24-Hour Program for Treatment, Storage, and Disposal Facility Personnel

Participant Guide

Acknowledgments

The Midwest Consortium developed this course for Hazardous Waste Worker Training under cooperative agreement number U45 ES 06184 from the National Institute of Environmental Health Sciences.

We encourage you to comment on these materials. Please give your suggestions to those leading the program in which you are now enrolled.

Warning

 The material was prepared for use by instructors experienced in the training of persons who are or who anticipate being employed at a Treatment, Storage, and Disposal facility. Authors of this material have prepared it for the training of this category of workers as of the date specified on the title page. Users are cautioned that the subject is constantly evolving. Therefore, the material may require additions, deletions, or modifications to incorporate the effects of that evolution occurring after the date of this material preparation.

Disclaimer

This training is intended to meet the requirements of the OSHA Hazardous Waste Operations and Emergency Response Final Rule (1910.120 effective March 6, 1990) for Treatment, Storage, and Disposal facility worker. The training program covers basic hazard recognition; use of provided protective equipment; basic control, containment, confinement, and decontamination procedures; other relevant standard operating procedures; and incident termination. It does **not** provide the necessary skills to equip trainees to perform site specific emergency response activities. Additional training is necessary to perform the activities of hazardous materials technicians or specialists. These activities include implementing the emergency response plan, identifying materials using monitoring instruments, selecting protective equipment, and performing advanced control, containment, or confinement.

For further information about this matter, consult the training instructor and/or your company’s safety/emergency response plan, your union health and safety specialist, or the Local Emergency Planning Committee for your city or county.

Content was updated March 27, 2024 and web links are active as of that date. If you find an error, please inform the facilitator so it can be updated.

Table of Contents

INTRODUCTION

The goal of this program is to help meet the training requirements for employees at treatment, storage, and disposal (TSD) facilities who may be exposed to hazardous wastes.

Chapter Objectives

In this introductory session, we will:

- Review the overall objectives of the course
- Describe successful completion and the role of evaluation
- Discuss TSD activities and hazards

Course Objectives

When complete, you will be better able to:

- Recognize hazards that may be present at your work site
- Identify adverse health effects of those hazards
- Use work practices and protective equipment to reduce hazards
- Use written programs such as Standard Operating Guides (SOGs) to control hazards
- Identify federal regulations and agencies that protect your health and safety and that of your fellow employees in hazardous waste site work

Emergency responders at TSD facilities require additional training before being called upon to perform in a real emergency situation. This type of detailed emergency response training is outside the scope of this initial training program.

This program was developed by the Midwest Consortium for Hazardous Waste Worker Training, a group of trainers from nine states dedicated to interactive training to meet the needs of workers. The Consortium receives funding from the federal government (National Institute of Environmental Health Sciences, or NIEHS) to develop and present ‘model’ training programs. By this the government means that we have a certain number of facilitators, include hands-on activities, and include methods to document the value of the training to participants through your feedback. In addition, we are required to define “successful completion” for the participants. This program includes a combination of several measures to obtain successful completion: completion of exercises, full attendance, and 70% on any written items.

Get the Most from Training

- Ask questions
- Participate in small group discussions
- Put your hands on equipment and tools
- Use resources
- Learn from experiences of others

What Is a Hazardous Material?

A **hazardous material** is any substance that may cause damage to people, property, or the environment.

Legal definitions of hazardous materials are found in various environmental laws. Sometimes non-hazardous materials will be considered hazardous when mixed with other materials.

To protect people and the environment, hazardous materials need to be dealt with safely. In the workplace, accidental releases could result from:

- Broken or rusted pipes
- Faulty valves or transfer hoses
- A leaking tank
- Fire
- Inadequate training of workers
- Lack of appropriate standard operating procedures
- Failure to follow the established procedures

Discussion

Your facilitator will lead a discussion of TSD activities that involve hazardous materials.

RIGHTS AND RESPONSIBILITIES

This section covers the basic rights and responsibilities that employers and employees have which help ensure safe working conditions. The focus will be on United States governmental agencies and laws and regulations which apply to hazardous materials' and wastes' treatment, storage, and disposal. Laws and regulations reviewed in this section include:

- Resource Conservation and Recovery Act (RCRA)
- Occupational Safety and Health Act (OSHAct)
- Superfund Amendments and Reauthorization Act of 1986 (SARA)
- Hazardous Waste Operations and Emergency Response (HAZWOPER)

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify the relevant government agencies and some health and safety regulations that they enforce.
- Identify applicable federal health and safety regulations which protect TSD workers.
- Describe key rights and responsibilities workers and employers have under OSHA

Governmental Agencies

Four governmental agencies are directly responsible for the promulgation and enforcement of regulations that concern hazardous materials handling.

Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) is concerned with the protection of U.S. worker health and safety on the job. OSHA administers rules and regulations set forth by the Department of Labor. OSHA is based in Washington, D.C. but has regional and area offices nationwide. Regulations set by OSHA are published in Section 29 of the Federal Register, with Part 1915 reserved for maritime industries, Part 1910 for General Industry, and Part 1926 for the Construction industry.

OSHA programs and responsibilities include:

- Setting legally enforceable standards for safety and health issues
- Inspecting workplaces to assure standards are being met
- Issuing citations and fines to companies who do not meet the standards
- Overseeing state plans for safety and health

Environmental Protection Agency

The Environmental Protection Agency (EPA) is concerned with the quality of the environment outside the workplace, including the air, land, and water. The EPA published regulations to define what is a hazardous waste generator, transporter, and a treatment, storage, or disposal facility for hazardous waste. It created identification and reporting systems so that the government can track the quantities and types of hazardous waste being generated and confirm their proper handling. Regulations set by the EPA are published in Section 40 of the Federal Register, Parts 200–400. The EPA is responsible for the Resource Conservation and Recovery Act (RCRA) which is covered in detail below.

The Federal EPA has delegated the enforcement of its regulations to state EPA agencies. Some states don't even call their agency EPA. Some call them DNR (Department of Natural Resources) or DEM (Department of Environmental Management). The TSD facility has to follow all the Federal EPA regulations, but the state where waste is accepted may create additional regulations. Some states have regulated other wastes in addition to EPA hazardous wastes, and they are called "special wastes." Examples of special wastes that come under state-by-state rules are waste oils and asbestos abatement waste.

Department of Transportation

The Department of Transportation (DOT) is concerned with the transfer of hazardous materials through interstate commerce. Hazardous materials that are being transferred by road are under the jurisdiction of the DOT. Regulations set by the DOT are published in Section 49 of the Federal Register, Parts 100–200.

United States Coast Guard

The United States Coast Guard (USCG) is responsible for monitoring the transportation of hazardous materials across navigable waterways and preserving our bodies of water.

Summary of Governmental Agencies

OSHA — Occupational Safety and Health Administration. Mandate (Purpose): Protects workers in industry, on construction sites, maritime, and shipbuilding.

EPA — Environmental Protection Agency. Mandate (Purpose): Protects environment (air, land, soil, and water). Protects citizens' health.

DOT — Department of Transportation. Mandate (Purpose): Protects roadways and transportation of hazardous materials.

USCG — United States Coast Guard. Mandate (Purpose): Protects the waterways and waterway spills.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) was established in 1976 to regulate the management and disposal of hazardous materials and wastes.

The EPA says a hazardous waste is a waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, ranging from industrial manufacturing process wastes to batteries and may come in many forms, including liquids, solids gases, and sludges. The EPA has developed a Hazardous Waste regulatory definition and also a process that identifies specific substances known to be hazardous. For additional information see: EPA Learn the Basics of Hazardous Waste

RCRA gave the EPA the jurisdiction and responsibility to create and enforce the regulations regarding the proper handling, labeling, storing, treating, and disposing of hazardous waste. RCRA regulations were amended in 1984 to cover underground storage tanks and ban certain wastes from landfills.

According to RCRA regulation 40 CFR Part 260.10, the functions of a Treatment, Storage, and Disposal facility are as follows:

- **Treatment:** Any method, technique, or process designed to change any hazardous waste in order to neutralize it, or make it non-hazardous or less hazardous. The results of treatment could include recovering the hazardous waste or making it safer to transport, store, or dispose of.
- **Storage:** The holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere.

- **Disposal:** Disposal methods include those in which the hazardous waste treated material could enter the environment without posing a threat. Methods could consist of discharge, deposit, injection, dumping, spilling, or leaking.

40 CFR Part 260.10

This number refers to the standardized system the federal government uses to index all its regulations.

- 40 = Environmental protection regulations are located in **40**
- CFR = Code of Federal Regulations is the title of the government publication
- 260.10 = Part number **260.10** denotes the specific standard. EPA regulations are located in parts 200.01-400

Regulations concerning treatment, storage, and disposal facilities are mainly found in 40 CFR Part 264–265. Regulations found in Part 264 Subparts F through X primarily deal with design and operating criteria (technical requirements) that must be met for facilities to get a permit. Part 265, Subparts F through X, covers facilities that have interim status permits and what is required of them (technical requirements).

Topics covered in Subparts F through X include:

- Groundwater protection requirements
- The use and management of containers
- The use and management of tank systems and incinerators

The administrative and non-technical requirements found in Parts 264 and 265 provide important information used in this training program. These requirements necessitate the proper establishment of procedures for the safe operation of the facility. The requirements are delineated in Subparts A–E of 40 CFR 264 and 265. The following table outlines the contents of subparts A–E of the RCRA regulations Parts 264–265.

Subpart Content of Section

- Who does the regulation apply to?
- General facility standards
  - Waste analysis
  - Security
  - Inspections
  - Training
  - Ignitable, reactive, or incompatible wastes
  - Local standards
- Preparedness and prevention
- Contingency plans and emergency procedures
- Manifest system, recordkeeping, and reporting

Who Does the Regulation Apply to?

Subpart A of the regulations specifies who is subject to the regulations. Conditions for exclusion range from being a farmer disposing of pesticides from his or her own use to transporters who store regulated shipments for less than 10 days.

General Facility Standards

Subpart B includes the following regulations:

- A waste analysis must be conducted prior to treatment, storage, or disposal. Detailed chemical and physical analysis must be performed. A written waste analysis plan that specifies tests and test frequencies must also be developed.
- The facility must be secured against entry by unauthorized personnel. Additionally, facilities must take precautions to secure the facility against fires, explosions, and generation of toxic gases.
- A written inspection schedule must be developed and followed. All findings of the inspection must be kept on file for three years.
- Workers must be trained for their jobs, records of training must be kept, and refresher training must be conducted.
- All ignitable or reactive wastes must be protected from sources of ignition or reaction, and incompatibility must be addressed in the storage of materials.
- Local standards may apply, especially to new facilities. Local standards might prohibit a facility from being located next to an earthquake fault or in a flood plain.

Preparedness and Prevention and Emergency Procedures

The regulations in Subparts C and D require that TSD facilities be prepared for emergencies that may occur. This important area will be covered in detail in the Emergency Response section of this manual.

Manifest System, Recordkeeping, and Reporting

A manifest is a document describing the waste. The manifest system for tracking hazardous materials is established in 40 CFR, Part 262. Facilities are required to return manifests to the hazardous waste generator in order to document the cycle of hazardous materials from their creation to their disposal. The manifest system will be described in more detail in the Hazard Recognition section of this manual.

Subpart E also specifies the necessity for records of plant operation and the availability, retention, and disposition of the records. This subpart also specifies that the facility must report releases and other occurrences to the EPA.

Employer Rights and Responsibilities Under RCRA

The previous sections have shown the RCRA requirements for owners and operators of facilities in order to protect the environment. A summary of employer requirements for protecting worker health and safety includes:

- All TSDF workers must receive training.
- A written plan for emergencies must be developed and implemented by the employer.
- Hazardous wastes must be handled, transported, treated, stored, and disposed of according to strict guidelines which would protect workers and the environment.

Employee Responsibilities

In order for RCRA regulations to be effective, the employee must:

- Follow procedures developed to prevent hazardous wastes from being released into the air, soil, or water.
- Tell his or her employer if waste handling procedures are not being followed.

Enforcement of Regulations

The EPA has several different enforcement options if there are violations of its regulations.

These options include:

- Informal actions
- Administrative orders
- Civil actions
- Criminal actions

Informal Actions

For relatively non-serious violations of RCRA standards, a warning letter may be issued. This letter will specify what corrective action needs to be taken and by what date, and it will warn of possible consequences if no action is taken.

Administrative Orders

For more serious violations, or when the operator of the TSDF doesn't respond to the informal actions, the EPA can issue an administrative order. These orders can force the facility to:

- Comply with specific regulations
- Take corrective action
- Perform monitoring, testing, or analysis of specific chemicals or hazards
- Address a threat to human health or the environment

Failure by the facility to comply with administrative orders by a mandatory date can result in penalties of up to **$25,000 for each day** the violation is not corrected.

Civil Actions

A civil action means a formal lawsuit is filed against a facility which has failed to comply with some legal requirements or administrative order. A civil action can also be filed against a facility which has contributed to the release of hazardous wastes or constituents. Civil actions are generally used where repeated or significant violations of the regulations have occurred or where there are significant environmental concerns.

Criminal Actions

These actions are the most serious the EPA can bring against a facility. Conviction can result in fines as well as imprisonment of the responsible parties. Section 3008 of the Resource Conservation and Recovery Act lists seven acts that carry criminal penalties ranging from a fine of **$50,000 per day** or a prison sentence of up to **five years** to a total fine of **$1,000,000**.

The seven criminal acts involve knowingly:

- Transporting waste to a non-permitted (unapproved) facility.
- Treating, storing, or disposing of waste without a permit or being in violation of a material condition of a permit or interim status standard.
- Omitting important information from, or making a false statement in, a label, manifest, report, permit, or compliance document.
- Generating, storing, treating, or disposing of waste without complying with RCRA's recordkeeping and reporting requirements.
- Transporting waste without a manifest.

- Exporting a waste without the consent of the receiving country.
- Transporting, treating, storing, disposing, or exporting any hazardous waste in such a way that another person is placed in imminent danger of death or serious bodily injury.

OSHAct and OSHA

The Occupational Safety and Health Act (OSHAct) of 1970 is a major law concerned with U.S. worker health and safety. It was passed to prevent workers from being killed or seriously harmed at work. The law requires employers to provide their employees with working conditions that are free of known dangers. The Act created the Occupational Safety and Health Administration (OSHA), which sets and enforces protective workplace safety and health standards. OSHA also provides information, training and other assistance to workers and employers. Regulations set by OSHA are published in Section 29 of the Federal Register, with Part 1915 reserved for maritime industries, Part 1910 for general Industry, and Part 1926 for the construction industry. Following passage of SARA, OSHA developed the HAZWOPER standard.

OSHA covers private sector employers of all sizes in all 50 states, the District of Columbia, and other U.S. jurisdictions. Small employers (fewer than 10 employees) are exempted from some injury record-keeping requirements (29 CFR 1904). Laws are administered by federal OSHA or through an OSHA-approved state program. State-run health and safety programs must be at least as effective as the Federal OSHA program. To find the contact information for the OSHA Federal or State Program office nearest you, see the Regional and Area Offices map at http://www.osha.gov/html/RAmap.html.

Employees who work for state and local governments are not covered by Federal OSHA, but have OSHAct protections if they work in a state that has an OSHA-approved state program. Four additional states and one U.S. territory have OSHA approved plans that cover public sector employees only: Connecticut, Illinois, New Jersey, New York, and the Virgin Islands. Private sector workers in these four states and the Virgin Islands are covered by Federal OSHA.

Federal agencies must have a safety and health program that meets the same standards as private employers. Although OSHA does not fine federal agencies, it does monitor federal agencies and responds to worker complaints.

Those not covered by the OSHAct include the self-employed, immediate family members of farm employers that do not employ outside employees, and employees at workplaces regulated by another Federal agency (for example, the Mine Safety and Health Administration, the Federal Aviation Administration, the Coast Guard).

In addition to setting standards, OSHA is charged with:

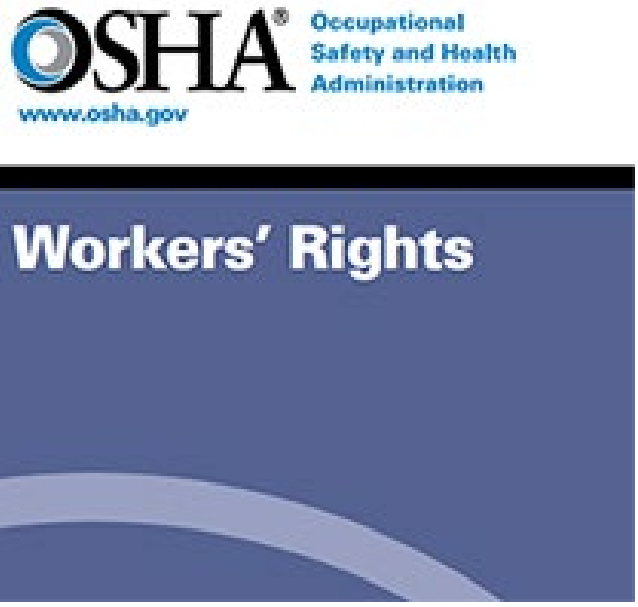
- Inspecting workplaces to ensure standards are being met
- Issuing citations and fines to companies that do not meet the standards
- Overseeing state plans for safety and health
- Encouraging the development of training programs for workers, management, and health professionals

Rights and Responsibilities Under OSHA

Workers and employers have a number of rights and responsibilities under the Act.

Worker Rights

Workers have a number of rights and responsibilities under OSHA. Detail is shown at the OSHA website, www.osha.gov - click on "You have the Right to a Safe Workplace." See also Workers' Rights booklet at https://www.osha.gov/Publications/osha3021.pdf:



A brief summary follows.

Worker Right to Have an Inspection of a Workplace

A worker can notify OSHA of a potential hazard by completing the OSHA Notice of Alleged Safety or Health Hazards form, below. This is often called a 'complaint form'. Once a complaint is received at the OSHA Office, it will be assigned to one of their compliance officers.

The inspection priority defined by OSHA is:

- Imminent danger
- Catastrophic (a fatality or three or more workers are hospitalized overnight as a result of an on-the-job exposure)
- Complaint inspection (filed by a worker or worker representative)
- Scheduled inspection (general OSHA inspection not because of a complaint or catastrophe, but because injury statistics show that the employer has more injuries and illness than similar employers)
- General inspection or "pick of the hat." (Previously inspected sites are pooled, and, through random selection, two sites are drawn and visited in a given year)

Note that complaints are high on the priority list. The form is shown at the end of this section on Rights. It can be anonymous (by mail or telephone) or can be completed online (https://www.osha.gov/workers/file_complaint.html).

Worker Right to Participate in the OSHA Walk-Around Inspection

Through an employee organization such as a union, an employee representative is designated to accompany the OSHA compliance officer in the walk-around inspection. It should be noted that OSHA regulations currently do not require the employer to pay the employee for time spent on the OSHA walk-around; however, some states with an OSHA plan require employees to be paid for the time spent during a walk-around. Walk-around activities include all opening and closing conferences related to the conduct of the inspection but do not include any post-citation appeal procedures.

Worker Right to Be a Witness or to Give Information

Every employee has the right to appear as a witness at an OSHA hearing. During the walk around inspection, or before or after the inspection for that matter, any employee has the right to provide OSHA with any information regarding possible safety and health hazards. This right is protected by law.

Worker Right to Be Informed of Imminent Dangers

All employees have the right to be informed by the OSHA compliance officer if it is determined that they are exposed to an imminent danger (one which could cause death or serious injury now or in the near future). The compliance officer will also ask the employer to stop the work process voluntarily and remove the employees. If the employer refuses to stop the work process upon the request of the compliance officer, a judge can force the employer to do so if necessary.

Worker Right to Be Told About Citations

Notices of OSHA citations must be posted in the workplace near the site where the violation occurred and must remain posted for three days or until the hazard is corrected, whichever is longer. Citations and penalty notification forms are, in general, available upon request from the OSHA Area Office. When an OSHA industrial hygiene inspection has taken place, the hygienist's report, which includes substances collected, procedure used, and measurement results, may also be obtained by the employees, their representatives, or their union upon request.

Worker Right to Appeal OSHA Performance

If OSHA fails to perform in a responsible and timely manner, the employees, employer, or union has the right to meet with the OSHA Area Director and the OSHA Regional Administrator. Any of the groups may ultimately appeal to the Secretary of Labor.

Worker Right to Appeal Abatement Dates (When a Violation Must Be Fixed)

The findings of the OSHA officer may be appealed within 15 working days of the issuance of the citation to the employer. The right to contest the citation is limited only to the question of the reasonableness of the abatement period of the citation. Employees or their organization cannot contest the penalty amount or the citation itself.

