance	Periodically clean and inspect particle filters, valve rings, and burner chamber. Check calibration and pumping system for leaks. Recharge batteries and refill hydrogen cylinder after each use.	Clean UV lamp frequently. Check calibration regularly. Recharge batteries after each use.
Useful range	0-1000 ppm	0-2000 ppm
Service life	Eight hours; 3 hours with strip chart recorder.	Ten hours; 5 hours with strip chart recorder.

(I.P.) which is the energy required to remove an electron from the molecule, yielding a positively charged ion and the free electron. The incoming gas molecules are subjected to ultraviolet (UV) radiation, which is energetic enough to ionize many gaseous compounds. Each molecule is transformed into charged ion pairs, creating a current between two electrodes.

Three probes, each containing a different UV light source, are available for use with the HNU. Ionizing energies of the probe are 9.5, 10.2, and 11.7 electron volts (eV). All three detect many aromatic and large molecule hydrocarbons. The 10.2 eV and 11.7 eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as the lamp's service life is longer than the 11.7 eV probe and it detects more compounds than the 9.5 eV probe.

Note: The use of any trade names does not imply their endorsement by the U.S. Environmental Protection Agency.

The HNU factory calibration gas is benzene. The span potentiometer (calibration) knob is turned to 9.8 for benzene calibration. A knob setting of zero increases the response to benzene approximately tenfold. As with the OVA, the instrument's response can be adjusted to give more accurate readings for specific gases and eliminate the necessity for calibration charts.

While the primary use of the HNU is as a quantitative instrument, it can also be used to detect certain contaminants, or at least to narrow the range of possibilities. Noting instrument response to a contaminant source with different probes can eliminate some contaminants from consideration. For instance, a compound's ionization potential may be such that the 9.5 eV probe produces no response, but the 10.2 eV and 11.7 eV probes do elicit a response. The HNU does not detect methane or most inorganic compounds.

The HNU is easier to use than the OVA. Its lower detection limit is also in the low ppm range. The response time is rapid; the meter needle reaches 90% of the indicated concentration in 3 seconds for benzene. It can be zeroed in a contaminated atmosphere.

IV. GENERAL CONSIDERATIONS

Both of these instruments can monitor only certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates, and other toxic gases and vapors cannot be detected. Because the types of compounds that the HNU and OVA can potentially detect are only a fraction of the chemicals possibly present at an incident, a zero reading on either instrument does not necessarily signify the absence of air contaminants.

The instruments are non-specific, and their response to different compounds is relative to the calibration setting. Instrument readings may be higher or lower than the true concentration. This can be an especially serious problem when monitoring for total contaminant concentrations if several different compounds are being detected at once. In addition, the response of these instruments is not linear over the entire detection range. Care must therefore be taken when interpreting the data. All identifications should be reported as tentative until they can be confirmed by more precise analysis. Concentrations should be reported in terms of the calibration gas and span potentiometer or gas-select-knob setting.

Since the OVA and HNU are small, portable instruments, they cannot be expected to yield results as accurate as laboratory instruments. They were originally designed for specific industrial applications. They are relatively easy to use and interpret when detecting total concentrations of individually known contaminants in air, but interpretation becomes extremely difficult when trying to quantify the components of a mixture. Neither instrument can be used as an indicator for combustible gases or oxygen deficiency.

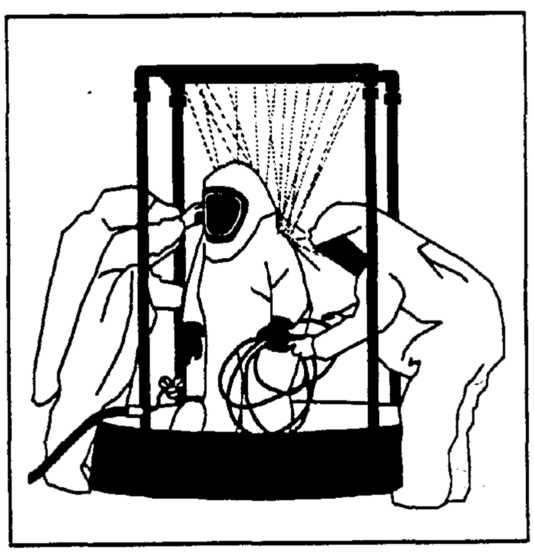
The OVA (Model 128) is certified by Factory Mutual to be used in Class I, Division 1, Groups A,B,C, and D environments. As HNU now markets three models, it should be noted that the basic HNU (PI 101) is certified by SIRA Class I, Division 2, Groups A, B, C, and D. However, a model certified for Class I, Division I, Groups A, B, C, and D is available.

APPENDIX E

SAMPLE DECONTAMINATION LAYOUTS AND PROCEDURES FOR LEVELS OF PROTECTION A THROUGH C

The objective of these procedures is to minimize the risk of exposure to hazardous substances in the field. Protective equipment must be worn by personnel when response activities involve known or suspected hazardous substances. The procedures for decontaminating personnel upon leaving the contaminated area are discussed for personal protective equipment levels A through C. The procedures given are for the maximum and minimum amount of decontamination used for each level of protection.

