Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities

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The *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* is a result of the collaborative efforts of individuals representing the National Institute for Occupational Safety and Health (NIOSH), the lead agency, and the Occupational Safety and Health Administration (OSHA), the U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA). Agency representatives on the steering committee for this project were:

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Notice

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1. Introduction

In the past decade, industry, government, and the general public have become increasingly aware of the need to respond to the hazardous waste problem, which has grown steadily over the past 40 years. In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—the Superfund law—to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites."

This manual is a guidance document for managers responsible for occupational safety and health programs at inactive hazardous waste sites. It assumes a basic knowledge of science and experience in occupational safety and health. It is the product of a four-agency committee (the National Institute for Occupational Safety and Health [NIOSH], the Occupational Safety and Health Administration [OSHA], the U.S. Coast Guard [USCG], and the U.S. Environmental Protection Agency [EPA]) mandated by CERCLA section 301(f) to study the problem of protecting the safety and health of workers at hazardous waste sites, and by CERCLA section 111(c)(6) to develop a program to protect the health and safety of employees involved in response to hazardous substance releases, removals, or remedial actions.

This manual 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.
- As a reference document for site personnel who need to review important aspects of health and safety.

This document is *not* a detailed industrial hygiene textbook or a comprehensive source book on occupational safety and health. It provides general guidance and should be used as a preliminary basis for developing a specific health and safety program. The appropriateness of the information presented should always be evaluated in light of site-specific conditions. Other sources and experienced individuals should be consulted as necessary for the detail needed to design and implement occupational safety and health programs at specific hazardous waste sites.

Although this manual cites federal regulations, it is not a definitive legal document and should not be taken as such. While it represents a cooperative effort of the four agencies to develop a document that blends their widely differing mandates, policies, and procedures in specific areas, the manual may not include elements of each agency's policies that should be considered when developing occupational safety and health programs for hazardous waste sites. Individuals who are responsible for the health and safety of workers at hazardous waste sites should obtain and comply with the most recent federal, state, and local regulations relevant to these sites, and are urged to consult with OSHA, EPA, and other appropriate federal, state, and local agencies.

This manual will be updated regularly. Please send comments and suggested revisions to any of these four organizations:

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A separate manual that specifically addresses response to hazardous substances emergencies will be published at a later date. In the meantime, much of the information in this manual can be used in planning for response to emergencies involving hazardous substances.

2. Hazards

Contents

Introduction

Hazardous waste sites pose a multitude of health and safety concerns, any one of which could result in serious injury or death. These hazards are a function of the nature of the site as well as a consequence of the work being performed. They include:

- Chemical exposure.
- Fire and explosion.
- Oxygen deficiency.
- Ionizing radiation.
- Biologic hazards.
- Safety hazards.
- Electrical hazards.
- Heat stress.
- Cold exposure.
- Noise.

Several factors distinguish the hazardous waste site environment from other occupational situations involving hazardous substances. One important factor is the uncontrolled condition of the site. Even extremely hazardous substances do not endanger human health or safety if they are properly handled. However, improper control of these substances can result in a severe threat to site workers and to the general public.

Another factor is the large variety and number of substances that may be present at a site. Any individual location may contain hundreds or even thousands of chemicals. Frequently, an accurate assessment of all chemical hazards is impossible due to the large number of substances and the potential interactions among the substances. In addition, the identity of the substances on site is frequently unknown, particularly in the initial stages of an investigation. The Project Team Leader (see Chapter 3, *Planning and Organization*) will often be forced to select protective measures based on little or no information. Finally, workers are subject not only to the hazards of direct exposure, but also to dangers posed by the disorderly physical environment of hazardous waste sites and the stress of working in protective clothing.

The combination of all these conditions results in a working environment that is characterized by numerous and varied hazards which:

- May pose an immediate danger to life or health.
- May not be immediately obvious or identifiable.
- May vary according to the location on site and the task being performed.
- May change as site activities progress.

General categories of hazards that may be present at a site are described in this chapter. In approaching a site, it is prudent to assume that all these hazards are present until site characterization has shown otherwise. A site health and safety program, as described in the subsequent chapters of this manual, must provide comprehensive protection against all potential hazards and specific protection against individual known hazards. It should be continuously adapted to new information and changing site conditions.

Chemical Exposure

Preventing exposure to toxic chemicals is a primary concern at hazardous waste sites. Most sites contain a variety of chemical substances in gaseous, liquid, or solid form. These substances can enter the unprotected body by inhalation, skin absorption, ingestion, or through a puncture wound (injection). A contaminant can cause damage at the point of contact or can act systemically, causing a toxic effect at a part of the body distant from the point of initial contact.

Chemical exposures are generally divided into two categories: acute and chronic. Symptoms resulting from acute exposures usually occur during or shortly after exposure to a sufficiently high concentration of a contaminant. The concentration required to produce such effects varies widely from chemical to chemical. The term "chronic exposure" generally refers to exposures to "low" concentrations of a contaminant over a long period of time. The "low" concentrations required to produce symptoms of chronic exposure depend upon the chemical, the duration of each exposure, and the number of exposures. For a given contaminant, the symptoms of an acute exposure may be completely different from those resulting from chronic exposure.

For either chronic or acute exposure, the toxic effect may be temporary and reversible, or may be permanent (disability or death). Some chemicals may cause obvious symptoms such as burning, coughing, nausea, tearing eyes, or rashes. Other chemicals may cause health damage without any such warning signs (this is a particular concern for chronic exposures to low concentrations). Health effects such as cancer or respiratory disease may not become manifest for several years or decades after exposure. In addition, some toxic chemicals may be colorless and/or odorless, may dull the sense of smell, or may not produce any immediate or obvious physiological sensations. Thus, a worker's senses or feelings cannot be relied upon in all cases to warn of potential toxic exposure.

The effects of exposure not only depend on the chemical, its concentration, route of entry, and duration of expo-

sure, but may also be influenced by personal factors such as the individual's smoking habits, alcohol consumption, medication use, nutrition, age, and sex (see Chapter 5, *Medical Program*).

An important exposure route of concern at a hazardous waste site is inhalation. The lungs are extremely vulnerable to chemical agents. Even substances that do not directly affect the lungs may pass through lung tissue into the bloodstream, where they are transported to other vulnerable areas of the body. Some toxic chemicals present in the atmosphere may not be detected by human senses, i.e., they may be colorless, odorless, and their toxic effects may not produce any immediate symptoms. Respiratory protection is therefore extremely important if there is a possibility that the work-site atmosphere may contain such hazardous substances. Chemicals can also enter the respiratory tract through punctured eardrums. Where this is a hazard, individuals with punctured eardrums should be medically evaluated specifically to determine if such a condition would place them at unacceptable risk and preclude their working at the task in question.

Direct contact of the skin and eyes by hazardous substances is another important route of exposure. Some chemicals directly injure the skin. Some pass through the skin into the bloodstream where they are transported to vulnerable organs. Skin absorption is enhanced by abrasions, cuts, heat, and moisture. The eye is particularly vulnerable because airborne chemicals can dissolve in its moist surface and be carried to the rest of the body through the bloodstream (capillaries are very close to the surface of the eye). Wearing protective equipment, not using contact lenses in contaminated atmospheres (since they may trap chemicals against the eye surface), keeping hands away from the face, and minimizing contact with liquid and solid chemicals can help protect against skin and eye contact.

Although ingestion should be the least significant route of exposure at a site, it is important to be aware of how this type of exposure can occur. Deliberate ingestion of chemicals is unlikely, however, personal habits such as chewing gum or tobacco, drinking, eating, smoking cigarettes, and applying cosmetics on site may provide a route of entry for chemicals.

The last primary route of chemical exposure is injection, whereby chemicals are introduced into the body through puncture wounds (for example, by stepping or tripping and falling onto contaminated sharp objects). Wearing safety shoes, avoiding physical hazards, and taking common sense precautions are important protective measures against injection.

Explosion and Fire

There are many potential causes of explosions and fires at hazardous waste sites:

- Chemical reactions that produce explosion, fire, or heat.
- Ignition of explosive or flammable chemicals.
- Ignition of materials due to oxygen enrichment.
- Agitation of shock- or friction-sensitive compounds.
- Sudden release of materials under pressure.