Worker Right to Have a Closing Conference After an Inspection

Employees have the right to meet privately with the OSHA officer and discuss the results of the inspection. OSHA procedures state that the OSHA inspector shall inform the employers and employees that a generally responsive discussion covering general issues will be held.

Worker Right to Know of Hazards

Workers have the right to information and training about hazards, methods to prevent harm and that OSHA standards that apply in the workplace. The training must be in a language and vocabulary understandable by the workers.

Employees have the right to be notified if exposed to occupational health hazards and to be notified of the results of occupational health studies conducted by the employer or OSHA officers. The employees or the employee organization can and should ask for all instrument readings or levels of contaminants investigated. A copy of the lab report should also be requested from OSHA. These documents are normally available upon request and may also be obtained by any member of the public pursuant to the Freedom of Information Act.

Worker Right to Have Access to OSHA Records

Generally, most OSHA records are available upon request. The employees, or their organization, should contact the OSHA Area Office where the plant is located.

Worker Right to Participate in Development of New Standards

Every employee has the right to participate in the development of new safety and health standards or modification of old codes through his or her employee organization. Individuals may also comment on proposed standards during open periods of comment.

Worker Right to Review a Citation Procedure When a Citation Is Not Issued

Every employee has the right to request an informal review when a citation is not issued or for any other issue related to an inspection, citation, notice of proposed penalty, or notice of intention to contest a citation. A written statement as to why a citation was not issued in particular instances may be requested.

Worker Right to File a Discrimination Complaint

If an employee has been discriminated against after exercising rights under OSHA, that employee has the right to file a complaint with the OSHA Area Office within 30 days. This time limit is strictly enforced. Similar rights to file a complaint may exist with state and local anti-discrimination agencies, as well as the employee organization.

U. S. Department of Labor
Occupational Safety and Health Administration
Notice of Alleged Safety or Health Hazards

For the General Public:

This form is provided for the assistance of any complainant and is not intended to constitute the exclusive means by which a complaint may be registered with the U.S. Department of Labor.

Sec 8(f)(1) of the Williams-Steiger Occupational Safety and Health Act, 29 U.S.C. 651, provides as follows: Any employees or representative of employees who believe that a violation of a safety or health standard exists that threatens physical harm, or that an imminent danger exists, may request an inspection by giving notice to the Secretary or his authorized representative of such violation or danger. Any such notice shall be reduced to writing, shall set forth with reasonable particularity the grounds for the notice, and shall be signed by the employee or representative of employees, and a copy shall be provided the employer or his agent no later than at the time of inspection, except that, upon request of the person giving such notice, his name and the names of individual employees referred to therein shall not appear in such copy or on any record published, released, or made available pursuant to subsection (g) of this section. If upon receipt of such notification the Secretary determines there are reasonable grounds to believe that such violation or danger exists, he shall make a special inspection in accordance with the provisions of this section as soon as practicable to determine if such violation or danger exists. If the Secretary determines there are no reasonable grounds to believe that a violation or danger exists, he shall notify the employees or representative of the employees in writing of such determination.

NOTE: Section 11(c) of the Act provides explicit protection for employees exercising their rights, including making safety and health complaints.

For Federal Employees:

This report format is provided to assist Federal employees or authorized representatives in registering a report of unsafe or unhealthful working conditions with the U.S. Department of Labor.

The Secretary of Labor may conduct unannounced inspections of agency workplaces when deemed necessary if an agency does not have occupational safety and health committees established in accordance with Subpart F, 29 CFR 1960; or in response to the reports of unsafe or unhealthful working conditions upon request of such agency committees under Sec. 1-3, Executive Order 12196; or in the case of a report of imminent danger when such a committee has not responded to the report as required in Sec. 1-201(h).

Instructions:

Open the form and complete the front page as accurately and completely as possible. Describe each hazard you think exists in as much detail as you can. If the hazards described in your complaint are not all in the same area, please identify where each hazard can be found at the worksite. If there is any particular evidence that supports your suspicion that a hazard exists (for instance, a recent accident or physical/health symptoms of employees at your site) include the information in your description. If you need more space than is provided on the form, continue on any other sheet of paper.

After you have completed the form, return it to your local OSHA office, found at https://www.osha.gov.

NOTE: It is unlawful to make any false statement, representation or certification in any document filed pursuant to the Occupational Safety and Health Act of 1970. Violations can be punished by a fine of not more than $10,000. or by imprisonment of not more than six months, or by both. (Section 17(g))

Paperwork Reduction Act Statement:

Public reporting burden for this voluntary collection of information is estimated to vary from 15 to 25 minutes per response with an average of 17 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An Agency may not conduct or sponsor, and persons are not required to respond to the collection of information unless it displays a valid OMB Control Number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Directorate of Enforcement Programs at DEP.PRA@dol.gov.

OMB Approval# 1218-0064; Expires: 07-31-2024

Do not send the completed form to this Office.

U. S. Department of Labor
Occupational Safety and Health Administration
Notice of Alleged Safety or Health Hazards

			Complaint Number	
Establishment Name				
Site Address				
	Site Phone		Site Fax	
Mailing Address				
	Mail Phone		Mail Fax	
Management Official			Telephone	
Type of Business				

HAZARD DESCRIPTION/LOCATION. Describe briefly the hazard(s) which you believe exist and on what date you last observed the hazard(s). Include the approximate number of employees exposed to or threatened by each hazard. Specify the particular building or worksite where the alleged violation exists.

Has this condition been brought to the attention of:	☐ Employer	☐ Other Government Agency (specify):

The OSH Act gives employees and employee representatives the right to request that their names not be revealed to their employer. Providing your name and address will only allow OSHA staff to communicate with you regarding your complaint. Please Indicate Your Desire:	☐ Do NOT reveal my name to my Employer ☐ My name may be revealed to the Employer
The Undersigned believes that a violation of an Occupational Safety or Health standard exists which is a job safety or health hazard at the establishment named on this form. (Mark "X" in ONE box).	☐ Former Employee ☐ Current Employee ☐ Representative of Employees ☐ Federal Safety and Health Committee ☐ Other (specify)

Complainant Name		Telephone	
Address (Street, City, State, Zip)			
Email Address			
Signature		Date	

If you are an authorized representative of employees affected by this complaint, please state the name of the organization that you represent and your title:

Organization Name:	Your Title:

Worker Responsibilities

Worker Responsibility to Abide by Established Safety Rules

Workers cannot be cited or fined by OSHA, but employers can take disciplinary action for violation of established safety rules.

Worker Responsibility to Wear and/or Use Required Safety Equipment

Workers are responsible for wearing and/or using required safety equipment.

Worker Responsibility to Seek Prompt Medical Treatment When Required

Workers should seek medical treatment promptly when required. Depending on applicable state law, workers have a right to be treated by a physician of their own choice for work-related injuries. The key here is not to delay medical treatment when necessary.

Worker Responsibility to Bring Safety and Health Concerns to the Attention of Management

Workers should bring safety and health hazards or concerns to the attention of their supervisors or forepersons as soon as possible. If the workers are organized, then they may want to ask the representative to bring the issue to the attention of management.

Worker Responsibility to Pay for Gear That Can Be Worn Off the Job

Workers will have to pay for ordinary safety-toed footwear, ordinary prescription safety eyewear, logging boots, and ordinary clothing and weather-related gear that can be worn off the job.

Employer Rights and Responsibilities

The OSHA publication shown below may be useful. See also the summaries below.

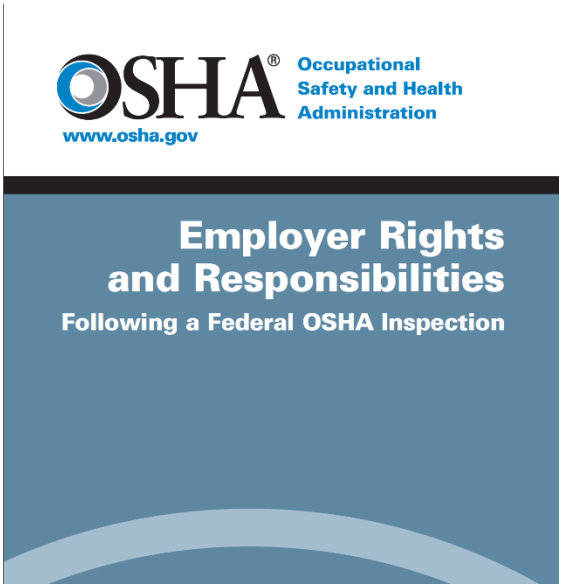


Image from: https://www.osha.gov/Publications/osha3000.pdf

Employer Rights

Employer Rights following an OSHA inspection

If a worksite inspection is conducted, the employer has rights to an informal conference to discuss the apparent violations, to contest the citation and to petition for a modification of abatement dates. See https://www.osha.gov/Publications/fedrites.html.

Employer Responsibilities

Employer Responsibility to Furnish a Safe and Healthy Job and Work Environment

The employer must furnish each employee a job and a place of employment free from recognized hazards that are likely to cause death or serious physical harm. This responsibility is commonly referred to as the “general duty clause” of the Act. It describes the overall or general responsibility of the employer not to expose employees to harmful situations or chemicals.

Employer Responsibility to Pay for Personal Safety Equipment

The employer must pay the full cost for almost all required personal protective equipment (PPE) used to comply with OSHA standards with the exception of safety shoes and prescription safety eyewear that may be used off the jobsite.

Employer Responsibility to Comply with OSHA Standards

Employers must comply with applicable parts of the OSHA General Industry Standards and the Construction Industry Standards. Several relevant standards are shown below:

The General Industry Standards cover most production industries and have other important requirements in addition to HAZWOPER (29 CFR 1910.120) that may apply at your worksite. These standards include:

1910.38	Emergency Action Plans
1910.119	Process Safety Management of Highly Hazardous Chemicals
1910.132	Personal Protective Equipment
1910.134	Respiratory Protection
1910.146	Permit-Required Confined Space
1910.147	The Control of Hazardous Energy (Lock-Out/Tag-Out)
1910.156	Fire Brigades
1910.165	Employee Alarm Systems
1910.1000	Permissible Exposure Limits on Airborne Toxic Substances
1910.1020	Employee Access to Exposure and Medical Records
1910.1200	The Hazard Communication (Right-to-Understand) Standard
1910.1201	Retention of DOT Markings, Placards and Labels

The Construction Standards cover activities such as earth-moving and construction of scaffolds and structures. Specific parts of the Construction Standards which may apply to emergency response operations include:

1926.55	Permissible Exposure Limits on Airborne Toxic Substances
1926.59	Right-to-Know (Hazard Communication) Standard
1926.65	HAZWOPER
1926.102	Eye and Face Protection
1926.150	Fire Protection and Prevention
1926.300	Hand and Power Tool Safety
1926.651	Excavations

Employer Responsibility to Report Fatalities and Injuries

Employers must inform OSHA of any fatality within 8 hours of the event. The employer must inform OSHA of any injury requiring inpatient hospitalization, an amputation, or any loss of an eye within 24 hours.

Employer Responsibility to Maintain Records of Injuries

Under the OSHAct, all employers with more than 10 employees must maintain a log of injuries and make it available to OSHA compliance officers upon request. Each year the employer must post an annual summary of the injury log for the information of the employees. This form is called the OSHA 300A and must be displayed each year for the months of February, March, and April. A portion of the form is shown on the following two pages.

Employers are required to record information about specific occupational injuries and illnesses. Every occupational death and non-fatal illness must be recorded on the OSHA log. Other non-fatal injuries which must be recorded include loss of consciousness, restriction of work motion, transfer to another job, or medical treatment other than First Aid.

Contact the local OSHA office with questions about recordable illnesses and injuries.

Employer Responsibility to Post Information

The official OSHA *Job Safety and Health – It's the Law* poster that describes rights and responsibilities must be posted prominently in the workplace at all times. Download it here: https://www.osha.gov/Publications/poster.html.

Any citation for apparent violations received from OSHA must be posted until the items are resolved where workers can see each page.

The annual summary of injury and illness data must be posted where workers can see the form during the months of February, March and April of each year.

Employer Responsibility to Not Retaliate

If a worker exercises rights under the law, including the right to report a work-related injury or illness, the employer must not retaliate.

See also https://www.osha.gov/as/opa/worker/employer-responsibility.html.

OSHA's Form 300A

Summary of Work-Related Injuries and Illnesses

All establishments covered by Part 1904 must complete this Summary page, even if no work-related injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and accurate before completing this summary.

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the Log. If you had no cases, write "0."

Employees, former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR Part 1904.35, in OSHA's recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
_____ (G)	_____ (H)	_____ (I)	_____ (J)

Number of Days

Total number of days of job transfer or restriction	Total number of days away from work
_____ (K)	_____ (L)

Injury and Illness Types

Total number of . . .
(M)

(1) Injuries _____
(2) Skin disorders _____
(3) Respiratory conditions _____
(4) Poisonings _____
(5) All other illnesses _____

Post this Summary page from February 1 to April 30 of the year following the year covered by the form.

Public reporting burden for this collection of information is estimated to average 50 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave., NW, Washington, DC 20210. Do not send the completed forms to this office.

OSHA's Form 300A

Summary of Work-Related Injuries and Illnesses

Establishment information

Your establishment name_____

Street _____

City _____ State _____ Zip _____

Industry description (e.g., Manufacture of motor truck trailers)
_____

Standard Industrial Classification (SIC), if known (e.g., SIC 3715) __ __ __ __

Employment information *(If you don't have these figures, see the Worksheet on the back of this page to estimate.)*

Annual average number of employees _____

Total hours worked by all employees last year _____

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

_____
Company executive Title

(_____)_____
Phone Date

Superfund Amendments and Reauthorization Act (SARA)

The Superfund Amendments and Reauthorization Act (SARA) was passed by Congress in 1986 to improve the Environmental Protection Agency's authority at safeguarding of the health and safety of workers and the community at large. It is made up of three separate sections or "Titles." Titles I and III deal with emergency response and planning, whereas Title II concerns a fund for hazardous waste clean-up. In brief, the Titles require the following:

Title I

- Training of emergency response personnel and workers at hazardous waste operation sites (HAZWOPER)
- Preparation of a written emergency response plan for companies where hazardous materials may be spilled or released
- Proper procedures for handling emergency response operations

Title II – Not applicable at this time

Title III (Community Right-to-Know)

- Development of comprehensive community emergency plans by Local Emergency Planning Committees (LEPCs)
- Reporting of certain chemical inventory and release information to fire departments, LEPCs, and the State Emergency Response Commission (SERC)

HAZWOPER - Hazardous Waste Operations and Emergency Response

SARA TITLE I required the Occupational Safety and Health Administration (OSHA) to develop a standard to protect emergency response personnel. That standard is commonly called HAZWOPER (Hazardous Waste Operations and Emergency Response) or 1910.120.

29 CFR 1910.120 refers to where the standard is found in federal regulations. This number refers to the standardized system the Federal government uses to index all its regulations. The system is similar to how books are catalogued in the library or to how auto parts are numbered so they can be located more easily.

Requirements for TSD Facilities		
		29 CFR 1910.120
29	=	OSHA regulations are located in Part **29**
CFR	=	*Code of Federal Regulations* is the title of the government publication
1910	=	Part number **1910** covers General Industry
.120	=	Section number **120** covers hazardous waste operations and emergency response
(p)	=	Applies specifically to TSD facilities
(8)	=	Training

Safety and Health Program

The employer must have a written safety and health program for employees involved in hazardous waste operations. The program must be available for inspection by employees, their representative(s), and OSHA personnel.

This program must also be designed to identify, evaluate, and control safety and health hazards in the facility. The safety and health program must also address emergency response.

Hazard Communication Program

Employers must have a hazard communication program that meets the requirements of 29 CFR 1910.1200, which will be discussed in detail later.

Medical Surveillance Program

The employer must have a medical surveillance program that meets the requirements of paragraph (f) of HAZWOPER. This requirement will be discussed in detail in the Health Hazard Recognition section of this manual.

Decontamination Program

The employer must have a decontamination program that meets the requirements of paragraph (k) of HAZWOPER. This section of the standard describes the following in detail:

- Decontamination procedures
- Decontamination location
- Equipment and solvents
- Personal protective equipment and clothing
- Unauthorized employees

These requirements are discussed in more detail later in this manual.

New Technology Program

The employer must meet the requirements under paragraph (o) for introducing new and innovative equipment developed for worker protection into the workplace.

Material Handling Program

For employees handling drums or containers, the employer must meet the requirements in paragraphs (j) (1) (ii) through (viii) and (xi), as well as (j) (3) and (j) (8). These sections cover the following issues:

- General material handling requirements
- Equipment used to transfer drums and containers
- Shipping and transport

These requirements will be covered in detail later.

Training Program

The employer must have a training program implemented into the safety and health program. Specific requirements are established for new employees, current employees, and trainers who will teach the initial training courses. New employees must receive 24 hours of training plus 8 hours of refresher training each year.

Current employees and those with equivalent work and/or training experience are exempt from the 24-hour requirements but not the 8 hours of refresher training.

Emergency Response Program

An emergency response plan must be developed by all employers. OSHA considers an "emergency" to exist when outside, non-maintenance personnel are called in to assist.

The plan must include the following information:

- Specific elements of an emergency response plan
- Training for emergency response employees
- Procedures for handling emergency incidents

Note: This training program may not qualify you to engage in emergency response at your facility. Additional industrial emergency response training is required tailored to your response duties.

Exceptions

- All facilities which treat, store, or dispose of hazardous waste are required to comply with the previously mentioned eight programs except:
- Large-quantity generators which store materials for less than 90 days comply only with the requirements for an emergency response plan.
- Small-quantity generators which have emergency response teams are required to have only an emergency response plan.
- Generators of wastes which do not have emergency response teams are required to have either an emergency response plan or emergency action plan [1910.38(a)].

More Specific OSHA Regulations

Other OSHA regulations have a direct impact on worker health and safety at a TSD facility. The Hazard Communication Standard, the Employee Access to Medical Records and Environmental Exposure Data Standard, and the Air Contaminants Standard will be discussed in this section.

Hazard Communication Standard

Hazardous wastes are **not** covered by the Hazard Communication Standard 1910.1200. See (b) (5) (i); however, your employer must have a hazard communication program for all hazardous materials that are not hazardous wastes. OSHA's Hazard Communication Standard was enacted for three major reasons:

- To ensure that the hazards of manufactured and imported chemicals are evaluated
- To ensure that information regarding chemical hazards in the workplace is related to employees
- To pre-empt state laws covering hazard communication

The Hazard Communication Standard consists of four primary sections:

- A written hazard communication program
- Labeling requirements
- Safety data sheets
- Employee information and training

Written Hazard Communication Program

This program must include the following:

- A written hazard communication program available to employees, designated representatives, OSHA, and the National Institute for Occupational Safety and Health (NIOSH) describing how the employer will comply with the Hazard Communication Standard
- A section covering container labeling, Safety Data Sheets (SDS), and employee training
- A list of hazardous chemicals in each work area

Labels

Regulations for labels include the following:

- Labels must be attached to the containers by the manufacturer, importer, or distributor of the shipped container
- The identity (chemical and common names), a hazard warning, and the name and address of the manufacturer must be printed on the label
- Employers must ensure that each container of hazardous chemicals in the workplace is labeled except for portable containers used by a single employee to transfer the chemical
- Piping systems and pipes are exempt from a labeling requirement

Safety Data Sheets

The following requirements concern Safety Data Sheets:

- Manufacturers, employers, and distributors must forward SDSs to an employer at the time of initial shipment.
- Employers are required to obtain and maintain SDSs for each hazardous chemical in their workplace.
- SDSs must include information on identity, physical and chemical characteristics, health effects, exposure limits, precautionary measures, emergency and first aid procedures, date of preparation, and identification of the party responsible for the SDS.
- SDSs must be filled out completely and accurately.
- New information must be incorporated on SDSs within three months.
- Copies of SDSs must be immediately accessible in the workplace for employees, designated representatives, OSHA, and NIOSH.

Employee Information and Training

Employees must be informed and trained by their employer according to the following guidelines:

- Training must take place at initial assignment and when new hazards are introduced.
- Education must include the requirements of the OSHA Hazard Communication Standard.
- Employees must be informed as to the location of their employer's written Hazard Communication Program, SDSs, and hazardous chemical lists.
- Employees must be made aware of specific chemical hazards in their work area.
- Employees must be taught how to read and interpret information on labels and SDSs.

Employee Access to Medical Records and Environmental Exposure Data Standard

This standard provides workers and their designated representatives access to medical test results, physician comments, air monitoring, and noise survey results. The monitoring data must be maintained for at least 30 years. The requirement is found in 1910.1020.