The maximum decontamination procedures for all levels of protection consist of specific activities at 19 stations. Each station emphasizes an important aspect of decontamination. When establishing a decontamination line, each aspect should be incorporated separately or combined with other aspects into a procedure with fewer steps (such as the minimum decontamination procedures). Decontamination lines are site-specific and vary depending on the types of contamination and work activities conducted on-site. When the decontamination line is no longer required, contamination wash and rinse solutions and contaminated articles must be contained and disposed of as hazardous wastes in compliance with State and Federal regulations.



EQUIPMENT NEEDED TO PERFORM MAXIMUM DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 1:
- a. Various Size Containers
- b. Plastic Liners
- c. Plastic Drop Cloths

Station 2:
- a: Containers (20-30 Gallons)
- b. Decon Solution or Detergent Water
- c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 3:
- a. Containers (20-30 Gallons
  OR
- b. Water
- c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 4:
- a. Containers (20-30 Gallons)
- b. Plastic Liners

Station 5:
- a. Containers (20-30 Gallons)
- b. Plastic Liners
- c. Bench or Stools

Station 6:
- a. Containers (20-30 Gallons)
- b. Plastic Liners

Station 7:
- a. Containers (20-30 Gallons)
- b. Decon Solution or Detergent Water
- c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 8:
- a. Containers (20-30 Gallons)
  OR
- b. Water
- c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 9:
- a. Air Tanks or Face Masks and Cartridge Depending on Level
- b. Tape
- c. Boot Covers
- d. Gloves

Station 10:
- a: Containers (20-30 Gallons)
- b. Plastic Liners
- c. Bench or Stools
- d. Boot Jack

Station 11:
- a. Rack
- b. Drop Cloths
- c. Bench or Stools

Station 12:
- a. Table

Station 13:
- a. Basin or Bucket
- b. Decon Solution
- c. Small Table

Station 14:
- a. Water
- b. Basin on Bucket
- c. Small Table

Station 15:
- a. Containers (20-30 Gallons)
- b. Plastic Liners

Station 16:
- a. Containers (20-30 Gallons)
- b. Plastic Liners

Station 17:
- a. Containers (20-30 Gallons)
- b. Plastic Liners

Station 18:
- a. Water
- b. Soap
- c. Small Table
- d. Basin or Bucket
- e. Field Showers
- f. Towels

Station 19:
- a. Dressing Trailer is Needed in Inclement Weather
- b. Tables
- c. Chairs
- d. Lockers
- e. Cloths

EQUIPMENT NEEDED TO PERFORM <u>MINIMUM</u> DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 1:
- a. Various Size Containers
- b. Plastic Liners
- c. Plastic Drop Cloths

Station 2:
- a. Containers (20-30 Gallons)
- b. Decon Solution
- c. Rinse Water
- d. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 3:
- a. Containers (20-30 Gallons)
- b. Plastic Liners
- c. Bench or Stools

Station 4:
- a. Air Tanks or Masks and Cartridges Depending Upon Level
- b. Tape
- c. Boot Covers
- d. Gloves

Station 5:
- a. Containers (20-30 Gallons)
- b. Plastic Liners
- c. Bench or Stools