Explosions and fires may arise spontaneously. However, more commonly, they result from site activities, such as moving drums, accidentally mixing incompatible chemicals, or introducing an ignition source (such as a spark from equipment) into an explosive or flammable environment. At hazardous waste sites, explosions and fires not only pose the obvious hazards of intense heat, open flame, smoke inhalation, and flying objects, but may also cause the release of toxic chemicals into the environment. Such releases can threaten both personnel on site and members of the general public living or working nearby. To protect against the hazard: have qualified personnel field monitor for explosive atmospheres and flammable vapors; keep all potential ignition sources away from an explosive or flammable environment; use nonsparking, explosion-proof equipment; and follow safe practices when performing any task that might result in the agitation or release of chemicals.

Oxygen Deficiency

The oxygen content of normal air at sea level is approximately 21 percent. Physiological effects of oxygen deficiency in humans are readily apparent when the oxygen concentration in the 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. To take into account individual physiological responses and errors in measurement, concentrations of 19.5 percent oxygen or lower are considered to be indicative of oxygen deficiency.

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 (see Chapter 8, *Personal Protective Equipment*) when oxygen concentrations drop below 19.5 percent by volume.

Ionizing Radiation

Radioactive materials emit one or more of three types of harmful radiation: alpha, beta, and gamma. 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, but can be hazardous if materials that emit alpha radiation are inhaled or ingested. Beta radiation can cause harmful "beta burns" to the skin and damage the subsurface blood system. Beta radiation is also hazardous if materials that emit beta radiation are inhaled or ingested. Use of protective clothing, coupled with scrupulous personal hygiene and decontamination, affords good protection against alpha and beta radiation.

Gamma radiation easily passes 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

radiation-emitting materials from entering the body by inhalation, ingestion, injection, or skin absorption.

If levels of radiation above natural background are discovered (see Table 6-2 in Chapter 6), consult a health physicist. At levels greater than 2 mrem/hr, all site activities should cease until the site has been assessed by health physicists.

Biologic Hazards

Wastes from hospitals and research facilities may contain disease-causing organisms that could infect site personnel. Like chemical hazards, etiologic agents may be dispersed in the environment via water and wind. Other biologic hazards that may be present at a hazardous waste site include poisonous plants, insects, animals, and indigenous pathogens. Protective clothing and respiratory equipment can help reduce the chances of exposure. Thorough washing of any exposed body parts and equipment will help protect against infection.

Safety Hazards

Hazardous waste sites may contain numerous safety hazards such as:

- Holes or ditches.
- Precariously positioned objects, such as drums or boards that may fall.
- Sharp objects, such as nails, metal shards, and broken glass.
- Slippery surfaces.
- Steep grades.
- Uneven terrain.
- Unstable surfaces, such as walls that may cave in or flooring that may give way.

Some safety hazards are a function of the work itself. For example, heavy equipment creates an additional hazard for workers in the vicinity of the operating equipment. Protective equipment can impair a worker's agility, hearing, and vision, which can result in an increased risk of an accident.

Accidents involving physical hazards can directly injure workers and can create additional hazards, for example, increased chemical exposure due to damaged protective equipment, or danger of explosion caused by the mixing of chemicals. Site personnel should constantly look out for potential safety hazards, and should immediately inform their supervisors of any new hazards so that mitigative action can be taken.

Electrical Hazards

Overhead power lines, downed electrical wires, and buried cables all pose a danger of shock or electrocution if workers contact or sever them during site operations. Electrical equipment used on site may also pose a hazard to workers. To help minimize this hazard, low-voltage equipment with ground-fault interrupters and water-tight, corrosion-resistant connecting cables should be used on site. In addition, 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. An additional electrical hazard involves capacitors that may retain a charge. All such items should be properly grounded before handling. OSHA's standard 29 CFR Part 1910.137 describes clothing and equipment for protection against electrical hazards.

Heat Stress

Heat stress is a major hazard, especially for workers wearing protective clothing. The same protective materials that shield the body from chemical exposure also limit the dissipation of body heat and moisture. Personal protective clothing can therefore create a hazardous condition. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly —within as little as 15 minutes. It can pose as great a danger to worker health as chemical exposure. In its early stages, heat stress can cause rashes, cramps, discomfort and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and coworkers. Continued heat stress can lead to heat stroke and death. Avoiding overprotection, careful training and frequent monitoring of personnel who wear protective clothing, judicious scheduling of work and rest periods, and frequent replacement of fluids can protect against this hazard. For further information on heat stress, see Chapter 8, *Personal Protective Equipment*.

Cold Exposure

Cold injury (frostbite and hypothermia) and impaired ability to work are dangers at low temperatures and when the wind-chill factor is low. To guard against them: wear appropriate clothing; have warm shelter readily available; carefully schedule work and rest periods, and monitor workers' physical conditions.

Noise

Work around large equipment often creates excessive noise. The effects of noise can include:

- Workers being startled, annoyed, or distracted.
- Physical damage to the ear, pain, and temporary and/or permanent hearing loss.
- Communication interference that may increase potential hazards due to the inability to warn of danger and the proper safety precautions to be taken.

If employees are subjected to noise exceeding an 8-hour, time-weighted average sound level of 90 dBA (decibels on the A-weighted scale), feasible administrative or engineering controls must be utilized. In addition, whenever employee noise exposures equal or exceed an 8-hour, time-weighted average sound level of 85 dBA, employers must administer a continuing, effective hearing conservation program as described in OSHA regulation 29 CFR Part 1910.95.

3. Planning and Organization

Contents

Introduction

Adequate planning is the first and the most critical element of hazardous waste site activities. By anticipating and taking steps to prevent potential hazards to health and safety, work at a waste site can proceed with minimum risk to workers and the public.

Three aspects of planning are discussed in this chapter: developing an overall organizational structure for site operations; establishing a comprehensive Work Plan that considers each specific phase of the operation; and developing and implementing a Site Safety and Health Plan (hereinafter referred to as Site Safety Plan in accordance with common usage). The organizational structure should identify the personnel needed for the overall operation, establish the chain-of-command, and specify the overall responsibilities of each employee. The Work Plan should establish the objectives of site operations and the logistics and resources required to achieve the goals. The Site Safety Plan should determine the health and safety concerns for each phase of the operation and define the requirements and procedures for worker and public protection.

A fourth important aspect of planning is coordinating with the existing response community. A national response organization was established by a Congressionally mandated National Contingency Plan to implement procedures for coordinating response to releases of hazardous substances into the environment. This National Contingency Plan establishes response teams composed of representatives of federal agencies and state and local governments [1]. A particularly important contact for hazardous waste site activities is the EPA-designated official responsible for coordinating federal activities related to site cleanup.

Planning should be viewed as an ongoing process: the cleanup activities and Site Safety Plan must be continuously adapted to new site conditions and new information. Thus, this chapter is intended to serve as a starting point for planning the response activities at hazardous waste sites.

Organizational Structure

An organizational structure that supports the overall objectives of the project should be developed in the first stage of planning. This structure should:

- Identify a leader who has the authority to direct all activities.
- Identify the other personnel needed for the project, and assign their general functions and responsibilities.
- Show lines of authority, responsibility, and communication.
- Identify the interface with the response community.

As the project progresses, it may be necessary to modify some organizational aspects of the project, such as personnel responsibilities and authorities, so that individual tasks can be performed as efficiently and safely as possible. Any changes to the overall organizational structure must be recorded in the appropriate parts of the Work or Site Safety Plans that are developed for individual phases or tasks and must be communicated to all parties involved.

Figure 3-1 presents one example of an organizational framework for a hazardous waste site response team. It shows the lines of authority for 24 categories of offsite and onsite personnel. The responsibilities and functions of each category are described in Tables 3-1 through 3-4. The onsite categories are divided into personnel that are essential for a safe and efficient response, and optional personnel that may be desirable in a large operation where responsibilities can be delegated to a greater number of people. As-needed personnel are specialists that are called upon for specific tasks, either off-site or on site.

This example is intended to illustrate the scope of responsibilities and functions that must be covered. The personnel categories described can be used as a starting point for designing an organizational structure appropriate to a particular situation. For smaller investigative and response efforts, single individuals may perform several of the functions described.