Air Contaminants Standard

The Air Contaminants Standard sets worker exposure limits for eight-hour workdays, as well as for 15-minute, short-term exposures. This part of the OSHA Standards, found in 1910.1000 and higher-numbered sections, is described more in the Monitoring section of this manual.

Other Regulations

The following are other important regulations that address the issues of worker health and safety and/or hazardous substances.

Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (HMTA, 1975) gave the Department of Transportation authority to regulate transport of hazardous materials.

Toxic Substance Control Act

The Toxic Substance Control Act (TSCA, 1976) required evaluation of chemicals before they are sold. This act created a list of reviewed harmful substances that require precautions and safe work practices by the community as well as industry.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 1980), also known as Superfund, authorized government money for clean-up of abandoned hazardous waste sites. The act also authorized clean-up and emergency response to transportation incidents involving chemical releases and payment to injured or diseased citizens. The act was amended in 1986 to create SARA (the Superfund Amendments and Reauthorization Act).

Exercise

You are a member of an employer-employee safety and health committee. The committee has decided to review all employer safety and health programs to make certain that they meet or exceed all existing safety and health regulations and laws. You have made up a list of questions or concerns, and your job is now to check them out and report back to the entire committee.

Instructions:

You will now meet as a committee to go through the following checklist, to determine (i) what sets of laws or regulations apply (there may be more than one), and (ii) where you would go to obtain copies or more information about those laws and regulations.

Someone in your small group should act as spokesperson and report back to the class.

Areas for Investigation

1) Are all manifests for incoming hazardous waste materials properly completed? Who checks this out? Where are the manifests stored?

2) What regulations govern respirators for routine or emergency use?

3) Your facility is located near a grain elevator on a Great Lake port. Who would you notify if an accidental release occurred?

4) Where could you find regulations which govern the safe handling of 55- gallon drums at your facility which contain hazardous wastes?

5) List as completely as possible which regulations govern training of workers. For each regulation, what type of training does it require?

6) Who is responsible for obtaining Safety Data Sheets when you receive cleaning and lubricating products? Where should these Safety Data Sheets be located?

7) What safety and health records that an employer maintains can an employee request?

Summary – Rights and Responsibilities

There are a variety of federal and state agencies with various laws and regulations which bear directly on worker safety and health. Federal agencies include the Occupational Safety and Health Administration, the Environmental Protection Agency, and the Department of Transportation.

Important regulations that have a direct impact on TSD workers include:

- RCRA
- SARA
- HAZWOPER
- OSHAct

RCRA was established in 1976 to regulate the management and disposal of hazardous materials and wastes. RCRA gave the Environmental Protection Agency (EPA) the jurisdiction and responsibility to create and enforce the regulations regarding the proper handling, labeling, storing, treating, and disposal of hazardous waste.

SARA is a law which includes provisions for training of emergency responders as well as:

- Continues “Superfund” for clean-up of hazardous waste sites
- Develops state and local emergency response plans and committees

HAZWOPER is an OSHA regulation developed in response to SARA to protect the health and safety of TSD workers and emergency response personnel.

The **OSHAct** establishes both employee and employer rights and responsibilities. A major employer responsibility is to furnish a workplace free of recognized safety and health hazards likely to cause serious physical harm. A major employee responsibility is to follow reasonable employer safety rules and to wear personal protective equipment when required. Both employers and employees have certain rights relative to OSHA enforcement, development of standards, and inspections.

Review Questions

1. List two employer responsibilities under the OSHAct.

2. List two employee responsibilities and two employee rights under the OSHAct.

3. In what way is RCRA concerned with employee safety and health?

4. What do HAZWOPER requirements for TSD workers include?

HEALTH HAZARD RECOGNITION

This section of the course will introduce you to basic chemical concepts and terminology that you may encounter as part of your job.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Define chemistry terms used to evaluate how a chemical will behave
- Identify potential effects of exposure to chemicals in the workplace
- Identify ways to limit exposure
- Describe key parts of medical surveillance

Chemical Reactions

There are a variety of chemicals that may be used in the workplace. If a chemical is accidently spilled or released, it is important to know how it will react if it comes in contact with other materials.

Various types of chemical reactions can occur when two or more compounds combine. These reactions may result in:

1. Toxic gases
2. Large amounts of heat/cold
3. Fire or explosion

An example of a harmless chemical reaction is Alka Seltzer™ and water. Two chemicals in the tablet react with the water, resulting in the release of carbon dioxide, a gas. Since the gas is lighter than water, bubbles form and float to the surface.

There are other chemical combinations which can be dangerous when the chemicals involved are **incompatible**. Chemicals such as chlorine and ammonia are incompatible and react when combined to produce a toxic gas. Incompatible materials can be found in the NIOSH Pocket Guide.

Other chemicals can catch on fire without a flame being introduced. This reaction is called **spontaneous combustion**. An example of spontaneous combustion is when white phosphorus is exposed to the air, resulting in a fire and a dense fog of toxic material.

Chemical and Physical Characteristics

Understanding the way chemicals behave can help the workers potential prevent an emergency. Scientists have developed many terms to describe the chemical and physical properties of substances. It is not important to memorize these terms, but a general understanding of their meanings may be helpful. Many are defined below, and examples given:

Freezing Point (FRZ)

- **Definition** Temperature at which a liquid or gas becomes a solid.
- **Example** Water changes to ice.
- **Importance** Helps determine what form the compound may take.

Melting Point (MP)

- **Definition** The temperature at which a solid becomes a liquid.
- **Examples** Ice changes to liquid at 32 degrees F.
- **Importance** Helps determine the physical form of a compound at a specific temperature.

Boiling Point (BP)

- **Definition** The temperature above which a liquid when heated to 'bubbling' at a specified pressure will evaporate rapidly.
- **Examples**

Water.....212° (100C°)	Cadmium.....1,409°F
Acetone..... 133°F	Chlorine.....–29°F

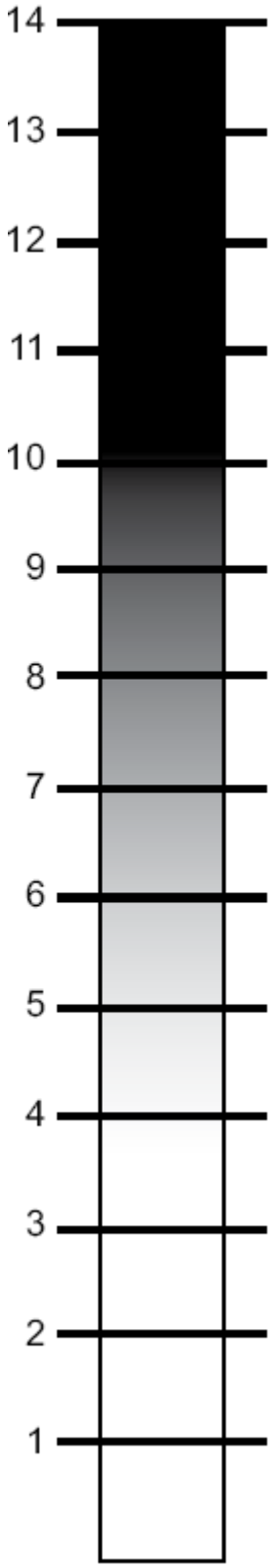
- **Importance** Determines whether a substance will be a liquid or gas at the temperature of the air.

pH

Definition Hydrogen ion concentration (pH) is used to determine if a substance is an acid or a base. A pH of 1 is very acidic; a pH of 14 is very alkaline. Because of the very large range in the values of pH, a special scale has been created. On it a change in pH of one unit (for example, from 3 to 4) represents a 10-fold change in acidity or alkalinity.

Example See scale.

Importance Compounds with high and low pH values will cause burns, irritate eyes, and irritate the nose and lungs. Substances with a pH less than or equal to 2 or greater than or equal to 12.5 are legally defined as hazardous waste. Materials with a pH less than 2.0 or greater than 11.5 will burn skin, eyes, and lungs.



liquid drain cleaner
caustic soda

bleach
oven cleaner

hair straighteners
(11.5 to 14.0)

soapy water

household ammonia
and cleaners

milk of magnesia,
mild detergent

toothpaste, hand
soap
perm solutions
baking soda, eggs,
seawater

shampoo (7 to 10)

“pure water”, blood

Urine, saliva, milk

Healthy skin, hair
and nails
Black coffee

Acid rain

Tomato juice, beer

Apples

Grapefruit and
orange juice

Lemon juice, vinegar

Stomach acid,
hydrochloric acid

Battery acid

Corrosive

Definition A compound which can quickly damage skin, eyes, other tissues, metal, and other solids. For example, concentrated acids (low pH) and bases (high pH) are corrosive.

Examples

- Sulfuric acid (oleum)
- Nitric acid
- Hydrochloric acid
- Acetic acid
- Sodium hydroxide
- Lime
- Lye
- Caustic soda

Importance Corrosives are reactive health and physical hazards and must be stored in glass or special plastics.

Flash Point (Fl. P.)

Definition The temperature at or above which there is enough vapor of a liquid chemical to ignite if an ignition source is applied.

Examples in degrees Fahrenheit (ºF)

Acetone	0
Stoddard solvent	11
Benzene	12
Methyl Ethyl Ketone (MEK)	20
Toluene	40
Gasoline	45
Xylene	84
Turpentine	95
Butyl toluene	155
Creosol	187
Chloroacetaldehyde	190

Importance The flash point is used to classify the relative fire hazards of liquids. If the flash point of a liquid is low, it is considered flammable. Flash point is a property of liquids only.

Flammable, Combustible, Ignitable

Definition The potential for a substance to catch fire. Highly **flammable** materials have a Fl. P. less than 100°F (DOT Fl. P. < 73°F). Flammables are further divided into Class 1A, 1B, and 1C, depending upon flash point and boiling point. Materials are said to be **combustible** if their flash points range from 100° to 200°F. **Ignitable** materials have a Fl. P. < 140°F.

Examples Gasoline, methyl ethyl ketone (MEK), and xylene are examples of flammable liquids. Propane is an example of a flammable gas.

Importance The flammable, combustible, or ignitable properties of a substance are important to know so a worker can determine the probability of a fire.

Autoignition Temperature

Definition The lowest temperature at which a flammable gas/vapor-air mixture will ignite from its own heat source or contact with a heated surface without needing a spark or flame. Vapors and gases will spontaneously ignite at a lower temperature in pure oxygen than in air (21% oxygen).

Examples
Acetone.....1,000°F (537°C)
Toluene.....997°F (536°C)
Benzene.....1,044°F (562°C)
Methane.....1,000°F (537°C)

Importance Autoignition temperatures of chemicals may be lowered by other substances in a hazardous waste site. Methane may be produced by decaying organic material.

Oxidizer

Definition A chemical that readily gives off large amounts of oxygen or other oxidizing substances (such as bromine, chlorine or fluorine) in a reaction with another chemical.

Examples

- Perchloric acid
- Benzoyl peroxide
- Ozone
- Hydrogen peroxide
- Household bleach
- Peroxides

Importance Fires or explosions are more likely to occur if oxidizers are stored near flammables. The potential to react is increased at higher temperatures.

Solubility in Water (Sol)

Definition The amount of a compound that will dissolve to saturate a specified amount of solvent (usually water) at a specified temperature (68 degrees F, unless another temperature shown). Expressed as % by weight, g/100 ml. Generally, when discussing solubility, the material to be dissolved is called a solute and the substance in which the solute is dissolved is called a solvent.

Examples Benzene.....0.07%
Methylene chloride.....2%
Hydrochloric acid ...67% (86oF)

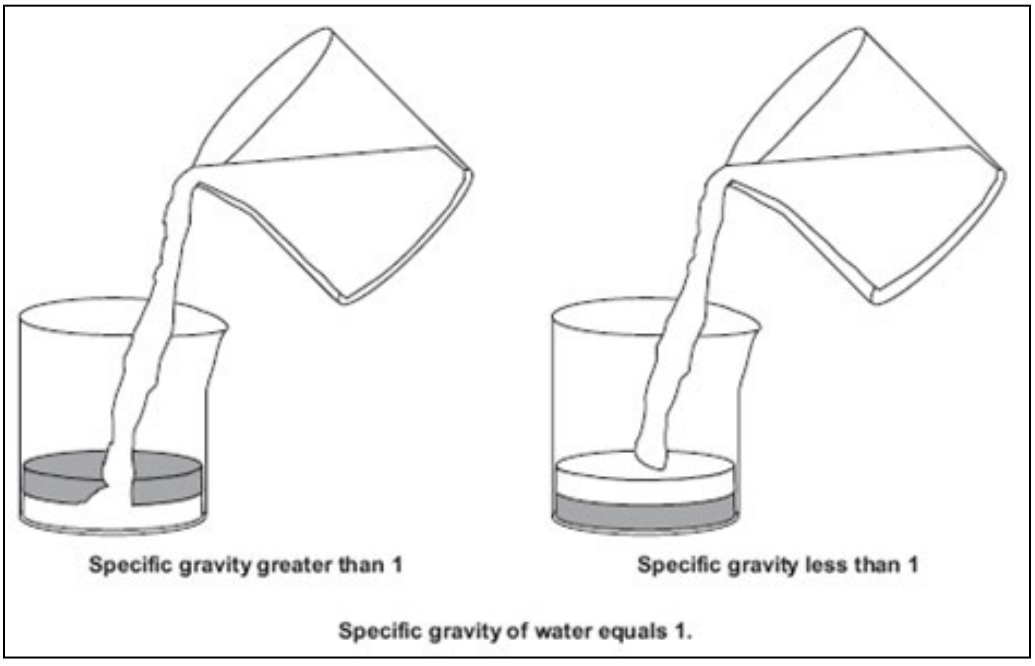
Importance If a soluble liquid or solid spills into water it will dissolve. Solubility can change with the conditions of the water, including temperature.

Specific Gravity (Sp. Gr./S.G.)

Definition (unitless) Ratio of density of equal volumes of one substance compared with density of another at a specified temperature: usually water is the comparison at 68°F. If a chemical does not dissolve in water (see solubility above) and has a specific gravity greater than 1, it will sink in water. If a chemical does not dissolve in water and has a specific gravity less than 1, it will float on water. See an illustration of the importance of specific gravity below.

Examples
Toluene.....0.87
Benzene.....0.88
Methylene chloride..... 1.33
Cadmium..... 8.65

Importance Important if floating compounds are flammable and/or toxic. If standing liquids separate in layers, by specific gravity, then removal of one contaminant may be easier (e.g., oil, slick)



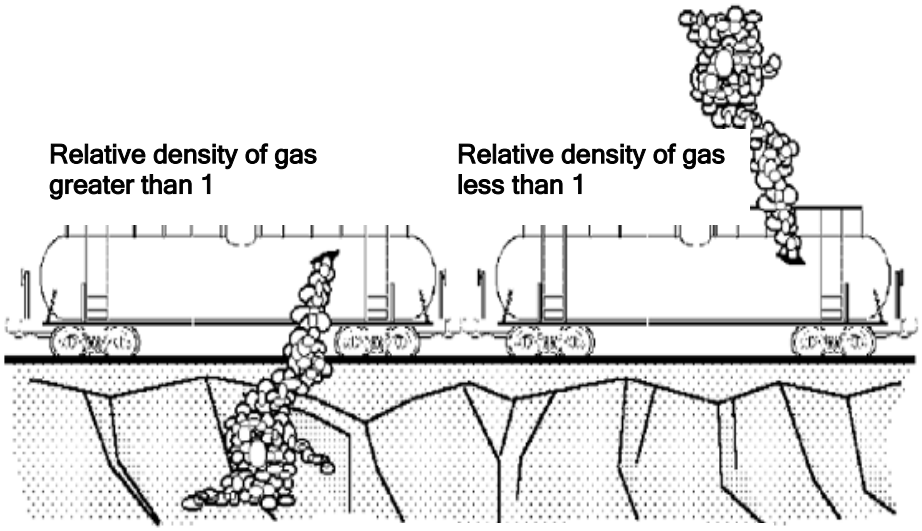
Relative Gas Density (RGasD) Also known as Vapor Density

Definition (Relative gas density of vapor compared to air=1). RGasD greater than 1 indicates the chemical is heavier than air; RGasD less than 1 indicates the chemical is lighter than air. See an illustration of relative gas density below.

Examples
Ammonia 0.59
Benzene.....2.70
Ethylene.....0.97
Gasoline.....4.40
Hydrogen sulfide.....1.19
Methylene chloride.....2.90
Trichloroethylene..... 4.50

Importance Materials heavier than air will accumulate in low-lying areas, especially when the air is still.

Relative Gas Density

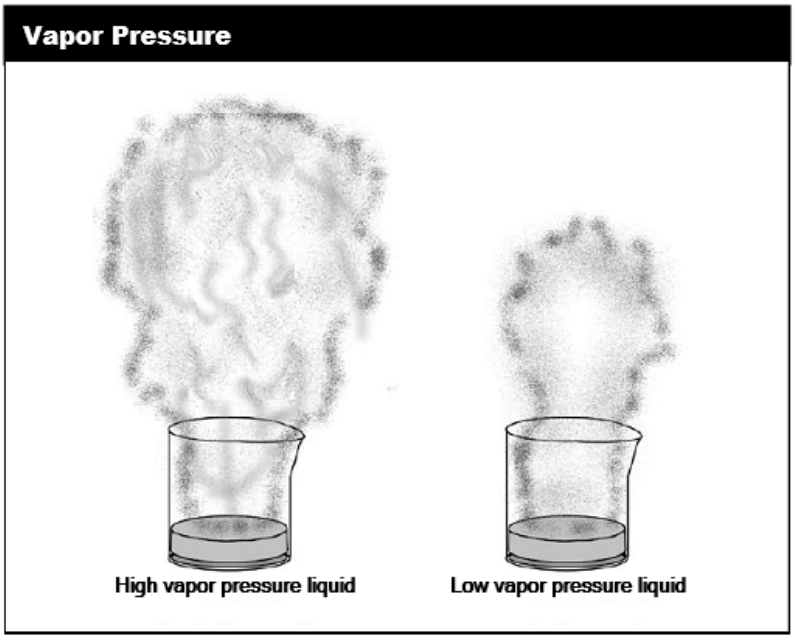


Vapor Pressure (VP)

Definition In a closed system, the pressure exerted by a vapor in equilibrium with the solid or liquid form. Expressed as millimeters of mercury (mm Hg), usually at 68°F; atmospheric pressure reference is 760 mm Hg. Vapor pressure increases with increasing temperature. The higher the VP, the faster the chemical evaporates into the space. See an illustration of vapor pressure below for two chemicals at the same temperature.

Examples	BP (°F)	VP (mmHg) at 68°F
Chlorine	-29	4800
Methylene Chloride	104	350
Acetone	133	180
Trichloroethylene	189	58
Xylene	269	9
Styrene	293	5
Cadmium	1,409	0

Importance A material with high vapor pressure will enter the air quickly and could overcome someone who is not protected. Also, the higher the vapor pressure of a sealed chemical container, the more likely it is to explode as the temperature rises.



Viscosity

Definition Thickness of a liquid or its ability to flow. As the temperature increases, the thickness of a liquid may become less.

Examples Water has a low viscosity
Molasses has a high viscosity

Importance Because viscosity can change with the temperature, a low-viscosity substance may become runny when exposed to heat and spread more rapidly.

Volatility

Definition Volatility refers to how readily a material will evaporate into the air (vaporize). Volatility increases as the temperature increases.

Examples Gasoline is a volatile liquid; lubricating oil is not.

Importance Volatile liquids can give off vapors which may be harmful to health. Some volatile materials can produce a vapor heavier than air (relative gas density) that can creep along the ground and fill manholes, trenches, or other low-lying areas. The vapor forces out oxygen and can result in death by suffocation. Some vapor concentrations are explosive or flammable.

Toxicity

Definition The types and level of harm caused by exposure.

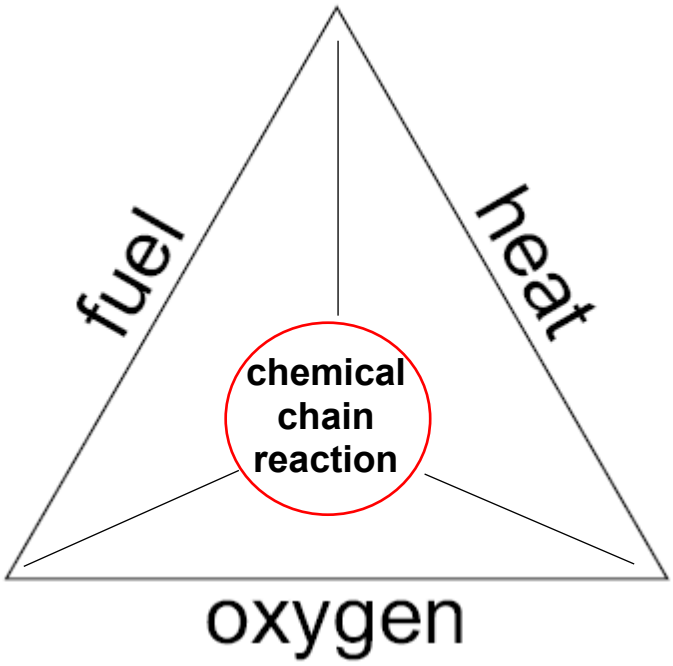
Examples Toxic by skin contact: *Acids and alkalies.*
Toxic by inhalation: *Methyl bromide and solvents.*
Toxic by ingestion: *Lead, pesticides.*

Importance The risk of a health effect depends on the toxicity of the chemical and many other factors, including level of exposure, duration of exposure and exposures to other toxic compounds.