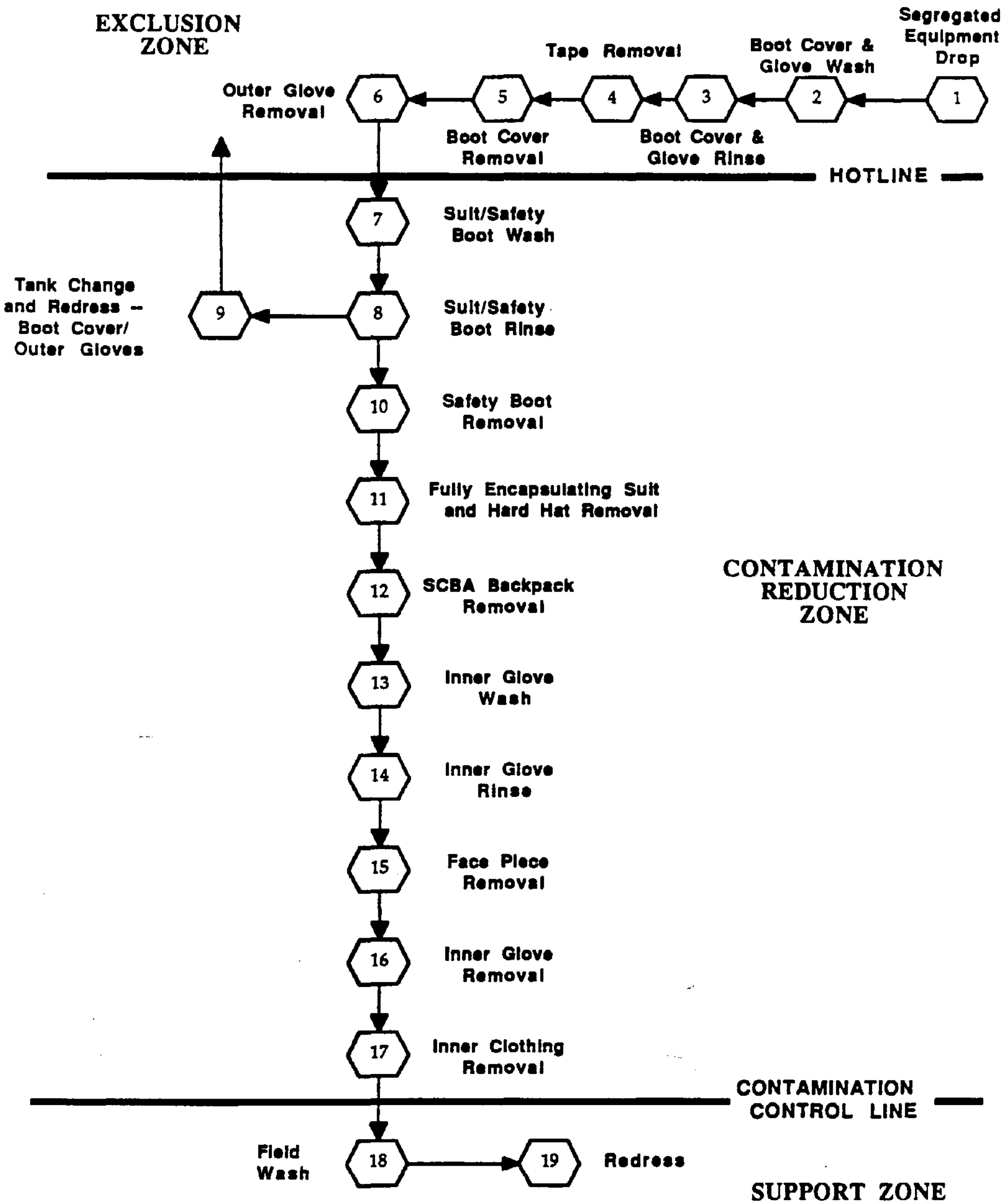
Station 6:
- a. Plastic Sheets
- b. Basin or Bucket
- c. Soap and Towels
- d. Bench or Stools

Station 7:
- a. Water
- b. Soap
- c. Tables
- d. Wash Basin or Bucket

<u>MAXIMUM</u> MEASURES FOR LEVEL A DECONTAMINATION

Station 1:	Segregated Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution or detergent/water.
Station 3:	Boot Cover and Glove Rinse	Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	Wash encapsulating suit and boots using scrub brush and decon solution or detergent/water. Repeat as many times as necessary.
Station 8:	Suit and Boot	Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Tank Change	If an air tank change is desired, this is the last step in the decontamination procedure. Air tank is exchanged, new outer gloves and boot covers are donned, and joints are taped. Worker returns to duty.
Station 10:	Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Station 11:	Fully Encapsulating Suit and Hard Hat Removal	Fully encapsulated suit is removed with assistance of a helper and is laid out on a drop cloth or hung up. Hard hat is removed. Hot weather rest station may be set up within this area for personnel returning to site.
Station 12:	SCBA Backpack Removal	While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve and proceed to next station.
Station 13:	Inner Glove Wash	Wash with decon solution that will not harm the skin. Repeat as often as necessary.
Station 14:	Inner Glove Rinse	Rinse with water. Repeat as many times as necessary.
Station 15:	Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	Remove inner gloves and deposit in container with liner.
Station 17:	Inner Clothing Removal	Remove clothing and place in lined container. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 18:	Field Wash	Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19:	Redress	Put on clean clothes.