Regardless of the size of the effort, all response teams should include a Site Safety and Health Officer (hereinafter referred to as Site Safety Officer in accordance with common usage) responsible for implementing health and safety requirements. The Site Safety Officer should have ready access to other occupational health and safety professionals, particularly an industrial hygienist. Once an organizational system has been developed, all individuals responsible for establishing and enforcing health and safety requirements should be identified and their respective authorities clearly explained to all members of the response team.

One of the most critical elements in worker safety is the attitude of all levels of project management. A strong and visible commitment to worker safety must be present from the beginning of a project. This initial attitude sets the tone for the entire operation. The Site Safety Officer and the Project Team Leader must have the clear support of senior-level management for establishing, implementing, and enforcing safety programs from the outset of the project. The importance of management's attitude toward safety throughout the project cannot be overemphasized; site personnel are more likely to cooperate with safety programs if they sense a genuine concern on the part of management.

Several organizational factors are indicators of successful worker safety programs. These factors include:

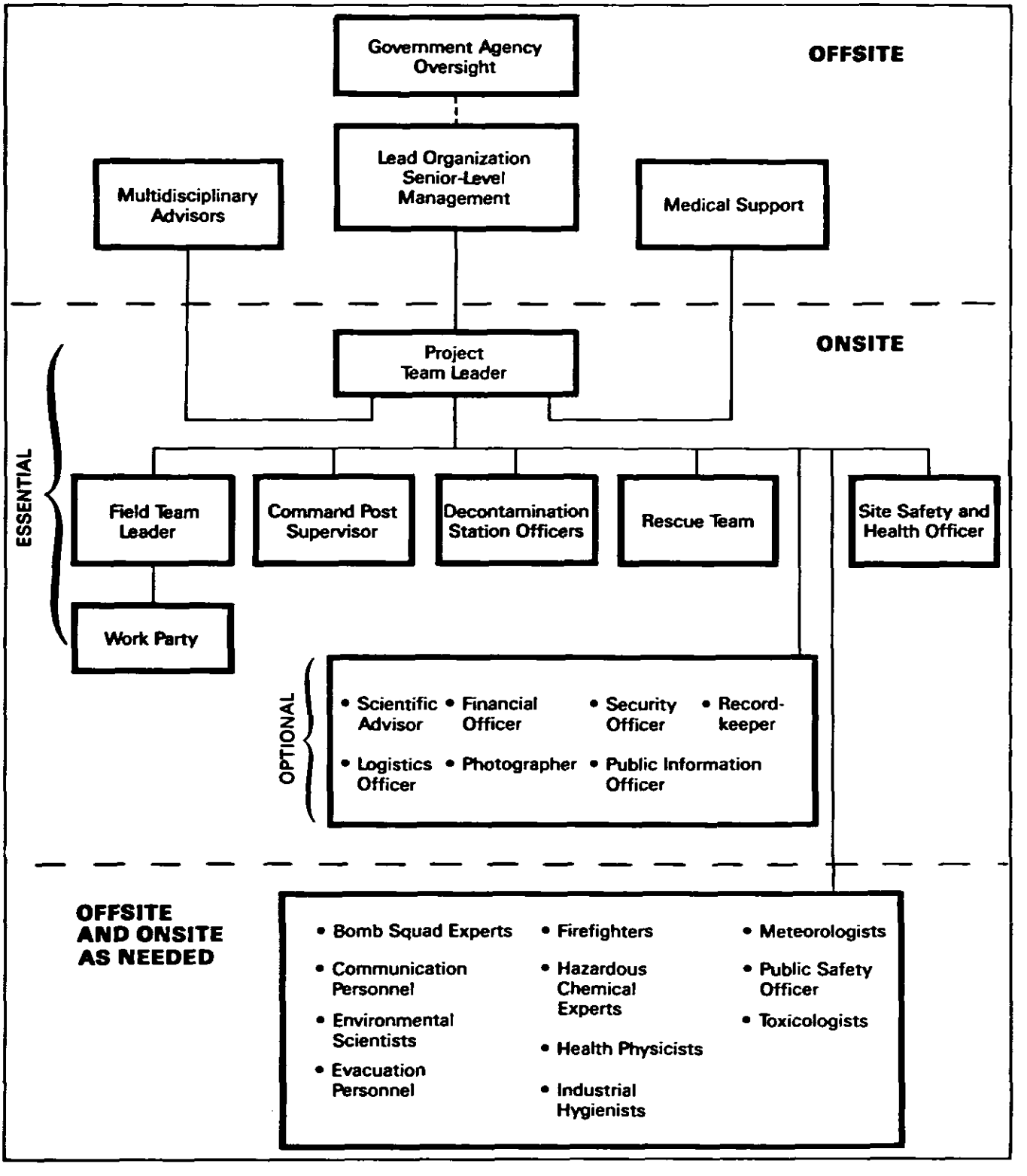

Figure 3-1. Generalized Approach to Personnel Organization for Site Investigation and Response.

- Strong management commitment to safety, as defined by various actions reflecting management's support and involvement in safety activities.
- Close contact and interaction among workers, supervisors, and management enabling open communication on safety as well as other job-related matters.
- A high level of housekeeping, orderly workplace conditions, and effective environmental quality control.
- Well-developed selection, job placement, and advancement procedures plus other employee support services.
- Training practices emphasizing early indoctrination and followup instruction in job safety procedures.
- Added features or variations in conventional safety practices that enhance the effectiveness of those practices.
- Effective disciplinary plan to encourage employees to adhere to safety practices.

Overall, the most effective industrial safety programs are successful in dealing with "people" variables. Open communication among workers, supervisors, and management concerning worksite safety is essential.

The effective management of response actions at hazardous waste sites requires a commitment to the health and safety of the general public as well as to the onsite personnel. Prevention and containment of contaminant release into the surrounding community should be addressed in the planning stages of a project. Not only must the public be protected, they must also be made aware of the health and safety program and have confidence in it. To accomplish these goals, the Project Team Leader, or Public Information Officer under the supervision of the Project Team Leader, should establish community liaison well before any response action is begun, and should be in continuous contact with community leaders.

Work Plan

To ensure a safe response, a Work Plan describing anticipated cleanup activities must be developed before beginning onsite response actions. The Work Plan should be periodically reexamined and updated as new information about site conditions is obtained.

The following steps should be taken in formulating a comprehensive Work Plan:

- Review available information, including:
  - Site records.
  - Waste inventories.
  - Generator and transporter manifests.
  - Previous sampling and monitoring data.
  - Site photos.
  - State and local environmental and health agency records.
- Define work objectives.
- Determine methods for accomplishing the objectives, e.g., sampling plan, inventory, disposal techniques.
- Determine personnel requirements.
- Determine the need for additional training of personnel. Evaluate their current knowledge/skill level against the tasks they will perform and situations they may encounter (see Chapter 4, *Training*).

Table 3-1. Offsite Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Senior-Level Management	Responsible for defining project objectives, allocating resources, determining the chain-of-command, and evaluating program outcome.	• Provide the necessary facilities, equipment, and money. • Provide adequate personnel and time resources to conduct activities safely. • Support the efforts of onsite management. • Provide appropriate disciplinary action when unsafe acts or practices occur.
Multi-Disciplinary Advisors	Includes representatives from upper-level management and onsite management, a field team member, and experts in such fields as: Chemistry, Engineering, Industrial hygiene, Information/public relations, Law, Medicine, Pharmacology, Physiology, Radiation health physics, Toxicology	• Provide advice on the design of the Work Plan and the Site Safety Plan.
Medical Support	Consulting physicians.	• Become familiar with the types of materials on site, the potential for worker exposures, and recommend the medical program for the site.
	Medical personnel at local hospitals and clinics.	• Provide emergency treatment and decontamination procedures for the specific type of exposures that may occur at the site. Obtain special drugs, equipment, or supplies necessary to treat such exposures.
	Ambulance personnel.	• Provide emergency treatment procedures appropriate to the hazards on site.