Fire Tetrahedron: Fuel, Oxygen/Oxidizing Agent, Heat and Chemical Reaction

For a fire to burn, there must be four things: fuel (which may be a flammable vapor), oxygen from the air or other source (such as an oxidizer), heat (or source of flame or spark) and a self-sustaining chemical reaction. These four items make up the **fire tetrahedron**. The fire tetrahedron helps predict situations that may result in fire.

Once a fire is started, the temperature is determined by the amount of heat produced by the fuel. Some types of fuel burn hotter than others. To put out a fire, one or more of the four elements must be removed.



For example:

In an automobile engine that burns gasoline, the fuel (gasoline), oxygen (in the air), and heat (spark plug) combine to form a rapid series of explosions which push the cylinders to power the vehicle. These explosions occur because the gasoline vapor (fuel) becomes so concentrated in the air (contains oxygen) that a spark from the plug produces a violent reaction.

Explosive Limits

When there is just enough gas or vapor in the air to cause an explosion, this concentration is called the **Lower Explosive Limit** or LEL (% in air). As the amount of chemical in the air increases, it will reach a point where there is too much to produce a fire and subsequent explosion. This concentration is called the **Upper Explosive Limit** or UEL (% in air).

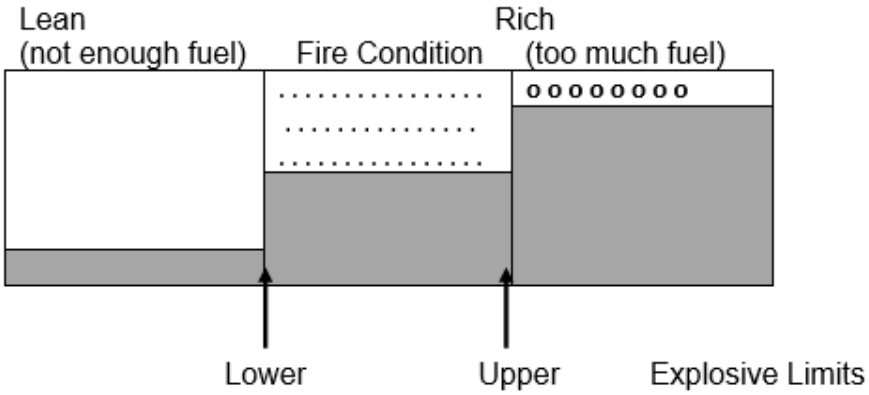
Compare these explosive limits to the operation of a car engine. When the mixture is too lean (not enough gas), the engine will not run. The gas vapor is below the LEL, and the engine will not run. If the engine floods (too much gas), then the UEL has been exceeded and the car will not run. When the mixture is right and the spark plugs are working, the gas/air mixture burns and the engine fires.

During an emergency involving flammable/explosive gases or vapors, constant air monitoring is essential, because the concentration of the gas can rapidly change. The air also needs to be monitored throughout the site, not just in the immediate area of the release. Monitoring devices such as a gas analyzer or 4 gas meter are used.

Lower Explosive Limit (LEL) is the minimum concentration (% in air) of a substance in air which is required for ignition. Concentrations below the LEL will not ignite. Below the LEL, the mixture is called “lean.” *If the concentration of a flammable vapor or gas is greater than 10% of the LEL, evacuate the area*.

Upper Explosive Limit (UEL) is the maximum concentration (% in air) of a substance in air which is required for ignition. Concentration above the UEL will not ignite. Above the UEL, the mixture is called “rich.”

Explosive Range is the concentration of a substance in air between the LEL and UEL. In this range, the substance will readily ignite.



Radioactivity

When a material is radioactive, some or all of its atoms emit particles or energy. There are three forms of ionizing radiation: Alpha, Beta, and Gamma. All of these forms are serious health hazards.

Alpha Radiation:

- Can damage the body if ingested or inhaled.
- Can be stopped or diverted by material as thin as a sheet of paper.
- Calls for the use of respiratory protection.

Beta Radiation:

- Can damage the body if ingested or allowed to penetrate into the body.
- Can result in skin burns or even skin cancer.
- Will travel through clothes, but is somewhat reflected by plastic.

Gamma Radiation:

- Can deeply penetrate the body.
- Can result in cancer, burns or, with massive exposure, death.
- Calls for heavy shielding, such as lead barriers.

Neutrons:

- Can cause materials to become radioactive or degrade.
- Use shielding materials such as water, polyethylene, paraffin wax or concrete.
- Gamma radiation may be produced from interaction with shielding.

For Protection from Radiation:

- Keep the amount of time exposed as short as possible.
- Maintain distance, keep as far away as possible.
- Use protective barriers, a respirator, and clothing specifically designed for the kinds of radioactive materials present.

Chemicals and the Body

Introduction

How does the body react to exposure?

Have you ever inhaled second-hand cigarette smoke? What reaction did you have: throat and airway irritation; nausea; dizziness? Did your eyes burn from being in a room filled with smoke?

Do you, or does someone you know, have a runny nose and red eyes during "pollen season"?

Have you ever consumed too much alcohol (ethanol or ethyl alcohol)? Did you experience slurred speech, dizziness, nausea, vomiting, "passing out," and/or a hangover complete with headache?

These are examples of responses of your body to an exposure. The effect on your body was felt rapidly in each of these examples.

Some Basic Principles of Toxicology

The health effects due to exposure to a hazardous substance can occur immediately or soon (acute) or be delayed for months or years (chronic).

Acute Effects or Acute Toxicity

An acute health effect means that the body's response occurs at the time of exposure or within a few hours or days. Acute effects may result from a single exposure to a high concentration of a substance for a short period of time as in an accidental chemical release. Examples of acute health effects include:

- Choking or coughing
- Nausea
- Dizziness
- Burning eyes, throat, or skin

After recovery from an exposure you may have no evidence of damage or may have temporary or permanent damage.

You may move away from an acute exposure if you experience a warning property.

Warning properties may be reactions such as:

- Irritation to the skin, eyes, or respiratory tract (upper airways or lungs)
- Bad/unpleasant smell (but don't depend on your nose to alert you)
- Dizziness or sleepiness such as a narcotic effect
- Tingling skin (e.g., caustic dusts)

Warning properties cannot be relied upon to provide adequate protection from harm.

Pictograms in the 2012 update to the Hazard Communication standard (29 CFR 1910.1200) indicate the potential for an acute effect. For example, the following Hazards are linked to the "Exclamation Mark" Pictogram on labels:

- Irritant (skin and eyes)
- Skin sensitizer
- Acute toxicity (harmful)
- Narcotic effects
- Respiratory tract irritant

Also, a material that has been determined to require a label with the Skull and Crossbones pictogram at the right is associated with:

Acute toxicity (fatal or toxic).

Chronic Effects or Chronic Toxicity

A chronic health effect is one that is recognized months or years after the exposure. Chronic effects generally involve repeated or prolonged exposure. Examples of chronic exposures and related health effects include:

Exposure	Effect (Disease)
Asbestos	Lung cancer
Carbon tetrachloride	Liver disease
Beryllium	Chronic beryllium disease
1,2-Dibromo-3-chloropropane (DBCP)	Male sterility

The following hazards are linked to the Health Hazard Pictogram, sometimes called the Bursting Chest:

- Carcinogen
- Mutagen
- Reproductive toxicity
- Respiratory sensitizer
- Target organ toxicity
- Aspiration toxicity

Note that most of these hazard words are often linked with chronic effects; however, responses like aspiration toxicity can be acute, resulting from a single exposure or event.

Some chemicals can cause both acute and chronic effects, depending on how long you were exposed and the chemical concentration. For example, high exposures to a solvent such as benzene may cause dizziness immediately; many years of exposure may result in cancer of the blood.

Routes of Entry

The way a harmful material enters the body is called the “route of entry”. The four routes of entry are skin absorption, inhalation, ingestion, and injection. Taking a toxic material into the body can result in acute or chronic effects.

- Lungs (inhalation)
- Skin (absorption) (Skin and eye contact are also considered)
- Mouth (ingestion)
- Injection (skin puncture)

Inhalation

As we breathe, we take in whatever is in the air. If dusts, fibers, or chemicals are in the air, they may react in/on the airways, be deposited in the lungs or cross into the bloodstream.

Skin Absorption/Contact; eye contact

The skin may be a major route of exposure as many chemicals (such as solvents and liquid insecticides) cross through the skin and get into the bloodstream. Some chemicals (e.g., formaldehyde) penetrate the skin and cause an allergic reaction. If skin is irritated, damaged, or punctured, absorption is increased. Human skin in different areas of the body lets chemicals through at different rates (called permeability). Some of the most permeable areas of the body are the scrotum, scalp and forehead, as shown in the following table.

Area of body	Times Greater Than Absorption Through the Foot
Scalp and forehead	34–36
Arms	10–15
Hands	5–10
Scrotum	300

Ingestion

Chemicals can be ingested through the mouth and swallowed when eating, drinking, or using contaminated cigarettes or cosmetics. Don’t eat, drink, smoke, or apply cosmetics in a contaminated area. Never carry food/snacks, cigarettes or cosmetics into contaminated areas.

Injection

A chemical can be accidentally injected into the body if you get injured by a tool, a compressed air/gas line, a fall, or punctured by a sharp object.

Multiple Routes of Entry

Some chemicals can enter the body in more than one way.

- Solvents: skin absorption, skin/eye contact, inhalation, ingestion, injection
- Metal fumes: inhalation, skin contact
- Carbon monoxide: inhalation, skin/eye contact (cryogenic liquid),
- Metal particles: skin/eye contact, inhalation, ingestion, injection

Be alert for secondary sources of exposure

Hand contamination can contribute to ingestion and inhalation!

Example: Lead on your fingers/hand can be transferred to food and ingested or transferred to a cigarette and inhaled.

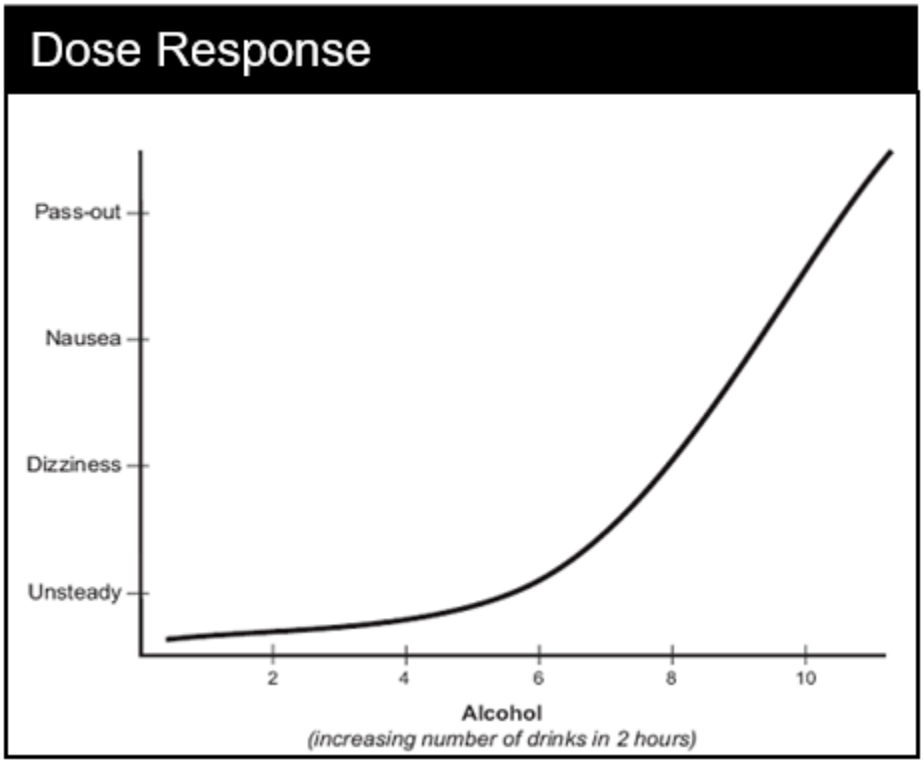
Example: Lead on your shirtsleeve or arm can be transferred to face/lips when wiping sweat away and then inhaled or ingested.

Example: Put your hands on back of a chair where someone with dusty shirt has been sitting and transfer to your hands and then ingested.

Factors That Influence the Body's Response to Exposure

Different chemicals can also cause varying responses at different concentrations. This is known as a dose-response relationship. (See the illustration that follows).

A chemical is considered relatively nontoxic if a large amount of a chemical (dose) is needed to cause an adverse health effect. The chemical is considered highly toxic if a small amount causes an adverse health effect.



Importance: As the intake increases, there is more in the body (the dose increases) and the effect also increases.

Different individuals have different responses to a chemical exposure. There are several factors which seem to influence response. These include current health status, age, race, sex, allergy history, genetics (heredity) and previous chemical exposure.

Exposure or Dose?

The concentration of a chemical in the air is Exposure. The concentration of the chemical or a metabolite in the body is Dose.

Exposure Interactions

When chemicals interact after they have entered the body, the effect can be different than if only one of the chemicals was present. For example, asbestos exposure plus cigarette smoking increases the risk for lung cancer. These interactions are shown below:

Additive (2 + 2 = 4) The combination of the parts equals the sum. For example, the insecticides Malathion™ and Sevin™ have the same effect on the body. If you were exposed to both Malathion™ and Sevin™, the effect would be additive.

Antagonistic (2 + 1 = 1) Antagonistic effects result when exposure to a combination of toxic chemicals results in an effect that is less than the effect of each. Such effects form the basis of many antidotes for poisonings. For instance, even though ethyl alcohol (ethanol) can have toxic effects on its own, it can antagonize (diminish) the effects of ingesting methyl alcohol (methanol) by displacing it from the enzyme that oxidizes the methanol.

Synergistic (2 + 8 = 16) The effects combine to be greater than the sum. Exposure to a combination of asbestos and cigarette smoke increases the risk of lung cancer far more than the risk of each added together.

Potentiation (2 + 0 = 4) This effect occurs when the toxic effect of one substance is increased with exposure to the second substance, even though the second substance does not cause that effect on its own. For example, even though exposure to methyl ethyl ketone does not damage the nerves in the arms and legs, it increases the ability of n-hexane to cause this damage.

Effects of Chemicals on the Body - Local and Systemic Effects and Target Organs

Chemicals can have health effects at the point where they contact the body, or they may travel through the bloodstream and have effects on other areas of the body.

Local effects occur at the point of contact with the skin, eyes, nose, throat, and airways. Chemical and physical agents that produce local damage include the corrosive action of acids and alkalis on the skin and eyes; irritation of the nose, throat, and lungs by chlorine, ammonia, and sulfur dioxide; and skin irritation from chemicals such as formaldehyde. The effect occurs in the tissue where the contact occurred.

Systemic effects occur when away from where the exposure entered the body. For example, the route of entry of solvents such as benzene may be at the skin or through the lungs, but the exposure affects the bone marrow or brain. A toxic gas such as hydrogen cyanide is inhaled, but the exposure affects the ability of cells to get energy; in these exposures, the heart (muscle) or brain (organ) is starved of energy, and death is rapid.

Target organ is the part of the body which is specifically affected by the exposure.

Exposure	Target Organ(s)
Methylene chloride (solvent)	Skin (local), liver (systemic)
Lead	Central nervous system (systemic)
Trichloroethylene	Skin (local), central nervous system (systemic)

Several examples of target organ toxicity (effect) are given below.

A **carcinogen** is a chemical or physical agent that can cause cancer when a worker is exposed, generally over a long period of time. There may be no safe level of exposure to carcinogens. The NIOSH Pocket Guide shows a listing of chemicals that the agency has categorized as carcinogenic. See http://niosh.dnacih.com/nioshdbs/npg/nengapdx.htm

Carcinogenic effects may be local or systemic.

A **mutagen** is a chemical or physical agent that changes the blueprint (DNA genetic code) of cells in your body. The effect is mutagenicity. Mutagenic effects are generally systemic.

Solvents irritate the skin, eyes, and airways of the nose, throat, and lungs. When solvents get into the blood, the nervous system is affected. Long-term exposure can cause damage to the liver and kidneys. Exposures to solvents may cause narcotic effects, making you feel sleepy and impairing judgment. The effects may be local or systemic.

Acids and bases (alkalis) damage the skin, eyes, and airways. Strong acids and bases are corrosive and can cause burns and ulcerations at the site of contact (local).

Certain chemicals can cause reproductive toxicity in men and women. Infertility, changes in hormone level and menstrual problems are associated with exposure to such chemicals as lead, mercury and styrene. Birth defects and developmental problems in children may also occur when the woman is exposed during pregnancy. A **teratogen** is a chemical or physical agent that causes birth defects. Some examples of teratogens are organic mercury compounds, arsenic and radiation. These effects are systemic.

A **sensitizer** causes little or no reaction on first exposure, but after repeated exposures a marked response may result at the site of contact (local) or in another part of the body (systemic). Isocyanates are respiratory sensitizers. A skin sensitizer causes an allergic response following skin contact; epoxy resin is one example.

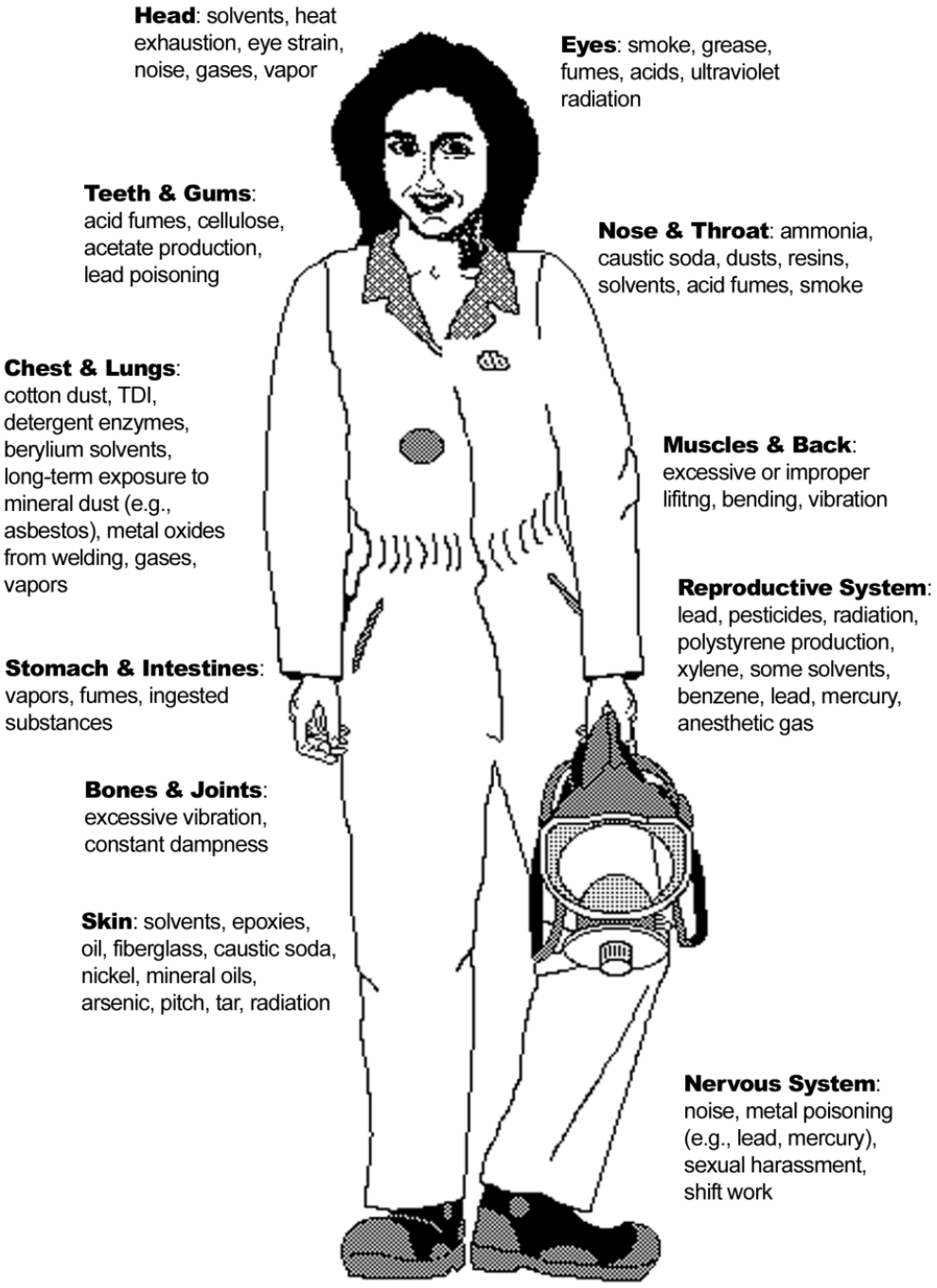
Aspiration is the entry of a liquid or solid chemical directly through the oral or nasal cavity (or indirectly during vomiting) into the trachea and lower respiratory system. Aspiration toxicity includes chemical pneumonia, other pulmonary injury or death. Petroleum distillates and chlorinated solvents have been shown to be aspiration toxins in humans.