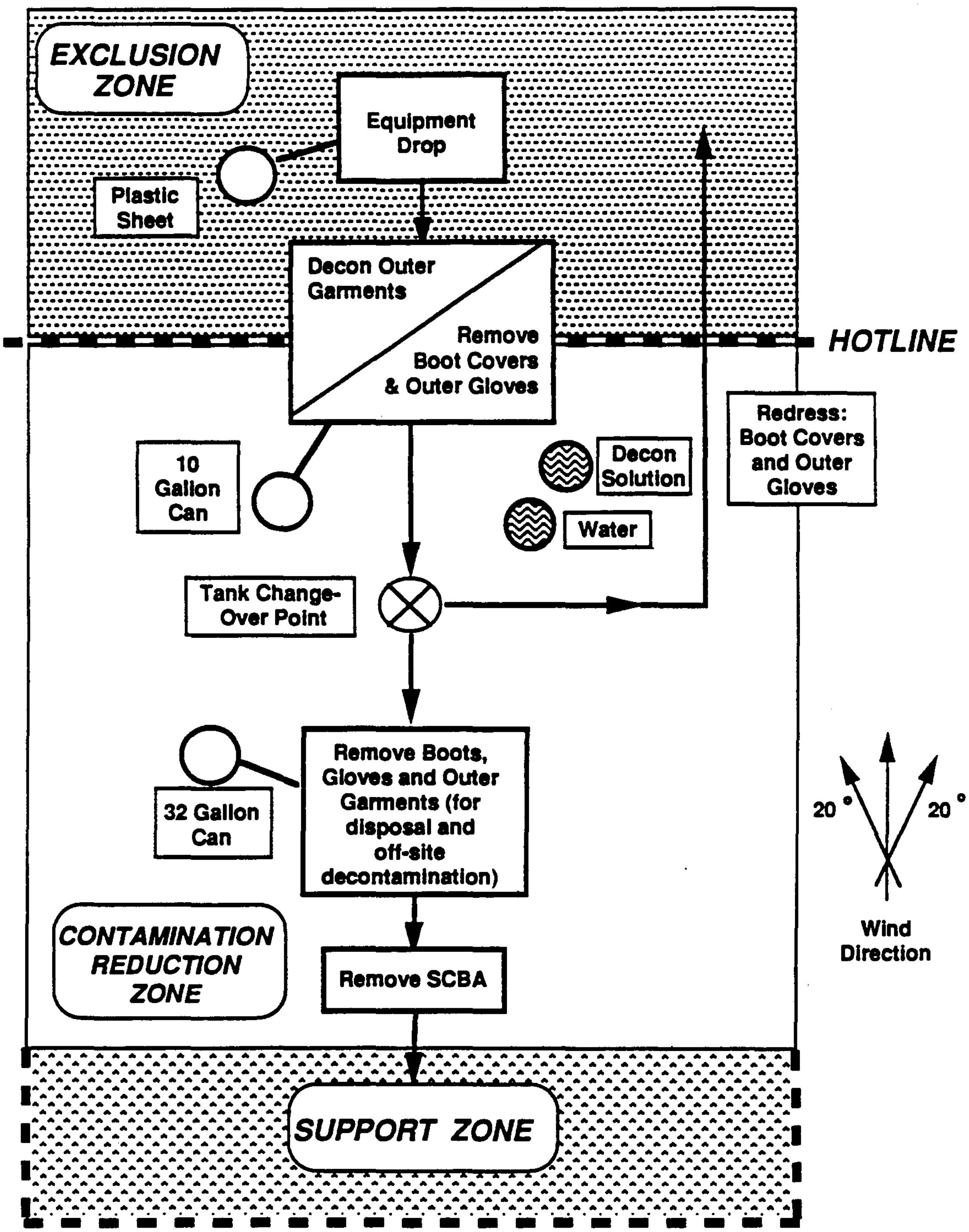
MAXIMUM DECONTAMINATION LAYOUT FOR LEVEL A PROTECTION



<u>MINIMUM</u> MEASURES FOR LEVEL A DECONTAMINATION

Station 1:	Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool-down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	Scrub outer boots, outer gloves and fully-encapsulating suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.
Station 5:	Boot, Gloves, and Outer Garment Removal	Boots, fully-encapsulating suit, and inner gloves are removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	SCBA backpack and facepieces are removed (avoid touching face with fingers). SCBA is deposited on plastic sheets.
Station 7:	Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