Table 3-2. Onsite Essential Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Project Team Leader	Reports to upper-level management. Has authority to direct response operations. Assumes total control over site activities.	• Prepares and organizes the background review of the situation, the Work Plan, the Site Safety Plan, and the field team. • Obtains permission for site access and coordinates activities with appropriate officials. • Ensures that the Work Plan is completed and on schedule. • Briefs the field teams on their specific assignments. • Uses the Site Safety and Health Officer to ensure that safety and health requirements are met. • Prepares the final report and support files on the response activities. • Serves as the liaison with public officials.
Site Safety and Health Officer (hereinafter referred to as Site Safety Officer in accordance with common usage)	Advises the Project Team Leader on all aspects of health and safety on site. Recommends stopping work if any operation threatens worker or public health or safety.	• Selects protective clothing and equipment. • Periodically inspects protective clothing and equipment. • Ensures that protective clothing and equipment are properly stored and maintained. • Controls entry and exit at the Access Control Points. • Coordinates safety and health program activities with the Scientific Advisor. • Confirms each team member's suitability for work based on a physician's recommendation. • Monitors the work parties for signs of stress, such as cold exposure, heat stress, and fatigue. • Monitors onsite hazards and conditions. • Participates in the preparation of and implements the Site Safety Plan. • Conducts periodic inspections to determine if the Site Safety Plan is being followed. • Enforces the "buddy" system. • Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department. • Notifies, when necessary, local public emergency officials. • Coordinates emergency medical care.
Field Team Leader	May be the same person as the Project Team Leader and may be a member of the work party. Responsible for field team operations and safety.	• Manages field operations. • Executes the Work Plan and schedule. • Enforces safety procedures. • Coordinates with the Site Safety Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as a liaison with public officials.
Command Post Supervisor	May be the same person as the Field Team Leader. Responsible for communications and emergency assistance.	• Notifies emergency response personnel by telephone or radio in the event of an emergency. • Assists the Site Safety Officer in a rescue, if necessary. • Maintains a log of communication and site activities. • Assists other field team members in the clean areas, as needed. • Maintains line-of-sight and communication contact with the work parties via walkie-talkies, signal horns, or other means.
Decontamination Station Officer(s)	Responsible for decontamination procedures, equipment, and supplies.	• Sets up decontamination lines and the decontamination solutions appropriate for the type of chemical contamination on site. • Controls the decontamination of all equipment, personnel, and samples from the contaminated areas. • Assists in the disposal of contaminated clothing and materials. • Ensures that all required equipment is available. • Advises medical personnel of potential exposures and consequences.
Rescue Team	Used primarily on large sites with multiple work parties in the contaminated area.	• Stands by, partially dressed in protective gear, near hazardous work areas. • Rescues any worker whose health or safety is endangered.
Work Party	Depending on the size of the field team, any or all of the field team may be in the Work Party, but the Work Party should consist of at least two people.	• Safely completes the onsite tasks required to fulfill the Work Plan. • Complies with Site Safety Plan. • Notifies Site Safety Officer or supervisor of unsafe conditions.

Table 3-3. Onsite Optional Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Scientific Advisor	Guides the Project Team Leader in scientific matters.	• Provides advice for: Field monitoring — Scientific studies Sample collection — Data interpretation Sample analysis — Remedial plans
Logistics Officer		• Plans and mobilizes the facilities, materials, and personnel required for the response.
Photographer		• Photographs site conditions. • Archives photographs.
Financial/Contracting Officer		• Provides financial and contractual support.
Public Information Officer		• Releases information to the news media and the public concerning site activities.
Security Officer		• Manages site security.
Recordkeeper		• Maintains the official records of site activities.

- Determine equipment requirements. Evaluate the need for special equipment or services, such as drilling equipment or heavy equipment and operators.

Preparation of the Work Plan requires a multidisciplinary approach, and may therefore require input from all levels of onsite and offsite management. Consultants may also be useful in developing sections of the Work Plan; for example, chemists, occupational health and safety professionals, and statisticians may be needed to develop the sampling plan.

Site Safety Plan

A Site Safety Plan, which establishes policies and procedures to protect workers and the public from the potential hazards posed by a hazardous waste site, must be developed before site activities proceed. The Site Safety Plan must provide measures to minimize accidents and injuries that may occur during normal daily activities or during adverse conditions such as hot or cold weather. This section describes the planning process for health and safety during normal site operations, i.e., non-emergency situations. Chapter 12 describes planning and response to site emergencies.

Development of a written Site Safety Plan helps ensure that all safety aspects of site operations are thoroughly examined prior to commencing field work. The Site Safety Plan should be modified as needed for every stage of site activity.

Because planning requires information, planning and site characterization should be coordinated. An initial Site Safety Plan should be developed so that the preliminary site assessment can proceed in a safe manner. The information from this assessment can then be used to refine the Site Safety Plan so that further site activities can proceed safely. Plans should be revised whenever new information about site hazards is obtained.

Development of a Site Safety Plan should involve both the offsite and onsite management and be reviewed by occupational and industrial health and safety experts, physicians, chemists, or other appropriate personnel.

At a minimum, the plan should:

- Name key personnel and alternates responsible for site safety (see Tables 3-1 through 3-4).
- Describe the risks associated with each operation conducted (see Chapter 6, *Site Characterization*).
- Confirm that personnel are adequately trained to perform their job responsibilities and to handle the specific hazardous situations they may encounter (see Chapter 4, *Training*).
- Describe the protective clothing and equipment to be worn by personnel during various site operations (see Chapter 8, *Personal Protective Equipment*).
- Describe any site-specific medical surveillance requirements (see Chapter 5, *Medical Program*).
- Describe the program for periodic air monitoring, personnel monitoring, and environmental sampling, if needed (see Chapter 6, *Site Characterization*, and Chapter 11, *Handling Drums and Other Containers*).
- Describe the actions to be taken to mitigate existing hazards (e.g., containment of contaminated materials) to make the work environment less hazardous.
- Define site control measures and include a site map (see Chapter 9, *Site Control*).
- Establish decontamination procedures for personnel and equipment (see Chapter 10, *Decontamination*).
- Set forth the site's Standard Operating Procedures (SOPs). SOPs are those activities that can be standardized (such as decontamination and respirator fit testing), and where a checklist can be used. These procedures should be:

  Prepared in advance.

  Based on the best available information, operational principles, and technical guidance.

  Field-tested by qualified health and safety professionals, and revised as appropriate.

  Appropriate to the types of risk at that site.

  Formulated to be easy to understand and practice.

Table 3-4. As-Needed Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Bomb Squad Explosion Experts		• Advise on methods of handling explosive materials. • Assist in safely detonating or disposing of explosive materials.
Communication Personnel	Civil Defense organizations; local radio and television stations. Local emergency service networks.	• Provide communication to the public in the event of an emergency. • Provide communication links for mutual aid.
Environmental Scientists	Consultants from industry, government, universities, or other groups.	• Predict the movement of released hazardous materials through the atmospheric, geologic, and hydrologic environment. • Assess the effect of this movement on air, groundwater, and surface water quality. • Predict the exposure of people and the ecosystem to the materials.
Evacuation Personnel	Federal, state, and local public safety organizations.	• Help plan for public evacuation. • Mobilize transit equipment. • Assist in public evacuation.
Firefighters		• Respond to fires that occur on site. • Stand by for response to potential fires. • Perform rescue.
Hazardous Chemical Experts	Consultants from industry, government, universities, or other groups.	• Advise on the properties of the materials on site. • Advise on contaminant control methods. • Advise on the dangers of chemical mixtures that may result from site activities. • Provide immediate advice to those at the scene of a chemical-related emergency.
Health Physicists		• Evaluate radiation health hazards and recommend appropriate action.
Industrial Hygienists		• Conduct health hazard assessments. • Advise on adequate health protection. • Conduct monitoring tests to determine worker exposures to hazardous substances.
Meteorologists		• Provide meteorological information.
Public Safety Personnel	The County Sheriff, industrial security forces, National Guard, police, etc.	• Control access to the site.
Toxicologists		• Advise on toxicological properties and health effects of substances on site. • Provide recommendations on protection of worker health.

Provided in writing to all site personnel, who should be briefed on their use.

Included in training programs for site personnel.

- Set forth a Contingency Plan for safe and effective response to emergencies.