Any time you suspect that signs or symptoms of illness are due to occupational exposure, consult an occupational healthcare provider.

Find an occupational healthcare provider: http://www.aoec.org/ , a nationwide Association of Occupational and Environmental Clinics.

The illustrations on the next two pages show harmful effects of chemicals and how different target organs may react to them.

Health Effects: Where does the health effect occur (Target Organ) and What are potential causes (the Hazard)?



Adapted from the International Metal Worker's Union

Health Effects: How Does Your Body React (Acute/Chronic; Local/Systemic)?

Head: dizziness, headache

Teeth & Gums: corrosion of tooth enamel, blue gums

Chest & Lungs: wheezing, congestion, shortness of breath on mild exercise, flu-like symptoms (e.g., "metal fume fever")

Stomach & Intestines: Vomiting, diarrhea

Bones & Joints: arthritis.

Skin: redness, dryness, itching, ulcers, skin cancer.

Eyes: redness, irritation, watering, grainy feeling, "welder's flash"

Ears: ringing, temporary deafness, hearing loss

Nose & Throat: sneezing, coughing, sore throat, nasal cancer

Muscles & Back: soreness, strain

Reproductive System: miscarriage, irregularities in menstruation, damage to fetus or chromosomes, sterilization

Nervous System: stress, nervousness, irritability, sleeplessness, tremors, speech changes

Adapted from the International Metalworker's Union

Exercise – Information Sources

Using the information resources provided by the facilitator, work in small groups to answer the following questions (not all information may be available in the resources). One member of the group should report back.

1. What is the name of the chemical or hazardous waste?

2. What does the placard or label tell you about the chemical?

3. What are the physical hazards of the substance–explosion, fire, reactive, oxidizing material, etc.?

4. What are the health hazards?

5. What target organs does this chemical affect?

6. What are the safe handling recommendations?

7. What personal protective equipment is recommended to limit worker exposure?

8. Is First Aid information given? What is it?

9. Is the chemical volatile? What is the vapor pressure and vapor density?

Medical Surveillance Program

Medical surveillance is a required consideration for emergency response (OSHA 29 CFR 1910.120[f]). It is essential to assess and monitor workers' health and fitness both prior to and during the course of employment, provide emergency and other treatment as needed, and retain accurate records for future reference. A medical surveillance program must be instituted by the employer for the following employees:

- All employees who are or may be exposed to hazardous substances or health hazards at or above the PEL or above another published exposure level (if no PEL) for 30 days or more a year
- All employees who wear a respirator for 30 days or more a year
- All employees who are injured due to overexposure from an emergency incident involving hazardous substances or health hazards
- Members of official hazardous materials response teams

In accordance with the standard, medical examinations and consultations are made available by the employer to each employee who falls into one or more of the above categories.

Medical exams should be conducted:

- Prior to a new job assignment (pre-placement or reassessment exam)
- At least once every year but not less often than every two years
- At termination
- If an employee exhibits signs or symptoms which may have resulted from exposure to hazardous substances during the course of an emergency incident, or if the employee has been injured or exposed above the PEL or published exposure levels in an emergency situation
- More than once each year, if the physician determines that an increased frequency of examination is medically necessary

All medical examinations and procedures must be performed by or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine. The exam is provided without cost to the employee, without loss of pay, and at a reasonable time and place.

The content of the examination or consultations made will be determined by the physician. The physician may not understand the details of the employee's work. Therefore before the examination, it is important to explain to the physician the

type of work, potential health risks, and the type of protective equipment which may be worn for the response. Materials provided may include but may not be limited to:

- Copy of 29 CFR 1910.120 (HAZWOPER)
- Information required by 29 CFR 1910.134 (Respiratory protection)

The employer should then obtain the following items from the attending physician and furnish the information to the employee:

- The physician's opinion relative to the individual's employment or job assignment. (Findings not relevant to the response duties are not to be included)
- The physician's recommended limitations upon the employee's assigned response role
- The results of the medical examination and tests if requested by the employee
- A statement that the employee has been informed by the physician of the examination results and any conditions which require further examination or treatment

The employee has a right to request and be given a copy of the physician's full report. The employer receives only work-related information. The report should be kept in a safe place or forwarded to your family physician.

The employer should keep records of medical exams and other exposure records for the duration of an individual's employment plus 30 years thereafter. The record should include at least the following items:

- Name and social security number and employee physician's report
- Employee reports of health effects related to exposure
- Copy of information provided to the physician by the employer, except for 1910.120

Exposure Records

Results of any exposure monitoring conducted by your employer relevant to your work activities are considered part of your medical record and must be available to you upon request.

See the OSHA Standard “Access to Employee Exposure and Medical Records” (29 CFR 1910.1020). Records that workers can request include either environmental information (including monitoring results, SDSs, lists of chemical, biological or physical agents related to the job, studies/analyses of data) or personal medical records. When requested, the employer must provide access within fifteen working days. The employer can comply by making a copy of the requested record at no cost to the employee or allowing the employee to use the employer copy machine to copy the requested record.

Things the Worker Should Do

- Report all work-related injuries or illnesses immediately to the company physician and/or a personal doctor
- Request and keep full copies of medical records
- Examine and keep copies of exposure records
- Actively participate in training on the potential health effects of all chemicals that you may encounter
- Ask questions of health and safety representatives
- See an occupational physician, if a second opinion is wanted

Summary – Health Hazard Recognition

Chemical reactions can cause harm to people and the environment by:

- Releasing toxic gases
- Putting out large amounts of heat
- Causing a fire or explosion

Chemical terms used to describe the chemical and physical properties of substances help workers understand the hazards that may be present at a site. Commonly used terms include:

- Freezing point
- Melting point
- Boiling point
- pH
- Corrosive
- Specific Gravity
- Flash point
- Flammable
- Autoignition temperature
- Oxidizer
- Solubility
- Specific gravity
- Relative gas density
- Vapor pressure
- Viscosity
- Volatility
- Toxicity

For a fire to burn, there must be four things: fuel (which may be a flammable vapor), oxygen from the air or other source (such as an oxidizer), heat (or source of flame or spark) and a self-sustaining chemical reaction. These four items make up the fire tetrahedron.

Knowing the upper and lower explosive limits help the worker determine if the atmosphere is potentially explosive. If the concentration of a flammable vapor or gas is greater than 10% of the LEL, the area should be evacuated.

The health effects due to exposure to a hazardous substance can occur immediately or soon (acute) or be delayed for months or years (chronic).

There are four main ways that chemicals and other harmful substances can enter the body: through the lungs, through the skin, by the mouth, or by injection.

Once chemicals enter the body, they can affect other organs like the liver, the blood and bone marrow, the kidneys and bladder, and the nervous system. Chemicals can have health effects at the point where they contact the body (local effect), or they

may travel through the bloodstream and have effects on other areas of the body (systemic effect).

Wearing protective gear adds to the risk of heat stress. Long periods of exposure to heat may cause illness, particularly if a worker is not accustomed to working with a high heat load. Heat builds up inside protective clothing, so there is a risk of heat stress even if outside temperatures are moderate. Cold stress is less common but may occur outdoors in winter months or in responses that involve cryogenic materials or cold storage areas.

Radiation can seriously harm the body. To minimize exposure to radiation, maintain distance from radioactive sources, establish a barrier between people and sources, and keep the amount of exposure to an absolute minimum.

Medical surveillance is a program which includes occupational histories, physical examinations, and laboratory tests. For certain workers, medical surveillance is required by HAZWOPER. The employer must pay for the exams, provide certain information to the physician, and maintain records of the exams. The employee should receive a copy of the physician's report and additional findings not relayed to the employer.

Records of work-related exposures, including monitoring results, SDSs, lists of potential chemical, biological or physical agent exposures related to the job, and studies/analyses of data are available to workers; these are considered part of medical records.

Workers should:

- Report all work-related injuries or illnesses immediately to the company physician and/or a personal doctor
- Request and keep full copies of medical records
- Examine and keep copies of exposure records
- Actively participate in training on the potential health effects of all chemicals that you may encounter
- Ask questions of health and safety representatives
- See an occupational physician, if a second opinion is wanted

Review Questions

1. Describe the importance of the following terms:

Boiling Point

Flammability

Flash Point

Relative gas density

2. What are the most common ways that substances enter the body?

3. What are some possible health effects of exposure to hazardous materials?

4. Who is legally required to be included in medical surveillance?

5. When should medical examinations be performed?

HAZARD RECOGNITION

In this section, hazard recognition is introduced. Routine methods used to recognize hazardous materials by signs and other identifiers are reviewed. Sources of information about specific chemicals, such as from Safety Data Sheets (SDSs), also are covered.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Recognize the major types of hazards, including chemical, biological, and physical hazards.
- Recognize hazardous materials placards, labels, symbols, and markings.
- Recognize the types of information on a manifest form, SDS, and waste profile sheet.
- Recognize the different types of physical safety and health hazards that are unique to TSD facilities.

In an industrial setting, most materials used at a plant are known ahead of time. However, materials may be accidentally delivered to the wrong site, so unknown or unexpected hazards may also occur. By using each of the sources of information discussed in this section, employees may be prepared to identify potential hazards.

Types of Hazards - Overview

Information in this section concerns the basic hazards which may exist and general methods of recognizing the nature of the hazard. Specific hazards at a plant site are described in the ERP. Specific hazards may require additional training. Health and safety hazards can be grouped into three main types. Examples of each type of hazard are listed below.

Chemical

- Flammable
- Toxic
- Carcinogens (cancer-causing)
- Corrosives
- Poisons

Biological

- Infectious wastes
- Poisonous plants
- Fungi, yeasts
- Insects, snakes, animals

Physical

- Radiation
- Ponds and lagoons
- Confined spaces and trenches
- Electricity
- Slips, trips and falls
- Ladder safety
- Struck-by hazards
- Vehicle safety (passenger & heavy equip.)
- Steam
- Ergonomic injuries
- Noise
- Buildings (structural integrity and type of construction)
- Fall from heights
- Temperature extremes
- Equipment maintenance

Information sources to recognize chemical and biological and some physical hazards are described. Many physical hazards are recognized by careful observation of surroundings.

Recognizing Chemical Hazards

The National Fire Academy (NFA) has identified six sources of information that will help you organize observations about potential hazards.

1. Occupancy (use of the space) and Location (where)
2. DOT Placards and Labels
3. Markings and Colors (and we add: Other label systems)
4. Container Shapes and Sizes
5. Shipping Papers and Safety Data Sheets (SDSs)
6. Senses

1. Occupancy and Location

Identify the purpose or activity conducted in the area Location can provide information on whether a hazard may be present. Certain areas of your facility may be known to contain hazardous materials. Releases or leaks in these areas (such as production vessels, laboratories, tank farms, reactors, etc.) should always be suspected of involving hazardous materials. Location also requires a description of the area. This includes any:

- Drain
- Process or electrical equipment
- Water way
- Roadway/highway
- Buildings with occupants
- Buildings where materials are stored
- Weather conditions that affect the scene (wind, temperature, precipitation)
- Smoke, flames
- Steam or vapor clouds

2. DOT Placards and Labels

The DOT system of placards and labels is required on hazardous materials during shipment. It is important to understand the systems which are used to identify hazardous materials. Hazard information is included on DOT placards fixed to large containers (trailers, rail cars, tanks) and manufacturer labels fixed to small containers (drums, packages, boxes). Caution must be exercised, because labels and placards may be missing, incorrect, or difficult to read.

The DOT system of placards and labels is used with hazardous materials during shipment. What does the DOT system look like?

- Diamond-shaped
- Color-coded

Color	**Hazard**
Orange	Explosive
Red	Flammable or combustible
Green	Non-flammable gas
Yellow	Reactive oxidizer or organic peroxide
White	Toxic/Poisonous or infectious substance
White and red vertical stripes	Flammable solid
White top with black bottom	Corrosive
Two colors	Two major hazards
Blue	Dangerous when wet
Yellow top with white bottom	Radioactive
White top with red bottom	Spontaneously combustible

Below is an example of the DOT placard for flammable or combustible (red)

- Word-coded (hazard class name)

For example:

- Explosives
- Blasting agents
- Dangerous (may be used with mixed loads)

Here is an example of the DOT placard for a radioactive hazard

- Symbol-coded

Symbol	Hazard
Bursting ball	Explosive
Flame	Flammable
W with slash	Dangerous when wet
Skull and crossbones	Poisonous
Circle and flame	Oxidizing material
Cylinder	Non-flammable gas
Propeller/Trefoil	Radioactive
Test tube/hand/metal	Corrosive
Special symbol	Infectious (discussed previously)

Below is a DOT placard with the symbol for a corrosive hazard

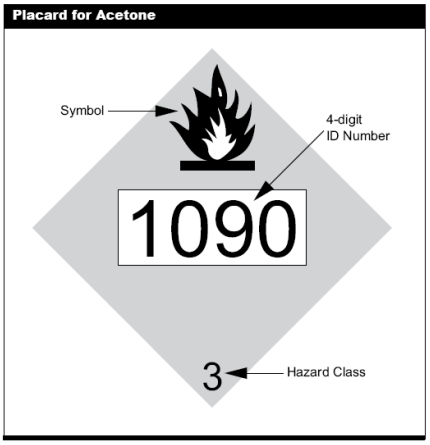
- Number-coded

A **four-digit** number in the **center** identifies a specific compound. These numbers are identified in the *Emergency Response Guidebook*. For example, 1223 is kerosene. The DOT placard above has the number 1760, which identifies the contents as one of several corrosive liquids. This number may be in the center of the placard or on an orange-colored panel below the placard.

The **one-digit** number at the **bottom** is the Hazard Identification Code.

#	Hazard Class
1	Explosives
2	Gases (compressed, liquefied, or dissolved under pressure)
3	Flammable liquids
4	Flammable solids or substances, spontaneously combustible materials, and dangerous when wet materials/ water-reactive materials.
5	Oxidizing substances and Organic peroxides
6	Poisonous and infectious substances
7	Radioactive substances
8	Corrosives
9	Miscellaneous dangerous substances/ organisms

The placard displayed below is red with white symbols except for the black four-digit number. This placard tells you that the substance is Flammable (the flame and red background), a Flammable Liquid (Hazard Class 3), and Acetone (the four-digit number 1090).



The acetone placard is called a “number placard,” which means that the number in the center of the placard specifies the exact contents of the container. “Word placards” are so named because a word designating a type of hazard (e.g., flammable) will be printed in the middle of the placard. Number placards must be

displayed on large portable tanks, tank trucks, and rail cars. A word placard means that drums or smaller containers are present.

To use the guidebook, you need to know either the chemical name or the identification number.

Using the DOT Emergency Response Guide

You can find more information on what these placard numbers and symbols mean in the DOT Chart and the *DOT Emergency Response Guide*. The 2020 ERG can be downloaded onto your device for free. Here is the link:

https://www.phmsa.dot.gov/hazmat/erg/erg2020-mobileapp

The **orange** pages are called the Guides. These pages are of use in determining the potential hazards of the chemical in question. Additionally, the Guides give a brief description of the emergency action that should be taken by appropriate emergency response personnel. In order to use the Guides, you must first find out the appropriate Guide Number by looking in the yellow or blue pages or referring to the Table of Placards.

The yellow pages list chemicals in numerical order based on their assigned ID number. If you are reading a placard or label which has a four-digit number in the center, you can look up the chemical name in the yellow pages, which will tell you the name of the chemical and the Guide number.

The **blue** pages list chemicals alphabetically by their name. From this listing you can determine each chemical's ID number and the Guide number.

The **green** pages indicate the Table of Initial Isolation and Protective Action Distances. This section of the DOT *Guide* describes the distances necessary for initial isolation around a chemical incident as well as the distance downwind that persons must be protected. Chemicals that are highlighted in green, in the blue and yellow pages, will be found in Table 1 (green pages). If the name of the material in Table 1 is followed by "(**when spilled in water**)", consult Table 2 for toxic gases produced. If there is an asterisk next to the ID number in Table 1, also consult Table 3.

- If you know the name of the substance, use the blue pages to find the *Guide Number*. The *Guide* in the orange pages contains more detailed information about the class of substance.

- If you know the number of the substance, use the **yellow** pages to find the *Guide Number*. The *Guide* in the orange pages contains more detailed information about the class of substance.

3. Markings and Colors (and Other Label Systems)

Markings

In addition to DOT placards, other markings may be placed on shipping containers, including:

- Orientation arrows
- Words
    - Inhalation Hazard
    - Poison

Color

Color is an important feature of placards and labels, even if other parts cannot be seen.

Other Label Systems (HazCom/HCS2012, NFPA, HMIS)

Globally Harmonized System for Labeling - Hazard Communication Standard

Labels are part of the OSHA Hazard Communication Standard (HazCom, HCS2012) and consistent with the Globally Harmonized System (GHS). This 2012 update to the Hazard Communication standard is sometimes referred to as HCS2012. The overall purpose of the OSHA Hazard Communication Standard is to ensure that everyone at a worksite has access to information about the chemicals that are used and has been trained to use them safely. This information is important for those who may manage an unexpected release.

HCS2012 requires all manufacturer labels to have pictograms, a signal word, hazard and precautionary statements, the product identifier, and supplier identification. HCS2012 covers most hazardous chemicals (excluding wastes) in an overall system that looks at physical hazards (such as flammability and corrosivity), health hazards (including both immediate and long-term health effects) and environmental hazards.

If a chemical is transferred from a labeled container to a portable container that is only intended for immediate use by the employee who performs the transfer, no label is required for the portable container. For more information, see OSHA Brief, Hazard Communication Standard: Labels and Pictograms, http://www.osha.gov/Publications/OSHA3636.pdf

The HCS2012 pictograms are graphic symbols. There are eight health and safety pictograms and one (non-mandatory) environmental pictogram. All pictograms are a red diamond enclosing a black symbol on a white background. The words below each pictogram are the Hazard Classes covered by the figure.

HCS2012 Pictograms and Hazard Classes

Health Hazard 	Flame 	Exclamation Mark 
Carcinogen Mutagenicity Reproductive Toxicity Respiratory Sensitizer Target Organ Toxicity Aspiration Toxicity	Flammables Pyrophorics Self-Heating Emits Flammable Gas Self-Reactives Organic Peroxides	Irritant (skin and eye) Skin Sensitizer Acute Toxicity (harmful) Narcotic Effects Respiratory Tract Irritant Hazardous to Ozone Layer (Non Mandatory)
Gas Cylinder 	Corrosion 	Exploding Bomb 
Gases under Pressure	Skin Corrosion/ burns Eye Damage Corrosive to Metals	Explosives Self-Reactives Organic Peroxides
Flame over Circle 	Environment (Non Mandatory) 	Skull and Crossbones 
Oxidizers	Aquatic Toxicity	Acute Toxicity (fatal or toxic)

A sample HCS label is shown on the next page.

SAMPLE LABEL PRODUCT IDENTIFIER

CODE
Product Name

SUPPLIER IDENTIFICATION

Company Name
Street Address
City State
Postal Code Country
Emergency Phone Number

PRECAUTIONARY STATEMENTS

Keep container tightly closed. Store in cool, well ventilated place that is locked.
Keep away from heat/sparks/open flame. No smoking.
Only use non-sparking tools.
Use explosion-proof electrical equipment.
Take precautionary measure against static discharge.
Ground and bond container and receiving equipment.
Do not breathe vapors.
Wear Protective gloves.
Do not eat, drink or smoke when using this product.
Wash hands thoroughly after handling.
Dispose of in accordance with local, regional, national, international regulations as specified.