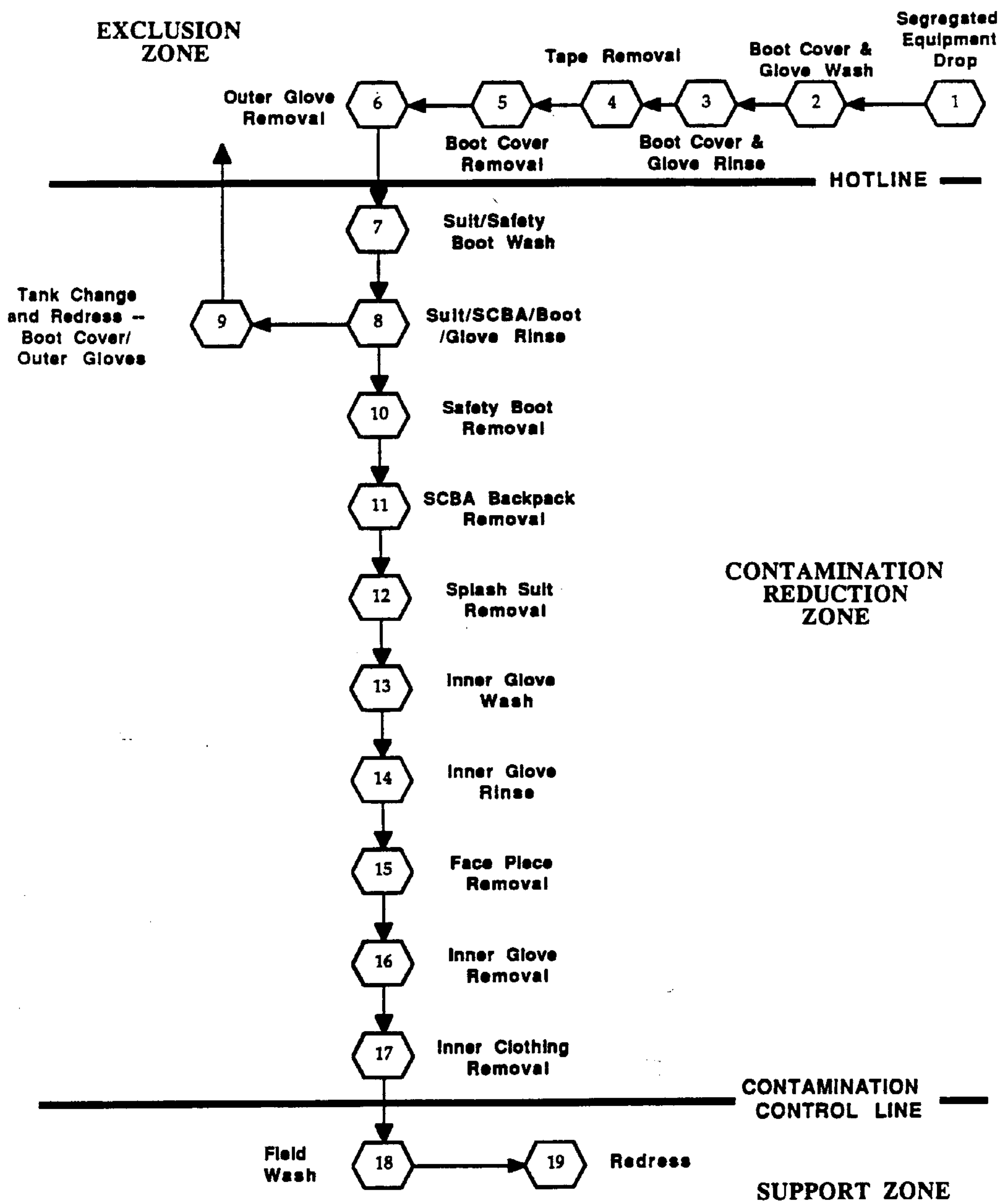
MINIMUM DECONTAMINATION LAYOUT FOR LEVELS A & B PROTECTION



<u>MAXIMUM</u> MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Segregated Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, cool-down stations may be set up within this area.
Station 2:	Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	Rinse off decon solution from Station 2 using copious amounts of water.
Station 4:	Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Safety Boot Wash	Wash chemical-resistant splash suit, SCBA, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution. Wrap SCBA regulator (if belt mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloths.
Station 8:	Suit, SCBA, Boot, and Glove Rinse	Rinse off decon solution using copious amounts of water.
Station 9:	Tank Change	If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.
Station 10:	Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Station 11:	SCBA Backpack Removal	While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve.
Station 12:	Splash Suit Removal	With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 13:	Inner Glove Wash	Wash inner gloves with decon solution.
Station 14:	Inner Glove Rinse	Rinse inner gloves with water.
Station 15:	Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	Remove inner gloves and deposit in container with liner.
Station 17:	Inner Clothing Removal	Remove inner clothing. Place in container with liner. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants may have been transferred in removing the fully-encapsulating suit.
Station 18:	Field Wash	Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19:	Redress	Put on clean clothes.