Appendix B provides a generic Site Safety Plan that can be adapted for hazardous waste site cleanup operations. The generic plan should be used as a guide, *not a standard*, for designing a Site Safety Plan.

Safety Meetings and Inspections

To ensure that the Site Safety Plan is being followed, the Site Safety Officer should conduct a safety meeting prior to initiating any site activity and before and after each work day. The purpose of these safety meetings is to:

- Describe the assigned tasks and their potential hazards.
- Coordinate activities.
- Identify methods and precautions to prevent injuries.
- Plan for emergencies.
- Describe any changes in the Site Safety Plan.
- Get worker feedback on conditions affecting safety and health.
- Get worker feedback on how well the Site Safety Plan is working.

The Site Safety Officer should also conduct frequent inspections of site conditions, facilities, equipment, and activities to determine whether the Site Safety Plan is adequate and being followed.

At a hazardous waste site, risks to workers can change quickly and dramatically when there are changes in:

- Work and other site activities.
- State of degradation of containers and containment structures.

- State of equipment maintenance.
- Weather conditions.

In order to make safety inspections effective, the following guidelines should be observed:

- Develop a checklist for each site, listing the items that should be inspected.
- Review the results of these inspections with supervisors and workers.
- Reinspect any identified problems to ensure that they have been corrected.
- Document all inspections and subsequent followup actions. Retain these records until site activities are completed and as as long as required by regulatory agencies.

The minimum frequency at which inspections should occur varies with the characteristics of the site and the equipment used on site. Factors that need to be considered are:

- The severity of risk on site.
- Regulatory requirements.
- Operation and maintenance requirements.
- The expected effective lifetime of clothing, equipment, vehicles, and other items.
- Recommendations based on professional judgment, laboratory test results, and field experience.

References

1. National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300.

4. Training

Contents

Introduction

Anyone who enters a hazardous waste site must recognize and understand the potential hazards to health and safety associated with the cleanup of that site. Personnel actively involved in cleanup must be thoroughly familiar with programs and procedures contained in the Site Safety Plan (see Chapter 3, *Planning and Organization*) and must be trained to work safely in contaminated areas. Visitors to a site must receive adequate training on hazard recognition and on the site's Standard Operating Procedures to enable them to conduct their visit safely.

The objectives of training programs for employees involved in hazardous waste site activities are:

- To make workers aware of the potential hazards they may encounter.
- To provide the knowledge and skills necessary to perform the work with minimal risk to worker health and safety.
- To make workers aware of the purpose and limitations of safety equipment.
- To ensure that workers can safely avoid or escape from emergencies.

The level of training provided should be consistent with the worker's job function and responsibilities. The training program should involve both classroom instruction in a wide range of health and safety topics and "hands-on" practice. Hands-on instruction should consist of drills in the field that simulate site activities and conditions. Any training program for work around hazardous substances should also incorporate onsite experience under the direct supervision of trained, experienced personnel.

All training information should be presented in clear, concise language. Particularly important information, such as the Standard Operating Procedures, should be provided in writing. A variety of teaching aids (i.e., films, tapes, slides, etc.) should be used, and lecture sessions should be interspersed with class participation and hands-on training. All employees should also complete refresher training, at least annually, to reemphasize the initial training and to update workers on any new policies or procedures.

Training Programs

Employees should not engage in field activities until they have been trained to a level commensurate with their job function and responsibilities and with the degree of anticipated hazards. Specific recommendations for the areas to be covered in training sessions are given in Table 4-1.

The training program should involve field drills that simulate emergency situations. Here workers wearing Level A personal protective equipment repair a leaking pipe as part of a training exercise.

General site workers, such as equipment operators, general laborers, technicians, and other supervised personnel, should attend training sessions that apply to their individual jobs and responsibilities, as well as training sessions that provide an overview of the site hazards and the means of controlling those hazards. Their training should include classroom instruction in the following subject areas, depending on their individual jobs:

- Site Safety Plan.
- Safe work practices.
- Nature of anticipated hazards.
- Handling emergencies and self-rescue.
- Rules and regulations for vehicle use.
- Safe use of field equipment.
- Handling, storage, and transportation of hazardous materials.
- Employee rights and responsibilities.
- Use, care, and limitations of personal protective clothing and equipment (see *Training* section of Chapter 8).
- Safe sampling techniques.

Table 4-1. Recommended Training by Job Category[a]

TRAINING TOPIC	EMPHASIS OF TRAINING	GENERAL SITE WORKER	ONSITE MANAGEMENT AND SUPERVISORS	HEALTH AND SAFETY STAFF	VISITORS
Biology, Chemistry, and Physics of Hazardous Materials	Chemical and physical properties; chemical reactions; chemical compatibilities.	R	R	R	
Toxicology	Dosage, routes of exposure, toxic effects, immediately dangerous to life or health (IDLH) values, permissible exposure limits (PELs), recommended exposure limits (RELs), threshold limit values (TLVs).	R	R	R	
Industrial Hygiene	Selection and monitoring of personal protective clothing and equipment.		R	R	
	Calculation of doses and exposure levels; evaluation of hazards; selection of worker health and safety protective measures.		R	R	
Rights and Responsibilities of Workers Under OSHA	Applicable provisions of Title 29 of the Code of Federal Regulations (the OSH Act).	R	R	R	
Monitoring Equipment	Functions, capabilities, selection, use, limitations, and maintenance.	R	R	R	
Hazard Evaluation	Techniques of sampling and assessment.		R	R	
	Evaluation of field and lab results.		R	R	
	Risk assessment.		O	R	
Site Safety Plan	Safe practices, safety briefings and meetings, Standard Operating Procedures, site safety map.	R	R	R	R
Standard Operating Procedures (SOPs)	Hands-on practice.	R	R	R	
	Development and compliance.		R	R	
Engineering Controls	The use of barriers, isolation, and distance to minimize hazards.	R	R	R	
Personal Protective Clothing and Equipment (PPE)	Assignment, sizing, fit-testing, maintenance, use, limitations, and hands-on training.	R	R	R	R
	Selection of PPE.		O	R	
	Ergonomics.			R	
Medical Program	Medical monitoring, first aid, stress recognition.	R	R	R	
	Advanced first aid, cardiopulmonary resuscitation (CPR); emergency drills.	O	R	R	
	Design, planning, and implementation.			R	
Decontamination	Hands-on training using simulated field conditions.	R	R	R	
	Design and maintenance.	R	R	R	
Legal and Regulatory Aspects	Applicable safety and health regulations (OSHA, EPA, etc.)	O	R	R	
Emergencies	Emergency help and self-rescue; emergency drills.	R	R	R	
	Response to emergencies; follow-up investigation and documentation.		R	R	

[a]R = Recommended.
O = Optional.

In addition to classroom instruction, general site workers should engage in actual field activities under the direct supervision of a trained, experienced supervisor.

Some general site workers who may be exposed to unique hazards or who may occasionally supervise others should receive additional training in the following subject areas:

- Site surveillance.
- Site Safety Plan development.
- Use and decontamination of fully encapsulating personal protective clothing and equipment.
- Use of instruments to measure explosivity, radioactivity, etc.
- Safe use of specialized equipment.
- Topics specific to identified site activities.

Onsite management and supervisors, such as Project Team Leaders, who are responsible for directing others, should receive the same training as the general site workers for whom they are responsible, as well as additional training to enhance their ability to provide guidance and make informed decisions. This additional training should include:

- Management of hazardous waste site cleanup operations.
- Management of the site work zones (see Chapter 9, *Site Control*).
- How to communicate with the press and local community.

Health and safety staff with specific responsibilities for health and safety guidance on site should be familiar with the training provided to general site workers and their supervisors, and should receive advanced training in health and safety issues, policies, and techniques.

Visitors to the site (including elected and appointed officials, reporters, senior-level management, and other interested parties) must also receive a briefing on safety. These visitors should not be permitted in the Exclusion Zone (see Chapter 9, *Site Control*) unless they have been trained, fit-tested, and medically approved for respirator use. All other visitors should not enter the Exclusion Zone; rather, they should observe site conditions from the clean area, e.g., using binoculars.

Record of Training

A record of training should be maintained in each employee's personnel file to confirm that every person assigned to a task has had adequate training for that task, and that every employee's training is up-to-date.