In Case of Fire: use dry chemical (BC) or Carbon dioxide (CO_2) fire extinguisher to extinguish.

First Aid
If exposed call Poison Center.
If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.

HAZARD PICTOGRAMS

SIGNAL WORD

Danger

HAZARD STATEMENT

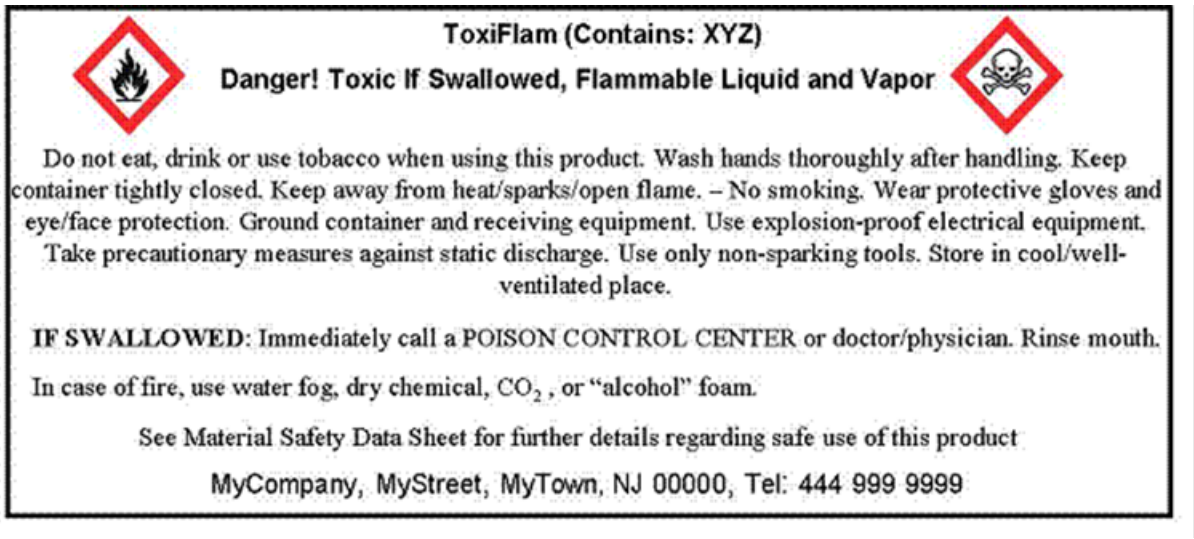
Highly flammable liquid and vapor.
May **cause liver and kidney damage.**

SUPPLEMENTAL INFORMATION

Directions for use

Fill weight: Lot Number
Gross weight: Fill Date:
Expiration Date:

Any alternative label must be consistent with the HCS2012 – no conflicting hazard warnings or pictograms are allowed. For example, an alternative format:



ToxiFlam (Contains: XYZ)

Danger! Toxic If Swallowed, Flammable Liquid and Vapor

Do not eat, drink or use tobacco when using this product. Wash hands thoroughly after handling. Keep container tightly closed. Keep away from heat/sparks/open flame. – No smoking. Wear protective gloves and eye/face protection. Ground container and receiving equipment. Use explosion-proof electrical equipment. Take precautionary measures against static discharge. Use only non-sparking tools. Store in cool/well-ventilated place.

IF SWALLOWED: Immediately call a POISON CONTROL CENTER or doctor/physician. Rinse mouth.

In case of fire, use water fog, dry chemical, CO_2, or "alcohol" foam.

See Material Safety Data Sheet for further details regarding safe use of this product

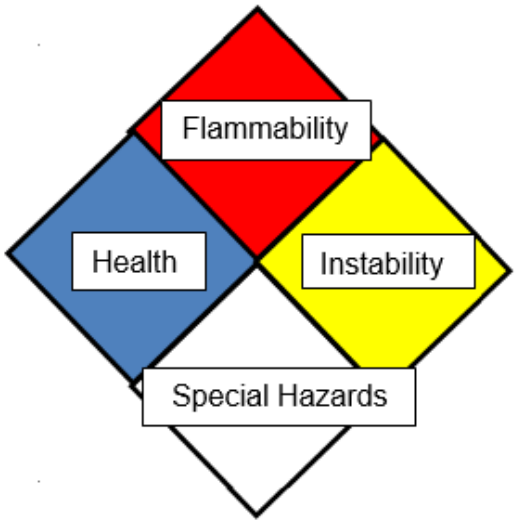
MyCompany, MyStreet, MyTown, NJ 00000, Tel: 444 999 9999

National Fire Protection Association (NFPA) - 704 System

The National Fire Protection Association (NFPA) system may be used on storage vessels and containers at a stationary facility. Some facilities may use this system throughout their departments and put the NFPA label on all hazardous materials. The facility's hazard communication training can inform the worker if this warning system is being used at the work site.

What does the NFPA system look like?

- Diamond-shaped
- Color-coded in four small diamonds



Color	Hazard
Red	Flammability
Blue	Health
Yellow	Instability
White	Special Hazards

- Number-coded in the red, blue, and yellow diamonds - Ranks the potential flammability, health, and instability hazard .Ranges from 0 (least hazard) to 4 (highest hazard).

The Special Hazards (white) section of the NFPA-704 label may contain symbols (examples shown below) that give more information about the chemical. The following symbols might be found in the Special Hazards (white) section of the NFPA-704 label.

NFPA-704 Standard Symbols

	OX	SA
Do not use Water	Oxidizer	Simple Asphyxiant

Non-Standard Symbols

- **COR:** Corrosives.
- **ACID** and **ALK** (Alkali) to be more specific.
- **BIO:** Biological Hazard.
- **POI:** Poisonous Material (e.g. strychnine)
- **CYL or CRYO:** Cryogenic Material (e.g. liquid nitrogen)
- **Radiation warning (also known as a trefoil):** Radioactive materials. (e.g. plutonium, uranium)
- The field may also be left blank if no special hazards are present.
- When multiple special hazards exist, add white panels below the placard to list the additional special hazards that apply.

Hazardous Materials Information System (HMIS)

These labels are used on storage vessels and containers.

What does the HMIS label look like?

- Rectangular
- Color-coded

The labels alert workers to:

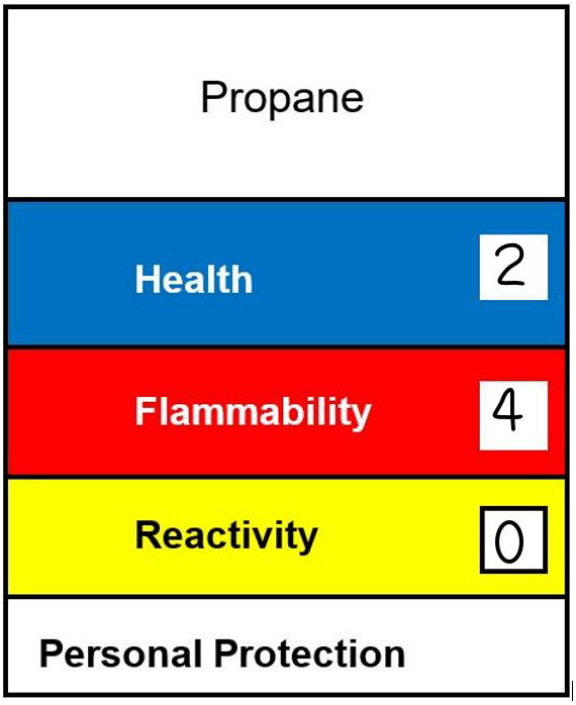
Color	Hazard
Blue	Health risk
Red	Flammability
Orange	Physical hazards
White	Personal protection

- Number-Coded

Ranks the potential health, flammability, and physical hazard. Ranges from 0 (minimal hazard) to 4 (severe hazard).

- Letter-coded

Tells you what personal protective equipment you should use to protect yourself when working with the material. Capital letters range from A (safety glasses) to K (full protective suit with gloves, boots, a hood or mask, and an airline or Self-Contained Breathing Apparatus). If the personal protection is coded X, specialized handling procedures are needed. Lower-case letters n through u, w, y and z are codes for specific protective equipment. For example, q represents boots and u represents an organic vapor respirator. A chart outlining each letter code should be available wherever these labels are used.



Example of a HMIS Label

Two boxes appear next to *Health*. The first box contains an asterisk (*) if the material poses a risk of a chronic health effect; otherwise, a slash (/) should be in the box. The box on the right contains the numerical hazard rating (0–4). Alternatively, the two symbols may be combined in the box on the right. For example, 3* in the box on the right would mean a serious chronic health effect.

The part of the body affected by exposure is also designated: blood, eye, nervous system, kidney, liver, reproductive, skin, or respiratory. Icons are available for each.

Physical hazards of a chemical includes: water reactive, organic peroxides, explosives, compressed gasses, pyrophorics, oxidizers and unstable reactives. Each is represented by an icon.

A Hazard Summary Label is available to be used for shipped containers; it has more complete information on health hazards, routes of exposure and physical hazards.

Note of caution: Employers may continue to use rating systems such as National Fire Protection Association (NFPA) diamonds or HMIS requirements (both discussed later in this chapter) for workplace labels, as long as they are consistent with the requirements of the Hazard Communication Standard and the employees have immediate access to the specific hazard information for the chemicals (for example, in an up-to-date SDS). An employer using NFPA or HMIS labeling must, through training, ensure that its employees are fully aware of the hazards of the chemicals used.

Note of caution: Any alternative label must be consistent with the HCS2012 – no conflicting hazard warnings or pictograms are allowed.

Note of caution: While HMIS and NFPA 704 are US systems that have been in place for many years, the transition to a globally harmonized approach as in HCS2012 may cause confusion. It is very important to recognize that the numbering system in the two approaches is not consistent - and is in fact opposite as shown below.

HCS2012 Hazard categories		HMIS/NFPA 704 numerical ratings	
1	Severe Hazard	0	Minimal Hazard
2	Serious Hazard	1	Slight Hazard
3	Moderate Hazard	2	Moderate Hazard
4	Slight Hazard	3	Serious Hazard
5	Minimal Hazard	4	Severe Hazard

Labels And Placards Checklist

What should I observe from labels/placards?

- type of placard (word or number)
- labeling system (DOT, NFPA-704, OSHA HCS2012, HMIS)
- shape
- color
- words
- numbers
- symbols/labels/pictograms

How do I observe them?

- From a distance
- Upwind
- With binoculars, if possible
- Uphill

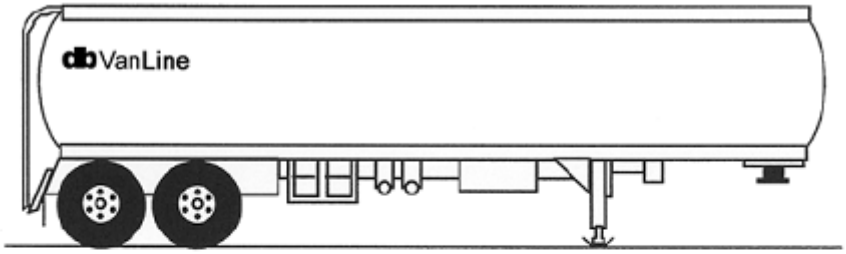
Container Shapes and Sizes

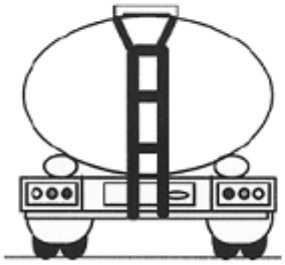
Containers are used to store and ship materials. Although the identity of materials in containers may be generally known at a facility, in an emergency the labels or placards may be damaged or blocked from view. Therefore, it may be important to recognize specific types of containers.

Some container types and their contents are identified in this section. Other specialized types of containers may be used at the plant and require review as part of preplanning.

Atmospheric Pressure Tank Truck

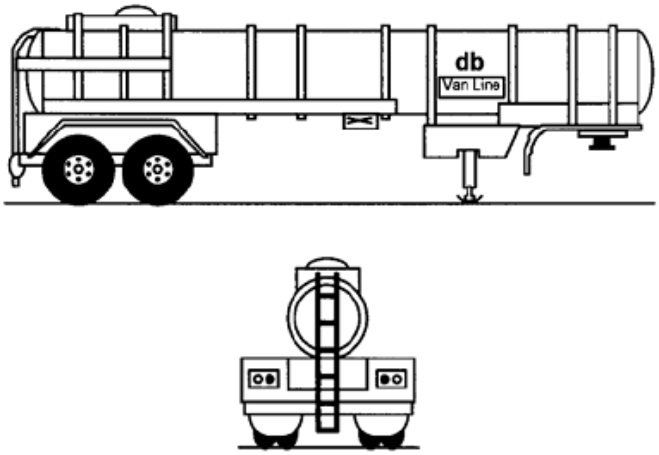
Trailers shaped like this, an oval cylinder, generally contain flammable and combustible liquids, usually liquids lighter than water (especially petroleum products). DOT406, TC407, SCT-306; MC306, TC306.





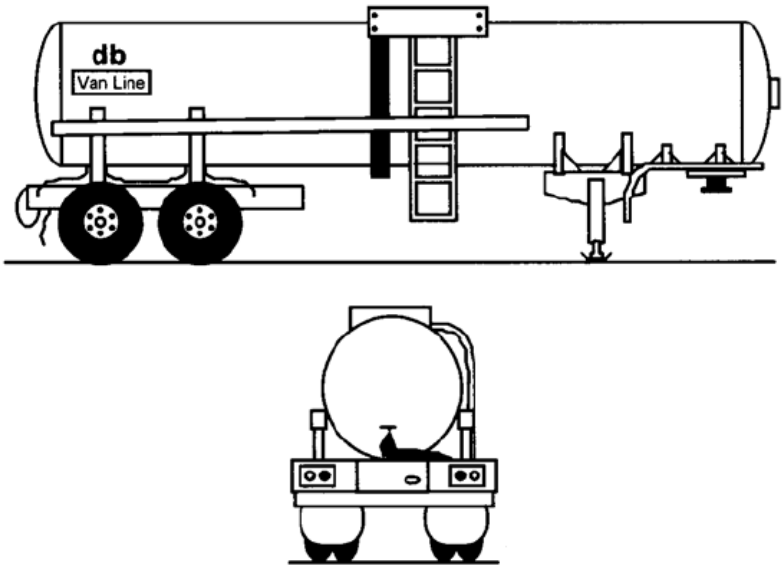
Low-Pressure Chemical Carrier

The trailer shown here, a round cylinder often insulated with a double shell, probably contains poisons, mild corrosives, or mild oxidizing solutions. This type of trailer may or may not have reinforcing rings. (Compare with the Corrosive Liquid Carrier below.) DOT407, TC407, SCT307; MC307, TC307.



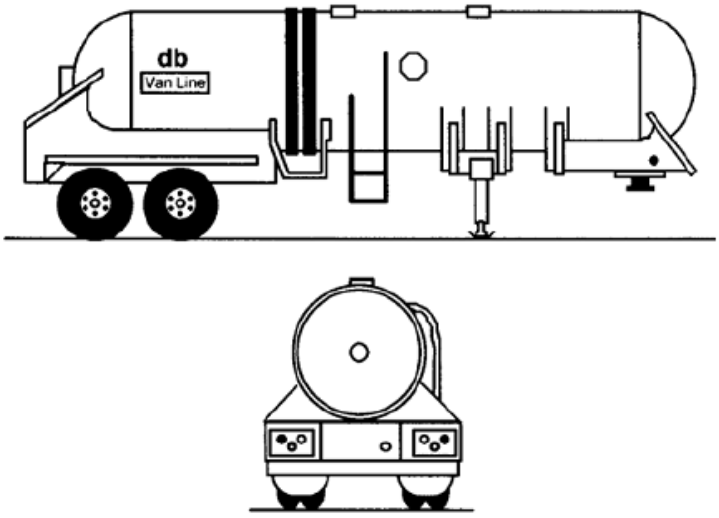
Corrosive Liquid Carrier

These tanks can be identified by their small circular diameter with reinforcing exterior stiffening rings. DOT412, TC412, SCT312; MC312, TC312.



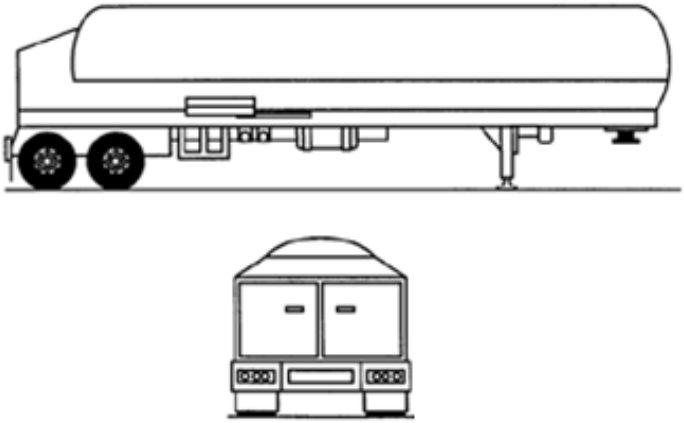
High-Pressure Liquefied Gas Tanker

These tanks are circular with rounded ends. They may carry propane, butane, or anhydrous ammonia under pressure. MC331, TC331, SCT-331.



Cryogenic Cargo Tanks

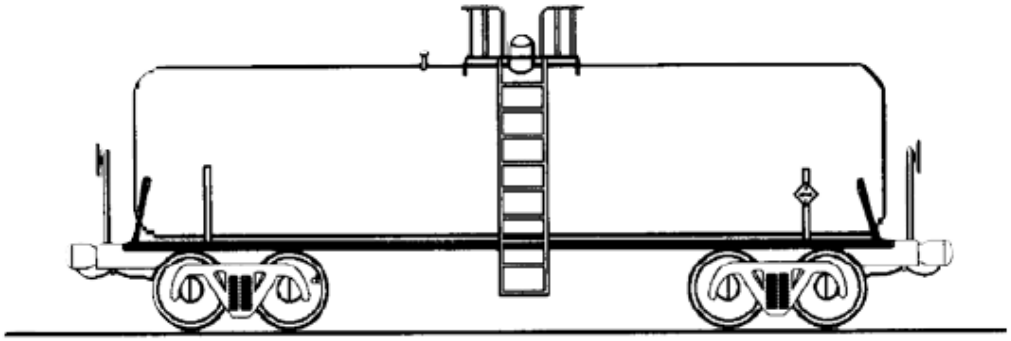
Cryogenic cargo tanks transport cryogenic liquids, which must be kept below –200°F. The cryogenic tank is actually a tank within a tank. The space between the inner and outer tanks is filled with insulation and normally maintained under vacuum. MC338, TC338, SCT-38; TC341, CGA341.



Other road trailer shapes are shown in the Emergency Response Guidebook (ERG).

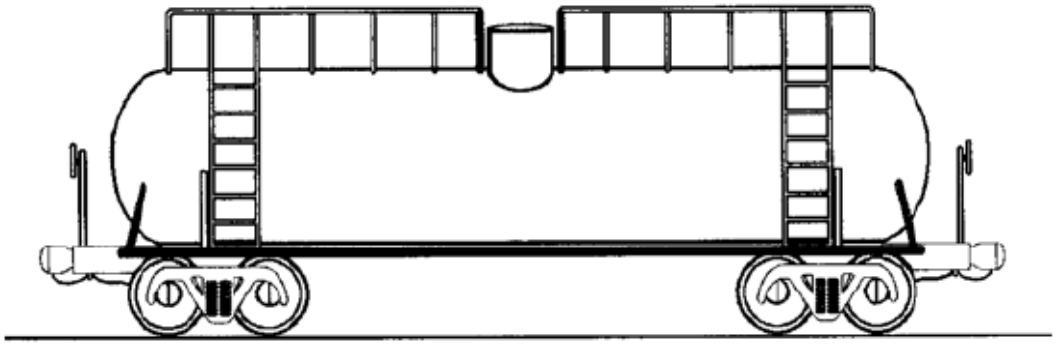
Non-Pressurized Rail Tank Cars

These rail tank cars are identified by the horizontal tank with flat ends and a manway at the top with valves and fittings. These tank cars carry flammable and combustible liquids, flammable solids, oxidizers, organic peroxides, poisons, and corrosives.



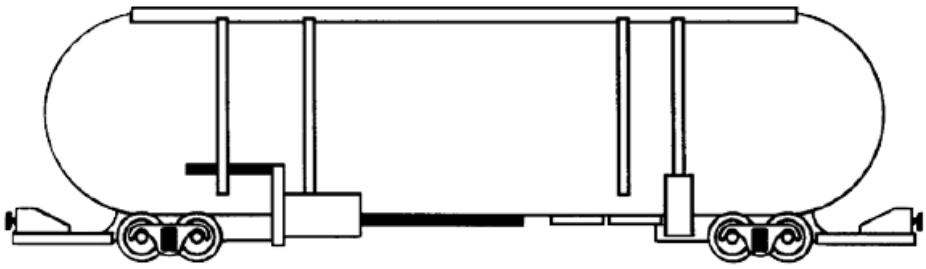
Pressurized Rail Tank Cars

These tank cars also have horizontal tanks but with rounded ends, unless they are double shelled and have a bonnet (dome cover). These tank cars usually carry flammable and nonflammable gases and poisons.