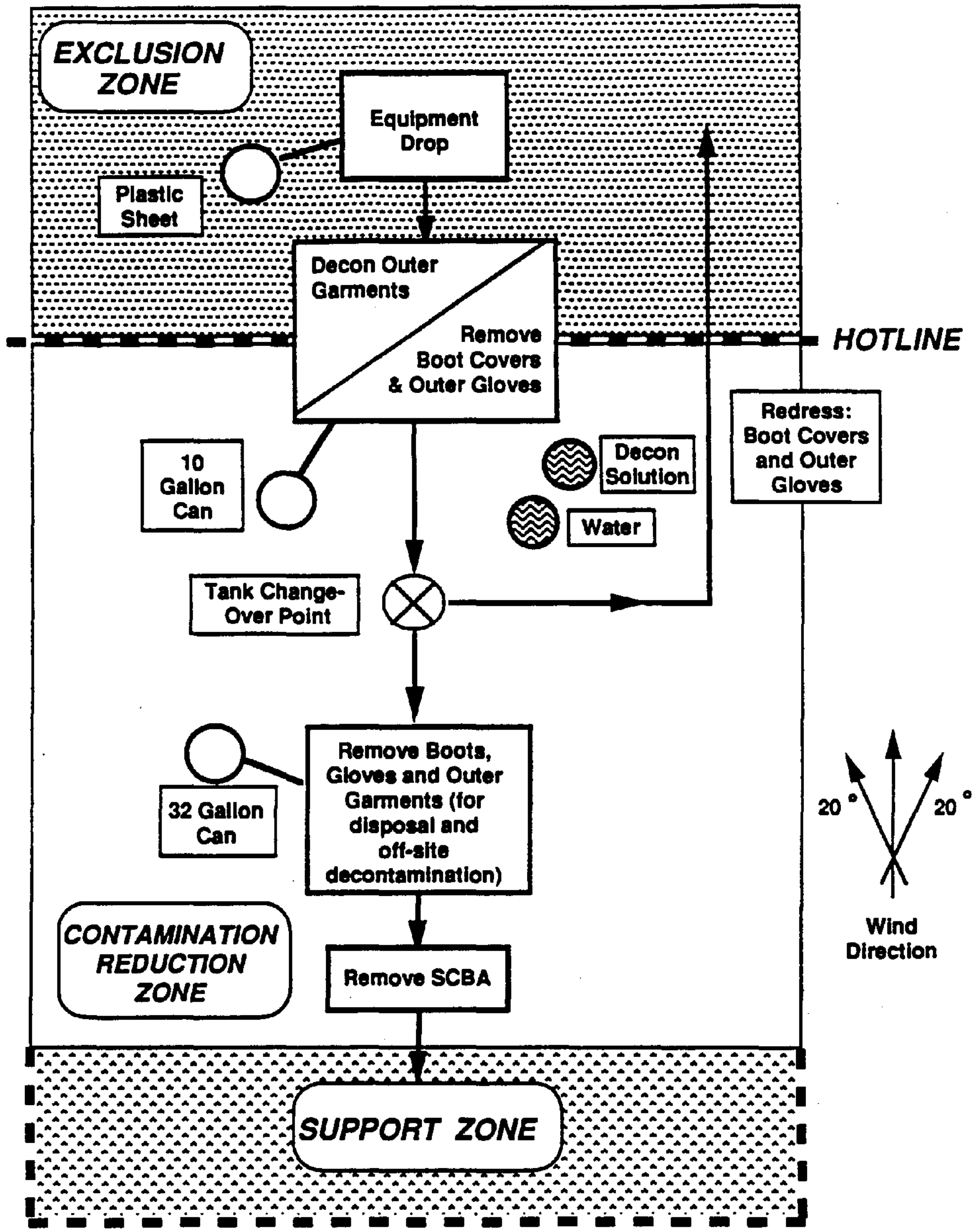
MAXIMUM DECONTAMINATION LAYOUT FOR LEVEL B PROTECTION



MINIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool-down station may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	Scrub outer boots, outer gloves, and chemical-resistant splash suit with decon solution or detergent water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.
Station 5:	Boot, Gloves, and Outer Garment Removal	Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	SCBA backpack and facepiece are removed. Avoid touching face with finger. SCBA is deposited on plastic sheets.
Station 7:	Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