5. Medical Program

Contents

Introduction

Workers handling hazardous wastes can experience high levels of stress. Their daily tasks may expose them to toxic chemicals, safety hazards, biologic hazards, and radiation. They may develop heat stress while wearing protective equipment or working under temperature extremes, or face life-threatening emergencies such as explosions and fires. Therefore, a medical program is essential to assess and monitor workers' health and fitness both prior to employment and during the course of work; to provide emergency and other treatment as needed; and to keep accurate records for future reference. In addition, OSHA recommends a medical evaluation for employees required to wear a respirator (29 CFR Part 1910.134[b][10]), and certain OSHA standards include specific medical requirements (e.g., 29 CFR Part 1910.95 and 29 CFR Parts 1910.1001 through 1910.1045). Information from a site medical program may also be used to conduct future epidemiological studies; to adjudicate claims; to provide evidence in litigation; and to report workers' medical conditions to federal, state, and local agencies, as required by law.

This chapter presents general guidelines for designing a medical program for personnel at hazardous waste sites. It includes information and sample protocols for pre-employment screening and periodic medical examinations, guidelines for emergency and non-emergency treatment, and recommendations for program recordkeeping and review. In addition, it supplies a table of some common chemical toxicants found at hazardous waste sites with recommended medical monitoring procedures.

The recommendations in this chapter assume that workers will have adequate protection from exposures through administrative and engineering controls, and appropriate personal protective equipment and decontamination procedures, as described elsewhere in this manual. Medical surveillance should be used to complement other controls.

Developing a Program

A medical program should be developed for each site based on the specific needs, location, and potential exposures of employees at the site. The program should be designed by an experienced occupational health physician or other qualified occupational health consultant in conjunction with the Site Safety Officer. The director of a site medical program should be a physician who is board-certified in occupational medicine or a medical doctor who has had extensive experience managing occupational health services. A director and/or examining physician with such qualifications may be difficult to find, due to the shortage of doctors trained in occupational medicine in remote geographic areas where many hazardous waste sites are located. If an occupational health physician is not available, the site medical program may be managed, and relevant examinations performed, by a local physician with assistance from an occupational medicine consultant. These functions may also be performed by a qualified Registered Nurse, preferably an Occupational Health Nurse, under the direction of a suitably qualified physician who has responsibility for the program.[1]

All medical test analyses should be performed by a laboratory that has demonstrated satisfactory performance in an established interlaboratory testing program [1]. The clinical or diagnostic laboratory to which samples are sent should meet either (1) minimum requirements under the Clinical Laboratories Improvement Act of 1967 (42 CFR Part 74 Subpart M Section 263[a]), or (2) the conditions for coverage under Medicare. These programs are administered by the Health Care Financing Administration (HCFA), U.S. Department of Health and Human Services (DHHS).

A site medical program should provide the following components:

- Surveillance:
  - Pre-employment screening.
  - Periodic medical examinations (and followup examinations when appropriate).
  - Termination examination.
- Treatment:
  - Emergency
  - Non-emergency (on a case-by-case basis)
- Recordkeeping.
- Program review.

Table 5-1 outlines a recommended medical program; screening and examination protocols are described in the following sections. These recommendations are based on known health risks for hazardous waste workers, 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 given.

The effectiveness of a medical program depends on active worker involvement. In addition, management should have a firm commitment to worker health and

[1] Certified, state-licensed (where required) Physician's Assistants may also perform these examinations if a physician is available on the premises.

Table 5-1. Recommended Medical Program

COMPONENT	RECOMMENDED	OPTIONAL
Pre-Employment Screening	• Medical history. • Occupational history. • Physical examination. • Determination of fitness to work wearing protective equipment. • Baseline monitoring for specific exposures.	• Freezing pre-employment serum specimen for later testing (limited to specific situations, see *Baseline Data for Future Exposures* in this chapter).
Periodic Medical Examinations	• Yearly update of medical and occupational history; yearly physical examination; testing based on (1) examination results, (2) exposures, and (3) job class and task. • More frequent testing based on specific exposures.	• Yearly testing with routine medical tests.
Emergency Treatment	• Provide emergency first aid on site. • Develop liaison with local hospital and medical specialists. • Arrange for decontamination of victims. • Arrange in advance for transport of victims. • Transfer medical records; give details of incident and medical history to next care provider.	
Non-Emergency Treatment	• Develop mechanism for non-emergency health care.	
Recordkeeping and Review	• Maintain and provide access to medical records in accordance with OSHA and state regulations. • Report and record occupational injuries and illnesses. • Review Site Safety Plan regularly to determine if additional testing is needed. • Review program periodically. Focus on current site hazards, exposures, and industrial hygiene standards.	

safety, and is encouraged to express this commitment not only by medical surveillance and treatment, but also through management directives and informal encouragement of employees to maintain good health through exercise, proper diet, and avoidance of tobacco, alcohol abuse and drug abuse. In particular, management should:

- Urge prospective employees to provide a complete and detailed occupational and medical history.
- Assure employees of confidentiality.
- Require workers to report any suspected exposures, regardless of degree.
- Require workers to bring any unusual physical or psychological conditions to the physician's attention. Employee training should emphasize that vague disturbances or apparently minor complaints (such as skin irritation or headaches) may be important.

When developing an individual program, site conditions must be considered and the monitoring needs of each worker should be determined based on the worker's medical and occupational history, as well as current and potential exposures on site. The routine job tasks of each worker should be considered. For instance, a heavy equipment operator exposed to significant noise levels would require a different monitoring protocol from a field sample collector with minimal noise exposure. Likewise, an administrator may only need a pre-employment screening for ability to wear personal protective equipment—if this is an occasional requirement—rather than a more comprehensive program.

The potential exposures that may occur at a site must also be considered. While it is often impossible to identify every toxic substance that exists at each hazardous waste site, certain types of hazardous substances or chemicals are more likely to be present than others. Some of these are:

- Aromatic hydrocarbons.
- Asbestos (or asbestiform particles).
- Dioxin.
- Halogenated aliphatic hydrocarbons.
- Heavy metals.
- Herbicides.
- Organochlorine insecticides.
- Organophosphate and carbamate insecticides.
- Polychlorinated biphenyls (PCBs).

Table 5-2 lists these groups, with representative compounds, uses, health effects, and available medical monitoring procedures.

Table 5-2. 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
Aromatic Hydrocarbons	Benzene Ethyl benzene Toluene Xylene	Commercial solvents and intermediates for synthesis in the chemical and pharmaceutical industries.	Blood Bone marrow CNS[a] Eyes Respiratory system Skin Liver Kidney	All cause: CNS[a] 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[b] 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)					
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.

Table 5-2. (cont.)

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
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 hands), headache, abdominal cramps, diarrhea, and anemia. Lead can also affect the blood-forming mechanism, kidneys, and the peripheral nervous system. Long-term effects[c] 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.
Herbicides	Chlorophenoxy compounds: 2,4-dichlorophenoxyacetic acid (2,4-D) 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) Dioxin (tetrachlorodibenzo-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.

Table 5-2. (cont.)

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[d] 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]CNS = Central nervous system.
[b]CBC = Complete blood count.
[c]Long-term effects generally manifest in 10 to 30 years.
[d]RBC = Red blood count.

In compiling a testing protocol, bear in mind that standard occupational medical tests were developed in factories and other enclosed industrial environments, and were based on the presence of specific identifiable toxic chemicals and the possibility of a significant degree of exposure. Some of these tests may not be totally appropriate for hazardous waste sites, since available data suggest that site workers have low-level exposures to many chemicals concurrently, plus brief high-level exposure to some chemicals [2]. In addition, most testing recommendations, even those for specific toxic substances, have not been critically evaluated for efficacy.

Another important factor to consider is that risk can vary, not only with the type, amount and duration of exposure, but also with individual factors such as age, sex, weight, stress, diet, susceptibility to allergic-type reactions, medications taken, and offsite exposures (e.g., in hobbies such as furniture refinishing and automotive body work).

Pre-Employment Screening

Pre-employment screening has two major functions: (1) determination of an individual's fitness for duty, including the ability to work while wearing protective equipment, and (2) provision of baseline data for comparison with future medical data. These functions are discussed below. In addition, a sample pre-employment examination is described.