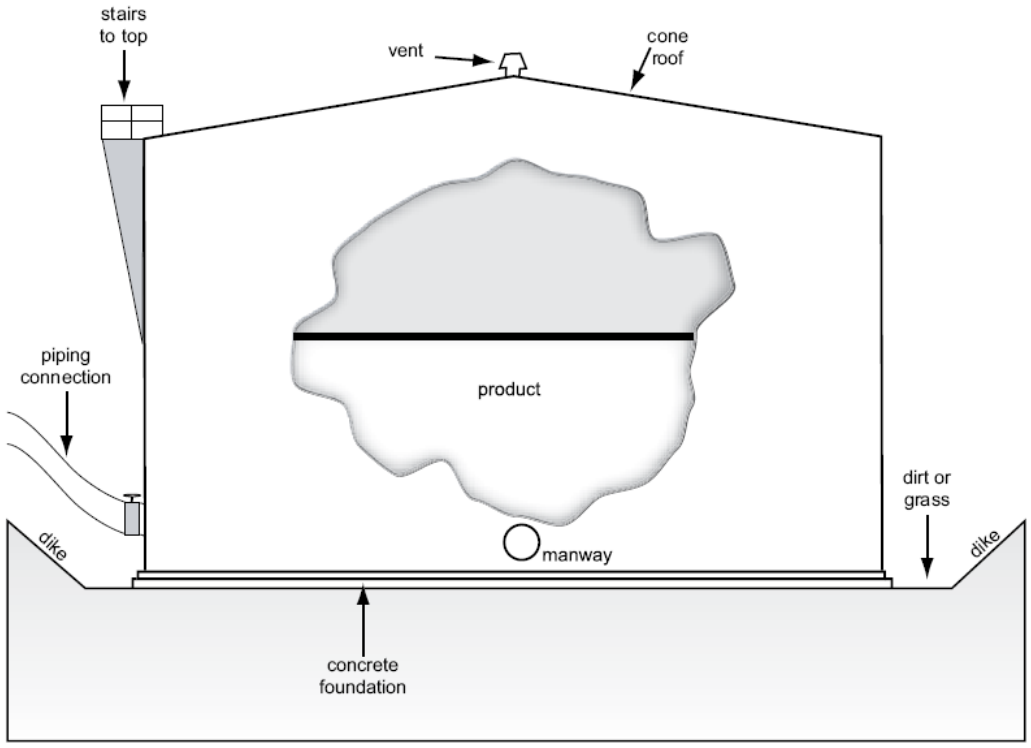
Specialized Tank Cars - Cryogenic

The cryogenic tank car is a tank within a tank. It is distinguished by the absence of top fittings, which are enclosed in cabinets at ground level on both sides or at one end of the car. Cryogenic tank cars may carry liquid argon, hydrogen, and nitrogen.



Fixed Roof Tanks

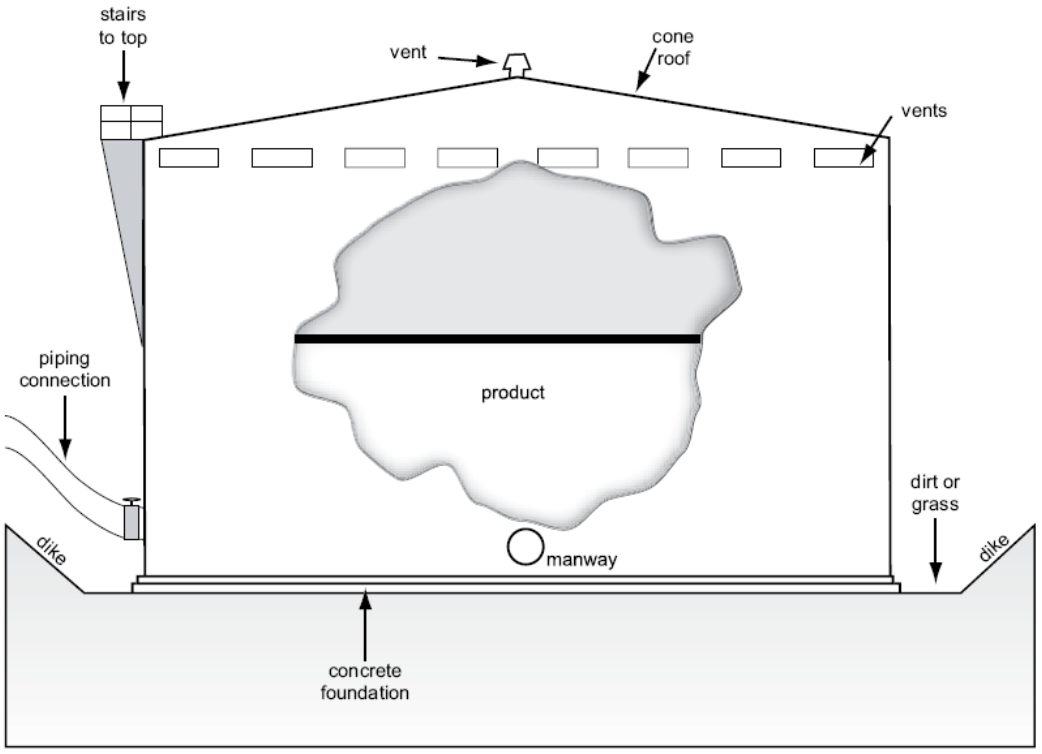
Fixed roof tanks are often identified by a cone roof. These tanks frequently contain hydrocarbons.



- May store anything that will not damage the tank, including flammables/combustibles (with vapor pressure close to atmospheric), corrosives, and poisons
- Pressure vacuum valves and purging with compatible gas eliminates air intake in the space above the product
- Filling and emptying are normally done by valves on the sides of the tanks near the bottom
- Quick opening gauge hatch at top of tank

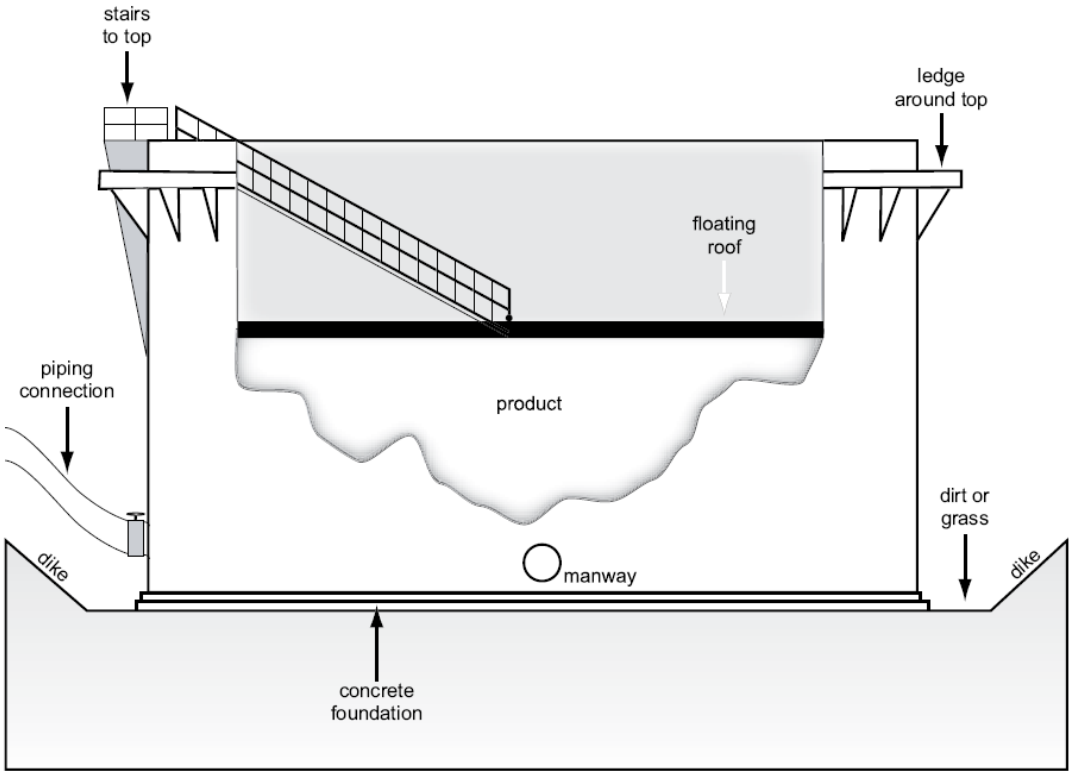
Internal Floating Roof Tank

These tanks are identified by the conical roof and vents around the edge of the tank. They commonly store materials that will easily burn or explode.



1. The floating roof is protected from weather, including lightning strikes
2. Vents prevent accumulation of vapors above the floating roof
3. Used for products with VP > 0.5 psia and < 11.2 psia (examples: gasoline, jet fuel, aldehyde, alcohols, ketones, aromatic hydrocarbons
4. Designed and manufactured based on temperature, pressure and chemical properties of material

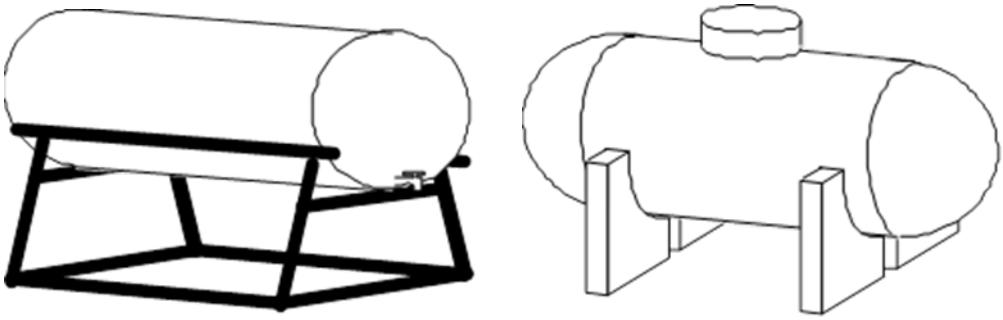
External Floating Roof Tank



- The flat roof floats up and down on the liquid in the tank
- Normally store petroleum products such as crude oil or condensate
- Roof floating on the liquid reduces release of vapors and prevents vapor build-up and rim-space fire hazard
- Snow and rain can accumulate on the roof. Weather can speed corrosion of the roof

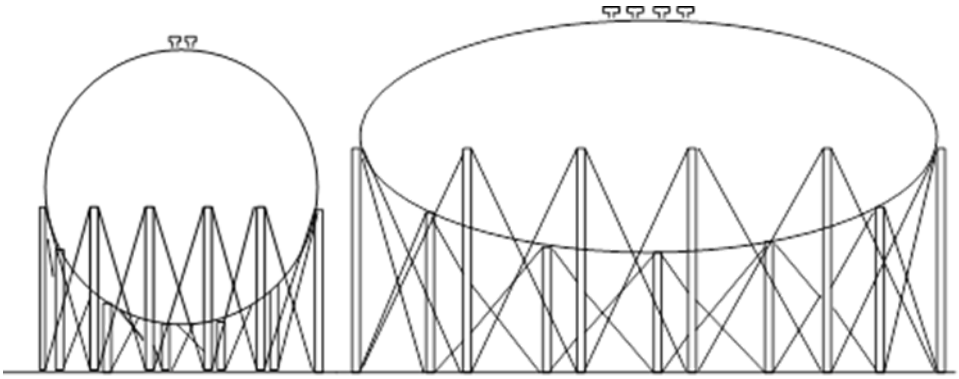
Horizontal Storage Tanks

Horizontal tanks are horizontal cylinders which sit on the ground or on legs. These tanks usually store flammable liquids, corrosives, and poisons but may contain most anything. Pay close attention to the ends of cylinders. Rounded ends may be a clue that the container holds a pressurized liquid or gas.



Sphere Storage Tanks

These may be round or elliptical and have large relief devices at the very top of the tank. Sphere tanks store pressurized materials such as methane, propane, LPG, heptane, ethane, and other light gases.



Underground Storage Tanks (USTs)

Petroleum products and raw materials used in manufacturing processes are frequently stored in underground storage tanks (USTs). Leaking underground storage tanks (LUST), deteriorating piping and product loss during overfilling or poor filling work practices have resulted in potential ground and water contamination.

Drums

The “clues” to the contents of drums come from the material from which the drums are made as well as whether the drum is closed-top or open-top. Closed-top drums are sealed and have small openings in the top through which liquids can be poured. Open-top drums have removable lids and may or may not have the small openings characteristic of the closed-top drum.

Some types of drums and their potential contents are listed below:

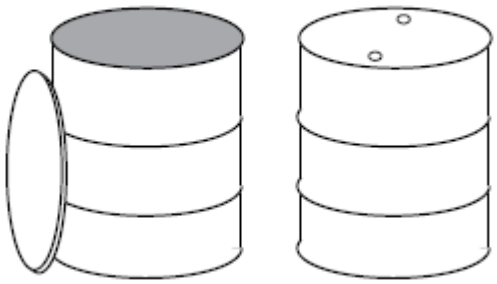
Closed-top metal drums normally contain non-corrosive products in liquid form

Closed-top plastic or composite (plastic inside metal or cardboard) drums usually contain corrosive liquids

Open-top metal drums usually contain non-corrosive solids or sludges

Open-top plastic drums usually contain corrosive solids or sludges

Other types of drums such as stainless steel, nickel, and Monel® are used for chemicals that require special container because of their specific properties. These containers usually can be recognized by their metallic color



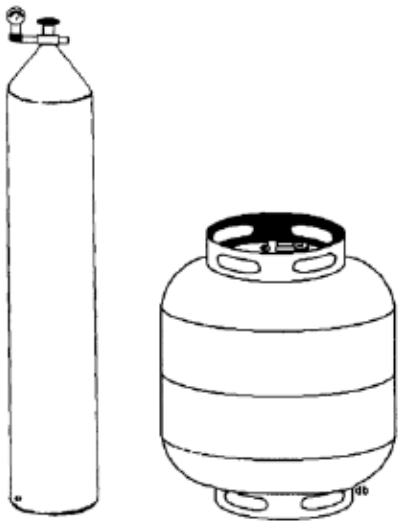
Open-Top (Left) and Closed-Top (Right) Drums

Cylinders

TSDF workers need to be aware of the potential danger posed by the presence of cylinders in an emergency.

Cylinders usually contain **pressurized flammable** or **non-flammable gases**. Cylinders may be involved in transportation or storage facility incidents.

Explosion potential of pressurized cylinders should be considered, particularly in fire situations. Ruptures of the cylinders may result in dangerous airborne projectiles.



Bulk Containers or Totes

Bulk containers are designed to hold up to several hundred gallons of liquid or solid raw material, intermediate or product that may be hazardous or non-hazardous. Intermediate bulk containers (IBCs) are mounted on a pallet and may be designed to be stacked with a forklift or other assistive device depending on construction. Contents (liquid or solid) are removed through a built-in tap. The large size (a 275-gallon IBC is equivalent to 5 55-gallon drums) is an advantage in material handling. Common construction materials are polyethylene housed in a metal cage or heavy gauge (e.g., 1/2-inch-thick) polyethylene that requires no housing and may have a built-in pallet at the base. Additional advantages of these construction materials are low weight, durability and corrosion resistance. IBCs may also be constructed from fiberboard, aluminum, wood and galvanized iron.

Two examples of Intermediate Bulk Storage containers in front of a bulk storage container

Flexible Intermediate Bulk Containers (FIBCs), giant sacks sometimes referred to as 'super sacks', are generally made from woven polypropylene and hold solids. FIBCs are constructed to be moved mechanically, usually by inserting forks into the large loops that are attached into the seams. FIBCs come in a variety of shapes (circular, baffled, u-panel) and sizes; openings and coatings and lift locations can be customized.

Flexible Intermediate Bulk container being off-loaded for shipment.

Workers at facilities using totes should be familiar with the shutoff valves on the specific containers as some have the on/off position opposite of normal due to the location of the valve.

Other types of containers may contain hazardous materials. Liquid hazardous materials may be stored in glass containers. Dry materials may be stored in boxes, bags, or wooden barrels. Hazardous materials stored in these types of containers may be transported by any means or stored at any location. Just because a material is in this type of container does not mean that it is safe.

Chemical container checklist

What information should I observe about the container?

Location

- road
- rail
- fixed facility (tank on pad)
- in building

Shape

- round
- oval
- flat or round ends
- spheres
- cone-shaped

Material

- plastic
- wood
- metal
- glass
- composite
- paper

How do I observe them?

- From a distance
- Upwind
- With binoculars, if possible
- Uphill

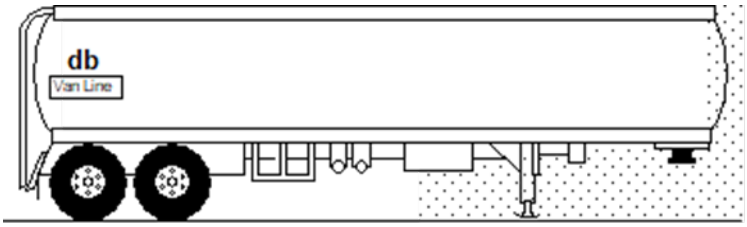
Report any suspect container to your supervisor or the person designated in the ERP.

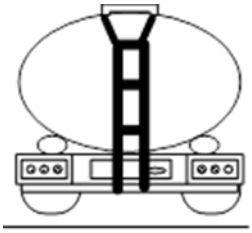
Exercise - Container Shapes and Sizes

The class will be divided into groups. Working with your group, describe the containers shown on the following pages.

Container Shape I

Side View





Back view

Description:_____

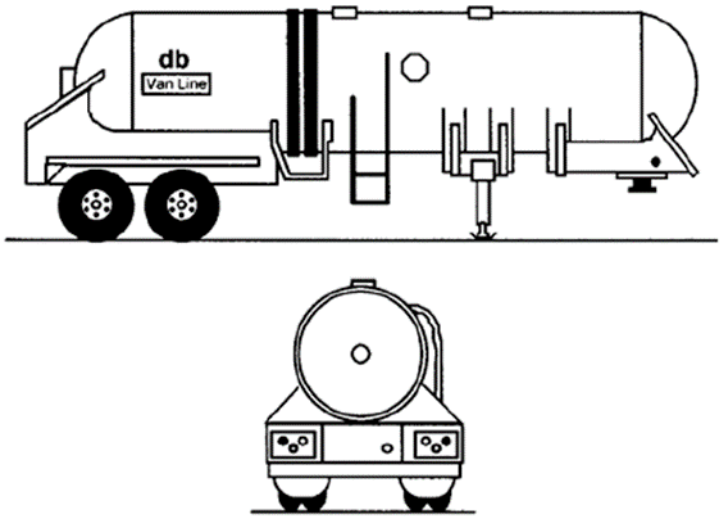
_____

_____

_____

_____

Container Shape II



Description:_____

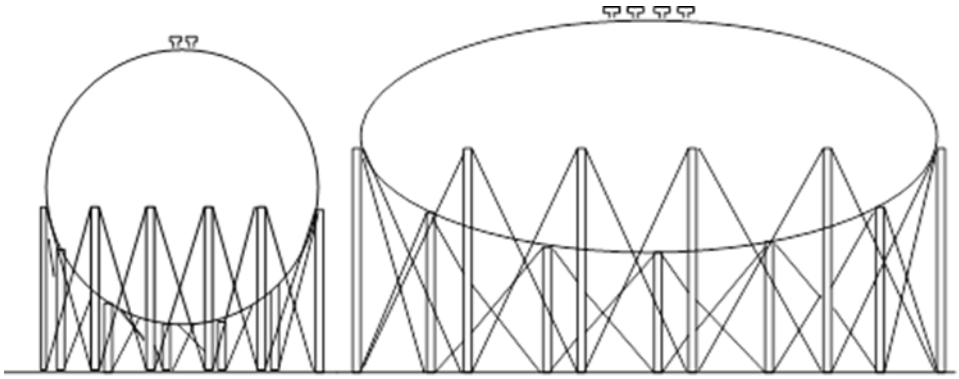
_____

_____

_____

_____

Container Shape III

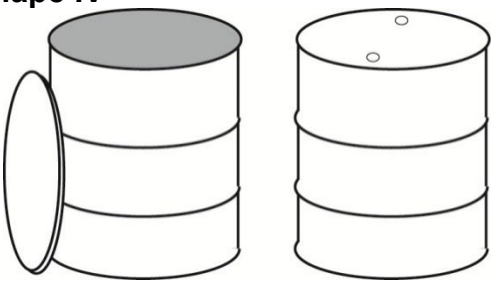


Description:_____

_____

_____

Container Shape IV



Description:_____

_____

_____

4. Documentation

Written documents are available describing the hazardous chemicals and wastes. Four important sources are shipping papers, manifest forms, waste profile sheets and Safety Data Sheets (SDSs). During site characterization, it is important to know whether these resources were found and the types of information each contains.