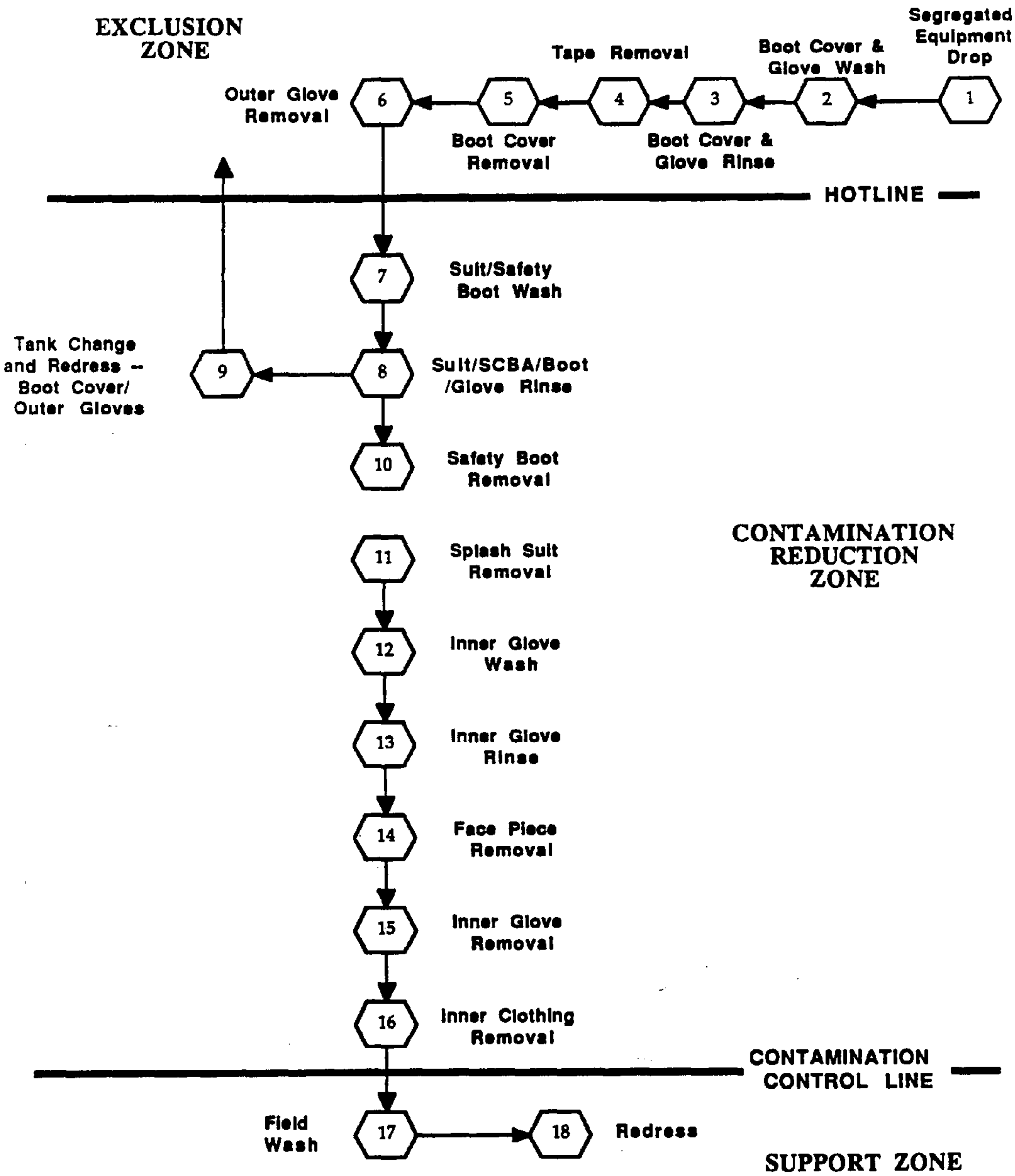
MINIMUM DECONTAMINATION LAYOUT FOR LEVELS A & B PROTECTION



MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Segregated Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	Rinse off decon solution from Station 2 using copious amounts of water.
Station 4:	Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	Remove boot covers and deposit in containers with plastic liner.
Station 6:	Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Station 8:	Suit, Boot, and Glove Rinse	Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Canister or Mask Change	If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers are donned, and joints are taped. Worker returns to duty.
Station 10:	Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Station 11:	Splash Suit Removal	With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 12:	Inner Glove Removal	Wash inner gloves with decon solution.
Station 13:	Inner Glove Wash	Rinse inner gloves with water.
Station 14:	Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	Remove inner gloves and deposit in lined container.
Station 16:	Inner Clothing Removal	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off-site since there is a probability that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 17:	Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 18:	Redress	Put on clean clothes.