Determination of Fitness for Duty

Workers at hazardous waste sites are often required to perform strenuous tasks (e.g., moving 55-gallon drums) and wear personal protective equipment, such as respirators and protective clothing, that may cause heat stress and other problems (see Chapter 8 for details). To ensure that prospective employees are able to meet work requirements, the pre-employment screening should focus on the following areas:

Occupational and Medical History

- Make sure the worker fills out an occupational and medical history questionnaire. Review the questionnaire before seeing the worker. In the examining room, discuss the questionnaire with the worker, paying special attention to prior occupational exposures to chemical and physical hazards.
- Review 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, and heat intolerance.
- Identify individuals who are vulnerable to particular substances (e.g., someone with a history of severe asthmatic reaction to a specific chemical).
- Record relevant lifestyle habits (e.g., cigarette smoking, alcohol and drug use) and hobbies.

Physical Examination

- Conduct a comprehensive physical examination of all body organs, focussing on the pulmonary, cardiovascular, and musculoskeletal systems.
- Note conditions that could increase susceptibility to heat stroke, such as obesity and lack of physical exercise.
- Note conditions that could affect respirator use, such as missing or arthritic fingers, facial scars, dentures, poor eyesight, or perforated ear drums.

Ability to Work While Wearing Protective Equipment [3]

- Disqualify individuals who are clearly 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 protective equipment (e.g., individuals who must wear contact lenses cannot wear full-facepiece respirators).
- Provide additional testing (e.g., chest X-ray, pulmonary function testing, electrocardiogram) for ability to wear protective equipment where necessary.
- Base the determination on the individual worker's profile (e.g., medical history and physical exam, age, previous exposures and testing).
- Make a written assessment of the worker's capacity to perform while wearing a respirator, if wearing a respirator is a job requirement. Note that the Occupational Safety and Health Administration (OSHA) respirator standard (29 CFR Part 1910.134) states that no employee should be assigned to a task that requires the use of a respirator unless it has been determined that the person is physically able to perform under such conditions.

Baseline Data for Future Exposures

Pre-employment screening can be used to establish baseline data to subsequently verify the efficacy of protective measures and to later determine if exposures have adversely affected the worker. Baseline testing may include both medical screening tests and biologic monitoring tests. The latter (e.g., blood lead level) may be useful for ascertaining pre-exposure levels of specific substances to which the worker may be exposed and for which reliable tests are available. Given the problem in predicting significant exposures for these workers, there are no clear guidelines for prescribing specific tests. The following approach identifies the types of tests that may be indicated:

- A battery of tests based on the worker's past occupational and medical history and an assessment of significant potential exposures. See Table 5-3 for examples of tests frequently performed by occupational physicians.
- Standard established testing for specific toxicants in situations where workers may receive significant exposures to these agents. For example, long-term exposure during cleanup of a polychlorinated biphenyls (PCB) waste facility can be monitored with pre-employment and periodic serum PCB testing [4]. Standard procedures are available for determining levels of other substances, e.g., lead, cadmium, arsenic, and organophosphate pesticides.
- Where applicable, pre-employment blood specimens and serum frozen for later testing. (PCBs and some pesticides are examples of agents amenable to such monitoring.)

Table 5-3. Tests Frequently Performed by Occupational Physicians

FUNCTION	TEST	EXAMPLE
Liver:		
General	**Blood tests**	Total protein, albumin, globulin, total bilirubin (direct bilirubin if total is elevated).
Obstruction	**Enzyme test**	Alkaline phosphatase.
Cell Injury	**Enzyme tests**	Gamma glutamyl transpeptidase (GGTP), lactic dehydrogenase (LDH), serum glutamic-oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT).
Kidney:		
General	**Blood tests**	Blood urea nitrogen (BUN), creatinine, uric acid.
Multiple Systems and Organs	**Urinalysis**	Including color; appearance; specific gravity; pH; qualitative glucose, protein, bile, and acetone; occult blood; microscopic examination of centrifuged sediment.
Blood-Forming Function	**Blood tests**	Complete blood count (CBC) with differential and platelet evaluation, including white cell count (WBC), red blood count (RBC), hemoglobin (HGB), hematocrit or packed cell volume (HCT), and desired erythrocyte indices. Reticulocyte count may be appropriate if there is a likelihood of exposure to hemolytic chemicals.

Sample Pre-Employment Examination

Occupational and Medical History

- Do a complete medical history emphasizing these systems: nervous, skin, lung, blood-forming, cardiovascular, gastrointestinal, genitourinary, reproductive, ear, nose, and throat.

Physical Examination

Include at least the following:

- Height, weight, temperature, pulse, respiration, and blood pressure.
- Head, nose, and throat.
- Eyes. Include vision tests that measure refraction, depth perception, and color vision. These tests should be administered by a qualified technician or physician. Vision quality is essential to safety, the accurate reading of instruments and labels, the avoidance of physical hazards, and for appropriate response to color-coded labels and signals.
- Ears. Include audiometric tests, performed at 500, 1,000, 2,000, 3,000, 4,000, and 6,000 hertz (Hz) pure tone in an approved booth (see requirements listed in 29 CFR Part 1910.95, Appendix D). Tests should be administered by a qualified technician, and results read by a certified audiologist or a physician familiar with audiometric evaluation. The integrity of the eardrum should be established since perforated eardrums can provide a route of entry for chemicals into the body. The physician evaluating employees with perforated eardrums should consider the environmental conditions of the job and discuss possible specific safety controls with the Site Safety Officer, industrial hygienist, and/or other health professionals before deciding whether such individuals can safely work on site.
- Chest (heart and lungs).
- Peripheral vascular system.
- Abdomen and rectum (including hernia exam).
- Spine and other components of the musculoskeletal system.
- Genitourinary system.
- Skin.
- Nervous system.

Tests

- Blood.
- Urine.
- A 14 x 17-inch posterior/anterior view chest X-ray, with lateral or oblique views only if indicated or if mandated by state regulations. The X-ray should be taken by a certified radiology technician and interpreted by a board-certified or board-eligible radiologist. Chest X-rays taken in the last 12-month period, as well as the oldest chest X-ray available, should be obtained and used for comparison. Chest X-rays should not be repeated more than once a year, unless otherwise determined by the examining physician.

Ability to Perform While Wearing Protective Equipment

To determine a worker's capacity to perform while wearing protective equipment, additional tests may be necessary, for example:

- Pulmonary function testing. Measurement should include forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and FEV_1—to-FVC ratio, with interpretation and comparison to normal predicted values corrected for age, height, race, and sex. Other factors such as FEF, MEFR, MVV, FRC, RV, and TLC[1] may be included for additional information. A permanent record of flow curves should be placed in the worker's medical records. The tests should be conducted by a certified technician and the results interpreted by a physician.
- Electrocardiogram (EKG). At least one standard, 12-lead resting EKG should be performed at the discretion of the physician. A "stress test" (graded exercise) may be administered at the discretion of the examining physician, particularly where heat stress may occur.

Baseline Monitoring

If there is likelihood of potential onsite exposure to a particular toxicant, specific baseline monitoring should be performed to establish data relating to that toxicant.

Periodic Medical Examinations

Periodic Screening

Periodic medical examinations should be developed and used in conjunction with pre-employment screening examinations. Comparison of sequential medical reports with baseline data is essential to determine 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. Generally, medical examinations have been recommended at least yearly. 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. For example, workers participating in the cleanup of a PCB-contaminated building were initially examined monthly for serum PCB levels. Review of the data from the first few months revealed no appreciable evidence of PCB exposure. The frequency of PCB testing was then reduced [4]. Periodic screening exams can include:

- Interval medical history, focusing on changes in health status, illnesses, and possible work-related symptoms. The examining physician should have information about the worker's interval exposure history, including exposure monitoring at the job site, supplemented by worker-reported exposure history and general information on possible exposures at previously worked sites.
- Physical examination.

[1] FEF = forced expiratory flow; MEFR = maximal expiratory flow rate; MVV = maximal voluntary ventilation; FRC = functional residual capacity; RV = residual volume; TLC = total lung capacity.

- Additional medical testing, depending on available exposure information, medical history, and examination results. Testing should be specific for the possible medical effects of the worker's exposure. Multiple testing for a large range of potential exposures is not always useful; it may involve invasive procedures (e.g., tissue biopsy), be expensive, and may produce false-positive results.

  Pulmonary function tests should be administered if the individual uses a respirator, has been or may be exposed to irritating or toxic substances, or if the individual has breathing difficulties, especially when wearing a respirator.

  Audiometric tests. Annual retests are required for personnel subject to high noise exposures (an 8-hour, time-weighted average of 85 dBA[1] or more), those required to wear hearing protection, or as otherwise indicated.

  Vision tests. Annual retests are recommended to check for vision degradation.

  Blood and urine tests when indicated.

Sample Periodic Medical Examination

The basic periodic medical examination is the same as the pre-employment screening (see previous section, *Sample Pre-Employment Examination*), modified according to current conditions, such as changes in the worker's symptoms, site hazards, or exposures.

Termination Examination

At the end of employment at a hazardous waste site, all personnel should have a medical examination as described in the previous sections (see *Sample Pre-Employment Examination*). This examination may be limited to obtaining an interval medical history of the period since the last full examination (consisting of medical history, physical examination, and laboratory tests) if all three following conditions are met:

- The last full medical examination was within the last 6 months.
- No exposure occurred since the last examination.
- No symptoms associated with exposure occurred since the last examination.

If any of these criteria are not met, a full examination is medically necessary at the termination of employment.

Emergency Treatment

Provisions for emergency treatment and acute non-emergency treatment should be made at each site. Preplanning is vital.

When developing plans, procedures, and equipment lists, the range of actual and potential hazards specific to the site should be considered, including chemical, physical (such as heat and/or cold stress, falls and trips), and biologic hazards (animal bites and plant poisoning as well as hazardous biological wastes). Not only site workers, but also contractors, visitors, and other personnel (particularly firefighters) may require emergency treatment.

Emergency medical treatment should be integrated with the overall site emergency response program (see Chapter 12). The following are recommended guidelines for establishing an emergency treatment program.

- Train a team of site personnel in emergency first aid. This should include a Red Cross or equivalent certified course in cardiopulmonary resuscitation (CPR), and first-aid training that emphasizes treatment for explosion and burn injuries, heat stress, and acute chemical toxicity. In addition, this team should include an emergency medical technician (EMT) if possible. Table 5-4 lists signs and symptoms of exposure and heat stress that indicate potential medical emergencies.
- Train personnel in emergency decontamination procedures in coordination with the Emergency Response Plan (see Chapter 12 for details).
- Predesignate roles and responsibilities to be assumed by personnel in an emergency.
- Establish an emergency/first-aid station on site, capable of providing (1) stabilization for patients requiring offsite treatment, and (2) general first aid (e.g., minor cuts, sprains, abrasions).

  Locate the station in the clean area adjacent to the decontamination area to facilitate emergency decontamination.

  Provide a standard first-aid kit or equivalent supplies, plus additional items such as emergency/deluge showers, stretchers, portable water, ice, emergency eyewash, decontamination solutions, and fire-extinguishing blankets.

  Restock supplies and equipment immediately after each use and check them regularly.
- 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, opthalmologist, cardiologist, and neurologist.
- Establish a protocol for monitoring heat stress (see *Monitoring* section of Chapter 8).
- Make plans in advance for emergency transportation to, treatment at, and contamination control procedures for a nearby medical facility.

  Educate local emergency transport and hospital personnel about possible medical problems on site; types of hazards and their consequences; potential for exposure; scope and function of the site medical program.

  Assist the hospital in developing procedures for site-related emergencies. This will help to protect hospital personnel and patients, and to minimize delays due to concerns about hospital safety or contamination.

  For specific illnesses or injuries, provide details of the incident and the worker's past medical history to the appropriate hospital staff. This is especially crucial when specific medical treatment is required, e.g., for exposure to cyanide or organophosphate pesticides.

[1] dBA = decibels on A-weighted scale (29 CFR Part 1910.95).

Table 5-4. Signs and Symptoms of Chemical Exposure and Heat Stress that Indicate Potential Medical Emergencies

TYPE OF HAZARD	SIGNS AND SYMPTOMS
Chemical Hazard	Behavioral changes
	Breathing difficulties
	Changes in complexion or skin color
	Coordination difficulties
	Coughing
	Dizziness
	Drooling
	Diarrhea
	Fatigue and/or weakness
	Irritability
	Irritation of eyes, nose, respiratory tract, skin, or throat
	Headache
	Light-headedness
	Nausea
	Sneezing
	Sweating
	Tearing
	Tightness in the chest
Heat Exhaustion	Clammy skin
	Confusion
	Dizziness
	Fainting
	Fatigue
	Heat rash
	Light-headedness
	Nausea
	Profuse sweating
	Slurred speech
	Weak pulse
Heat Stroke (may be fatal)	Confusion
	Convulsions
	Hot skin, high temperature (yet may feel chilled)
	Incoherent speech
	Convulsions
	Staggering gait
	Sweating stops (yet residual sweat may be present)
	Unconsciousness

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.

- Post conspicuously (with duplicates near the telephones) the names, phone numbers, addresses, and procedures for contacting:

  On-call physicians.
  Medical specialists.
  Ambulance services.
  Medical facility(ies).
  Emergency, fire, and police services.
  Poison control hotline.

- Provide maps and directions.
- Make sure at least all managers and all individuals involved in medical response know the way to the nearest emergency medical facility.
- Establish a radiocommunication system for emergency use.
- Review emergency procedures daily with all site personnel at safety meetings before beginning the work shift.

Non-Emergency Treatment

Arrangements should be made for non-emergency medical care for hazardous waste site workers who are experiencing health effects resulting from an exposure to hazardous substances. In conjunction with the medical surveillance program, offsite medical care should ensure that any potential job-related symptoms or illnesses are evaluated in the context of the worker's exposure. Offsite medical personnel should also investigate and treat non-job-related illnesses that may put the worker at risk because of task requirements (e.g., a bad cold or flu that might interfere with respirator use). A copy of the worker's medical records should be kept at the site (with provisions for security and confidentiality) and, when appropriate, at a nearby hospital. Treating physicians should have access to these records.

Medical Records

Proper recordkeeping is essential at hazardous waste sites because of the nature of the work and risks: employees may work at a large number of geographically separate sites during their careers, and adverse effects of long-term exposure may not become apparent for many years. Records enable subsequent medical care providers to be informed about workers' previous and current exposures.

Occupational Safety and Health Administration (OSHA) regulations mandate that, unless a specific occupational safety and health standard provides a different time period, the employer must:

- Maintain and preserve medical records on exposed workers for 30 years after they leave employment (29 CFR Part 1910.20).

- Make available to workers, their authorized representatives, and authorized OSHA representatives the results of medical testing and full medical records and analyses (29 CFR Part 1910.20).
- Maintain records of occupational injuries and illnesses and post a yearly summary report (29 CFR Part 1904).

Program Review

Regular evaluation of the medical program is important to ensure its effectiveness. Maintenance and review of medical records and test results aid medical personnel, site officers, and the parent company and/or agency managers in assessing the effectiveness of the health and safety program. The Site Safety Officer, medical consultant, and/or management representative should, at least annually:

- Ascertain that each accident or illness was promptly investigated to determine the cause and make necessary changes in health and safety procedures.
- Evaluate the efficacy of specific medical testing in the context of potential site exposures.
- Add or delete medical tests as suggested by current industrial hygiene and environmental data.
- Review potential exposures and Site Safety Plans at all sites to determine if additional testing is required.
- Review emergency treatment procedures and update lists of emergency contacts.

References

1. Proficiency Testing Programs

   Division of Technology Evaluation and Assistance
   Laboratory Program Office
   Center for Disease Control
   Atlanta, GA 30333

   College of American Pathologists
   7400 N. Skokie Blvd.
   Skokie, IL 60077

   American Association for Bioanalysts
   205 W. Levee Street
   Brownsville, TX 78520

2. Costello, R.J. 1983. U.S. Environmental Protection Agency Triangle Chemical Site, Bridge City, Texas. NIOSH Health Hazard Evaluations Determination Report, HETA 83-417-1357.

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