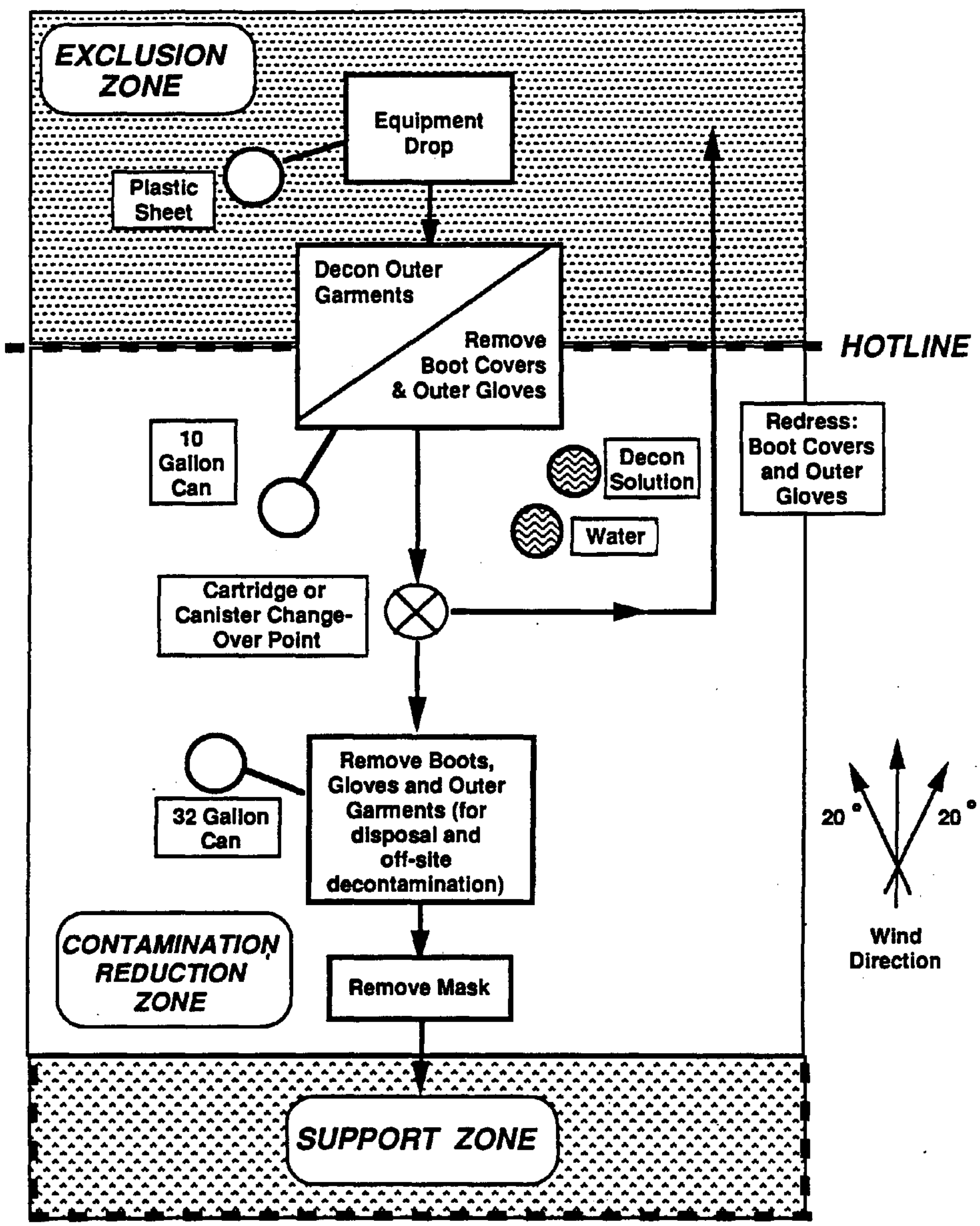
MAXIMUM DECONTAMINATION LAYOUT FOR LEVEL C PROTECTION



<u>MINIMUM</u> MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	Scrub outer boots, outer gloves, and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Canister or Mask Change	If worker leaves exclusive zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.
Station 5:	Boot, Gloves and Outer Garment Removal	Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.
Station 6:	Face Piece Removal	Facepiece is removed. Avoid touching face with fingers. Facepiece is deposited on plastic sheet.
Station 7:	Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

<u>MINIMUM</u> DECONTAMINATION LAYOUT FOR LEVEL C PROTECTION



APPENDIX F

REGIONAL CONTACTS

This Appendix provides the addresses and telephone numbers of Headquarters and Regional contacts at both EPA and OSHA.

U.S. ENVIRONMENTAL PROTECTION AGENCY

U.S. EPA/Environmental Response Team
2890 Woodbridge Avenue
Building 18, MS 101
Edison, NJ 08837-3679
(908) 321-6740
24 Hour Hotline: (908) 321-6660

EPA REGIONAL OFFICES

- **EPA Region 1**
  John F. Kennedy Federal Building
  Room 2203
  Boston, MA 02203
  (617) 565-3715

- **EPA Region 2**
  Jacob K. Javitz Federal Building
  26 Federal Plaza
  New York, NY 10278
  (212) 264-2657

- **EPA Region 3**
  841 Chestnut Building
  Philadelphia, PA 19107
  (215) 597-9800

- **EPA Region 4**
  345 Courtland Street, NE
  Atlanta, GA 30365
  (404) 347-4727

- **EPA Region 5**
  Metcalfe Federal Building
  77 W. Jackson Boulevard
  Chicago, IL 60604
  (312) 353-2000

- **EPA Region 6**
  1445 Ross Avenue,
  9th Floor
  Dallas, TX 75202
  (214) 655-6444

- **EPA Region 7**
  726 Minnesota Avenue
  Kansas City, KS 66115
  (913) 551-7000

- **EPA Region 8**
  999 18th Street
  Suite 500
  Denver, CO 80202-2405
  (303) 293-1603

- **EPA Region 9**
  75 Hawthorne Street
  San Francisco, CA 94105
  (415) 744-1305

- **EPA Region 10**
  1200 6th Avenue
  Seattle, WA 98101
  (206) 442-1200

Note: Commercial and FTS telephone numbers are now identical with the institution of the new FTS system.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Occupational Safety and Health Administration
Department of Labor
200 Constitution Avenue NW
Room N-3647
Washington, DC 20210
(202) 523-8151
OSHA Notification Service (Complaint Hotline) for Emergency Situations
1-800-321-6742

OSHA REGIONAL OFFICES

- **OSHA Region 1**
  133 Portland Street, 1st Floor
  Boston, MA 02114
  (617) 565-7164

- **OSHA Region 2**
  201 Varick Street, Room 670
  New York, NY 10014
  (212) 337-2325

- **OSHA Region 3**
  Gateway Building, Suite 2100
  3535 Market Street
  Philadelphia, PA 19104
  (215) 596-1201

- **OSHA Region 4**
  1375 Peachtree Street NE, Suite 587
  Atlanta, GA 30367
  (404) 347-3573

- **OSHA Region 5**
  230 South Dearborn Street
  32nd Floor, Room 3244
  Chicago, IL 60604
  (312) 353-2220

- **OSHA Region 6**
  525 Griffin Street, Room 602
  Dallas, TX 75202
  (214) 767-4731

- **OSHA Region 7**
  911 Walnut Street
  Kansas City, MO 64106
  (816) 426-5861

- **OSHA Region 8**
  1951 Stout Street
  Denver, CO 80204
  (303) 844-3061

- **OSHA Region 9**
  71 Stevenson Street
  Suite 415
  San Francisco, CA 94105
  (415) 744-6670

- **OSHA Region 10**
  1111 Third Avenue
  Suite 715
  Seattle, WA 98101-3212
  (206) 442-5930

Note: Commercial and FTS telephone numbers are now identical with the institution of the new FTS system.

U.S. EPA REGIONAL MAP