Shipping Papers

Each shipment of hazardous materials must have paperwork documenting the specific contents of the shipment and relevant information. When hazardous and non-hazardous materials are listed on the same shipping paper, the hazardous materials must be listed first or emphasized by bold font or contrasting color. This paperwork has different names depending on location, as shown below:

Transportation	Location during transport	Common name(s)
Truck	In the cab	Bill of Lading, Waste Profile Sheet
Train	With the conductor	Waybills, Consists, Wheel Reports, Train List
Barge or Ship	In the wheelhouse or on the barge	Dangerous Cargo Manifests
Airplane	In the cockpit	Shipper's Certification for Restricted Airlines

When a shipment arrives at a plant, a copy of the shipping papers is given to plant personnel. As part of site characterization, shipping papers may be found for materials ultimately transferred to the site.

A copy or electronic copy must be retained and include the date of acceptance by the initial carrier. This is retained by shipper for 2 years and the carrier for 1 year. Hazardous waste manifests must be kept 3 years by both carrier and shipper. These must be accessible at the principal place of business and available upon request.

Shipping papers are required by the Department of Transportation (DOT). The shipper of the material provides this information. One of the most frequent violations of the Hazardous Materials Regulations (HMR), 49 CFR Parts 100-185 is a failure to properly describe hazardous material on the shipping papers.

The proper shipping description of hazardous cargo includes the following 4 categories:

- Basic description
- Additional information, depending on the material and mode of transport
- The quantity of the hazardous material
- The type of packaging used

The basic description should include:

- Identification number
- Proper shipping name
- Hazard class
- Packing group

The order in which this information must be shown is given in 49 CFR 172, Subpart C.

- The shipper must provide a certification statement, certifying that the shipment complies with the HMR. The shipping papers must also contain an emergency response telephone number, unless exempted. This number must be monitored by a knowledgeable person at all times while the shipment is underway.
- Shipments of hazardous materials must also include emergency response information to assist emergency responders in the event of an incident. The minimum requirements for the contents of the emergency response information are:
- Basic description
- Immediate hazards to health
- Risks of fire or explosion
- Immediate precautions to take in the event of an incident
- Immediate methods for handling fires
- Initial methods for handling spills or leaks
- Preliminary first aid measures
- For additional information, see http://www.phmsa.dot.gov/

Bill of Lading

The following information must be given in a Bill of Lading:

- Proper shipping name found in the Hazardous Materials Table (HMT) in the HMR
- Hazard class or division number (subsidiary risks)
- Identification number packaging group
- Total quantity being shipped
- Special permits (Examples) DOT-SP, DOT-E
- Emergency Response telephone
- Empty Package
- Transport Modes
- Shipper's Certification
- Packing group
- Marine Pollutants - Vessel mode (non-bulk)
- Poison or toxic inhalation (add info/continuation pages)
- Limited Quantity Hazardous Substance Reportable Quantity (RQ)
- Radioactive

Manifest Form

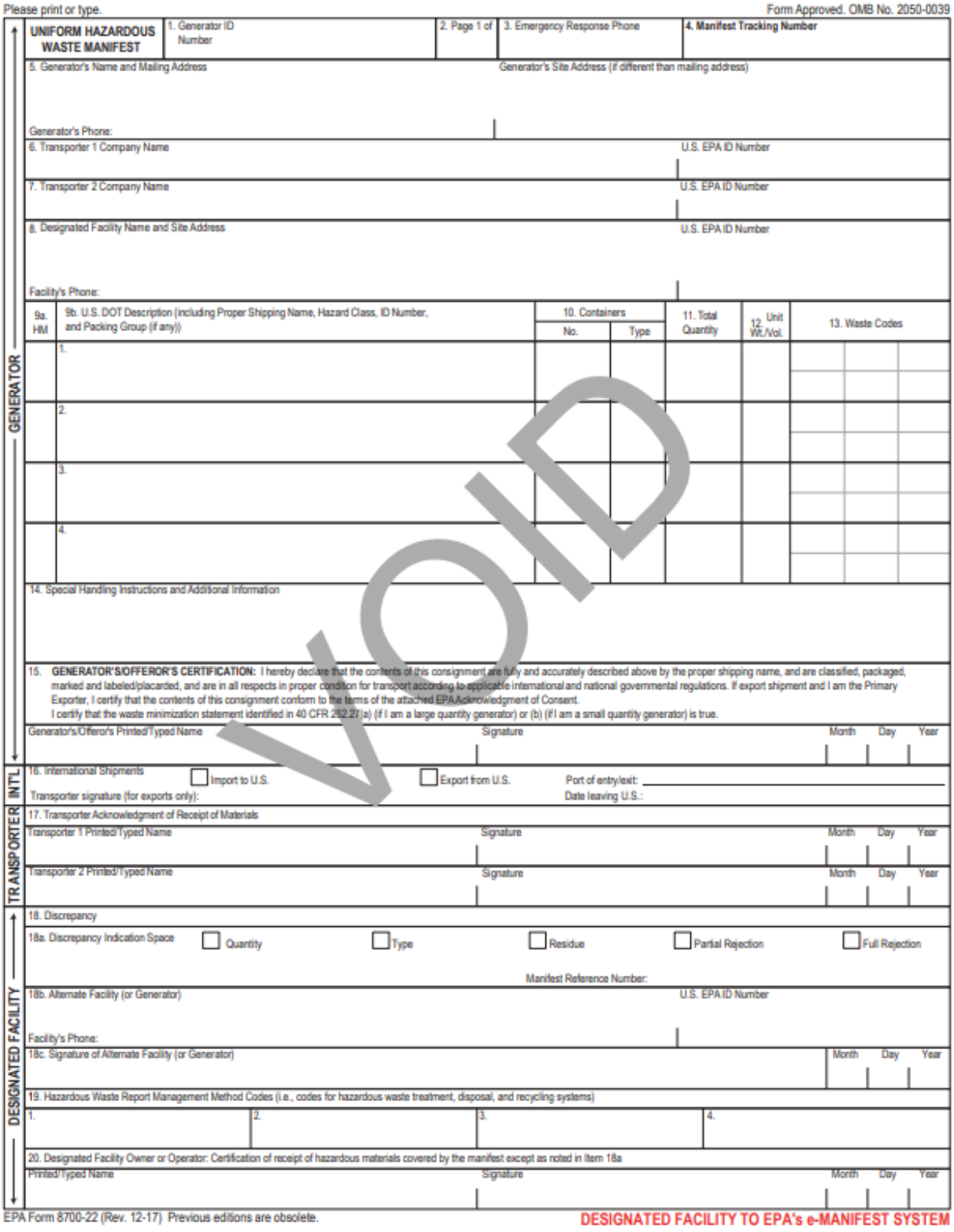
The uniform hazardous waste manifest provides cradle-to-grave tracking of hazardous wastes. As required by the EPA and DOT, all hazardous waste shipments must be accompanied by this form. The manifest consists of a number of copies which are given to the generator, transporter, and site characterization workers. Manifest information may be identified during site characterization. The information on the waste form includes:

- The identification number, name, and address of the generator
- The identification number, name, and address of the permitted work site
- The identification number and name of the hazardous waste hauler
- A description of the contents

For example, a 55-gallon drum of benzene would be labeled U-019 on the manifest form. A hazardous waste stream would have the required EPA identification number on the form (e.g., F002, D001).

An example of a hazardous waste manifest form is presented on the following page.

Uniform Hazardous Waste Manifest Form



Please print or type. Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number | 2. Page 1 of | 3. Emergency Response Phone | **4. Manifest Tracking Number**

GENERATOR

5. Generator's Name and Mailing Address — Generator's Site Address (if different than mailing address)

Generator's Phone:

6. Transporter 1 Company Name — U.S. EPA ID Number

7. Transporter 2 Company Name — U.S. EPA ID Number

8. Designated Facility Name and Site Address — U.S. EPA ID Number

Facility's Phone:

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1.					
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name — Signature — Month Day Year

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name — Signature — Month Day Year

Transporter 2 Printed/Typed Name — Signature — Month Day Year

DESIGNATED FACILITY

18. Discrepancy

18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

18b. Alternate Facility (or Generator) — U.S. EPA ID Number

Facility's Phone:

18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1. | 2. | 3. | 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a

Printed/Typed Name — Signature — Month Day Year

EPA Form 8700-22 (Rev. 12-17) Previous editions are obsolete. **DESIGNATED FACILITY TO EPA's e-MANIFEST SYSTEM**

VOID

Waste Profile Sheets

The waste profile sheet (pre-acceptance laboratory analysis sheet) is a document provided by the laboratory that conducted the analysis of the hazardous waste. The profile sheet describes the waste sample, including details of the physical and chemical properties such as the concentration, toxicity, and disposal restrictions. Information from any available waste profile sheets is important for site characterization. An example can be found at: https://www.epa.gov/sites/production/files/2015-04/documents/tsdf-wap-guide-final.pdf.

Safety Data Sheets (SDSs)

SDSs are required by the OSHA Hazard Communication Standard (29 CFR 1910.1200). Prior to December 1, 2015, an employer provides the SDSs required by HCS2012, or the older version, Material Safety Data Sheets (MSDSs). After that date, SDSs must be used. Manufacturers and suppliers are responsible for providing the new labels and SDSs.

To make this safety information more useful, the SDS consists of 16 required sections as shown in the OSHA Quick Card: Hazard Communication Safety Data Sheets, on the next page. Regardless of supplier or manufacturer, the order of the information must be as listed.

Workers must be trained in reading SDSs and how to work with materials that are routinely used. The SDSs for products used in remediation must be present on the hazardous waste site and available to employees during all shifts.

OSHA QUICK CARD™

Hazard Communication Safety Data Sheets

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS requires new SDSs to be in a uniform format, and include the section numbers, the headings, and associated information under the headings below:

Section 1, Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.
Section 2, Hazard(s) identification includes all hazards regarding the chemical; required label elements.
Section 3, Composition/information on ingredients includes information on chemical ingredients; trade secret claims.
Section 4, First-aid measures includes important symptoms/ effects, acute, delayed; required treatment.
Section 5, Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire.
Section 6, Accidental release measures lists emergency procedures; protective equipment; proper methods of containment and cleanup.
Section 7, Handling and storage lists precautions for safe handling and storage, including incompatibilities.
Section 8, Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).
Section 9, Physical and chemical properties lists the chemical's characteristics.
Section 10, Stability and reactivity lists chemical stability and possibility of hazardous reactions.
Section 11, Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.
Section 12, Ecological information*
Section 13, Disposal considerations*
Section 14, Transport information*
Section 15, Regulatory information*
Section 16, Other information, includes the date of preparation or last revision.
*Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15(29 CFR 1910.1200(g)(2)).

Employers must ensure that SDSs are readily accessible to employees.

For more information: www.osha.gov

OSHA (800) 321-OSHA (6742) U.S. Department of Labor

Limitations of Documents

Although the SDSs, shipping papers, manifest forms, and waste profile sheets contain important information, they have a number of limitations. Some of these problems are listed below.

- Limited information:
  - Information may be incomplete or inaccurate
  - Space on the form may be inadequate
  - Information may not be relevant for the site or specific use
  - Information may be too general for use
  - SDS may not be current
  - Insufficient time to read and understand the information, particularly in an emergency
  - Insufficient time to call manufacturer/supplier contact, particularly in an emergency
- May not be readily available:
  - Not part of site characterization data
  - SDSs identified during site characterization may be located at a remote location
- Labels on waste containers may be old (not HCS2012) or only partly visible. Alert safety personnel to learn if the contents were identified as part of site characterization.

6. Senses

Your eyes and ears are important to gather information.

Use your eyes to gather information to describe:

- Occupancy and Location
  - Activities conducted in area
  - Location
  - Wind, temperature, precipitation
  - Dead or injured animals
  - Affected grass, trees
  - Smoke or flames
  - Steam or visible vapor release
- DOT Placards and Labels (and other label systems)
  - Markings and Colors
- Container Shapes and Sizes
- Shipping Papers and SDSs

Use your ears to gather information to describe:

- Communication heard from those involved, including injured
- Changes in pressure or pressure releases (hissing)
- Instability (contact sound as loads shift)

Be aware of any new sensation on your skin, especially if clothing is contaminated :

- Burn, tingle

Caution regarding relying on your nose:

- Many hazards (e.g., carbon monoxide, radiation) have no warning properties by smell.
- Some hazards overwhelm the sense of smell and the odor is no longer detected by your nose, but it has not gone away (e.g., hydrogen sulfide or sewer gas)
- Sense of smell varies during illnesses

Caution regarding relying on your eyes:

Some people have difficulty distinguishing colors

Recognizing Biological Hazards

Workers may also be exposed to biological hazards such as bacteria, viruses, certain parasites, mold and animal/bird droppings. Specialized training and equipment are needed to detect or measure these biological hazards. The visual identification of possible mold and bird/animal droppings may be considered ‘positive’ for a hazard.

Infectious Wastes

The most common type of packaged biological waste is probably infectious waste from a research institution or hospital or other health care facility. This type of waste should be in boxes, plastic containers, or **red** plastic bags. These containers should be marked on all sides with the **fluorescent orange** infectious materials symbol shown below.

Infectious Materials Symbol

Examples of infectious materials include used needles and syringes, soiled bandages, test tubes, and disposable vials. Less frequently encountered biological hazards would include biological research materials such as genetic materials and viral and bacterial cultures. If the research materials involve biological agents, the containers should be clearly marked.

Observations of potential hazards may be linked to the characteristics of the area, including:

Poisonous plants

Poison ivy, oak and sumac contact can result in severe allergic reactions. If any part of the response involves the burning of areas where these plants are present, inhalation exposure can occur.

Fungi and yeasts

Mold (a fungus) may be present in storage areas that have been wet. Bird droppings on the support beams of storage buildings (fungus or yeasts cause lung disease). Look for deposits on the highest structures. Disturbing droppings can result in airborne exposure.

Insects

Insects buzzing in the air (infected insects spread Zika, West Nile virus, St. Louis encephalitis, Easter Equine Encephalitis—often referred to as Triple E) may spread disease; workers may be allergic to bee/wasp/hornets stings.

Ticks on the ground in tall grass and wooded areas may carry Lyme and other diseases.

Fire ants and scorpions may hide under items on the ground and sting when moving debris or stored containers.

Spiders may be disturbed under eaves or in leaves or debris. Black widow and the Brown recluse bites can cause serious reactions.

Snakes

Poisonous snakes may be disturbed when materials are moved or if work is in or near bodies of water (rattlesnakes, copperheads, cottonmouths/water moccasins, are hazards)

Animals

Rabid animals (raccoons, skunks, bats, foxes) may bite if approached. Do not approach.

Know how to recognize biologic hazards in your area - If allergic, be prepared.

Recognizing Physical Hazards

Physical and safety hazards include a wide range of potential exposures. Many of the hazards that exist at TSD facilities and operations are the same as those faced by industry every day; and regardless of the type of TSDF, there are several common hazards.

Landfills, waste piles, and land treatment facilities face many of the same problems as the construction industry, including hazards associated with:

- Heavy equipment
- Excavation
- Cave-ins
- Material handling
- Confined-space work

Treatment facilities performing chemical, physical, thermal, biological, and batch treatment face many of the same hazards as the chemical industry. These include hazards associated with:

- Processing equipment (furnaces, reactors)
- Mechanical equipment (pumps, piping)
- Confined-space work (tanks, pits)
- Material handling (forklift, lifting)

In addition, many TSDFs have their own unique hazards. Some examples include:

Landfills

- Unstable work surfaces in landfills due to the types of objects that are placed in them, ranging from machinery to drums to dirt.
- Close working quarters of men and equipment.

Thermal Treatments/Incinerators

- Fire hazards due to heat and volume of flammable materials handled in facilities that do thermal treatment or have incinerators.
- The necessity to treat toxic gases produced during burning to prevent exposure.
- Potential for incompatible material reaction.
- Release of untreated material, fire, or toxic gas from equipment failure.

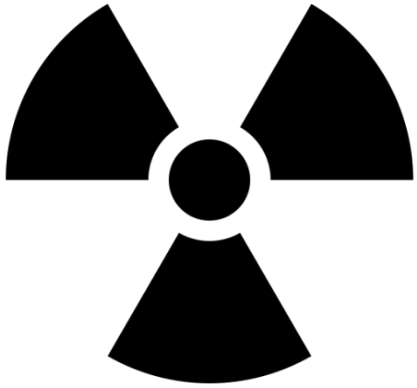
Chemical Treatment

- Potential for incompatible material reaction.
- Improper treatment, control, or equipment failures, resulting in toxic gas release.
- Release of untreated material.
- Exposure to chemicals used for treatment.

The remainder of this section outlines specific physical and safety hazards. Workers need to be on the lookout for physical and safety hazards and use preventive measures.

Radiation

Radioactive sources are used in industry and medicine, and radioactive wastes result from energy and weapons production. The best indication that a radiation source is present is the symbol shown here. It is usually **magenta** or **purple-colored** on a **yellow** background. Workers should keep as far away as possible from any containers with this marking unless they have had specific training and know that they are adequately protected. Where radiation hazards exist, the company must include Standard Operating Procedures (SOPs) in the safety and health plan.



Radiation symbol

All forms of radiation should be considered very hazardous. **Treat anything with this label with respect!**

Ponds and Lagoons

Ponds and lagoons found at hazardous waste sites are used to store large volumes of materials. The hazards around ponds and lagoons include:

- Drowning
- Partially solidified surface
- Corrosive or toxic materials
- Gases or vapors

The precautions that should be used around ponds and lagoons include:

- Using protective equipment such as life jackets, safety belts, or lifelines when working close to unrailed areas
- Wearing protective clothing if material could cause injury if contacted or inhaled
- Keeping railings and work surfaces in good repair
- Limiting access
- Training workers

Confined Spaces and Trenches

Confined space work should never be attempted without training in proper procedures. Examples of confined spaces at hazardous waste sites include trenches, leachate collection tanks and cells that receive waste at landfill operations. Confined spaces will be discussed further in the “Work Practices” chapter of this manual. The regulation covering permit-required confined spaces is 29 CFR 1910.146.

OSHA requires a competent person to oversee any excavation. They do not require cave-in prevention in stable soil if the trench is less than 5 feet deep and removed soil is at least 2 feet from the edge of excavation. Unstable soil excavation of any depth requires protection. Excavation workers are generally required to wear head and foot protection to prevent injury. Refer to the OSHA Construction Standard, 29 CFR 1926.651, for additional details.

Other excavation safety considerations include:

- Locating overhead and underground utilities safely. Many communities have numbers to call to have the utility company mark the location of utilities before you dig.
- Removal of soil (spoil) at least 2 feet from the edge of excavation
- Providing access every 25 feet for ingress and egress
- Identifying vibration or moisture sources that may cause banks to cave in

Electricity

Electrocution may result at hazardous waste sites if there is contact with energized equipment or damaged supply lines. The hazard increases if working in wet areas. Precautions to prevent electrocution include:

- Lock-out/tag-out. (This will be discussed in more detail in the Work Practices chapter)
- Using double-insulated tools
- Using pneumatic equipment
- Using ground fault circuit interrupters (GFCI) on all circuits on outdoor jobs and other potentially wet areas
- Using cords and equipment in good repair and with ground prong in good condition
- Using the OSHA-required electrical PPE for the voltage rating of the circuit

Electrical repair/maintenance work must be done by qualified personnel only.

Slips, Trips, and Falls

Slips, trips, and falls are common causes of injuries at sites. Prevention is the key to avoiding injuries such as broken bones or injured backs. Avoid wet or oily floors. Don't climb up the fall line on steep slopes. Avoid climbing over equipment. Don't put yourself in situations which could result in injury. Examples of situations causing slips, trips, and falls at sites include:

- Slick surfaces
- Steps
- Ice and snow
- Poor-fitting PPE

Ladder safety

Improper use of ladders is a major cause of falls. To prevent accidents when using ladders, the following practices are suggested:

- Inspect ladders before use
- Extend extension ladders 3 feet above the level to be reached
- Tie off extension ladders to prevent slippage
- Check that the distance from the wall is one-fourth of the used length of the ladder
- Avoid carrying items in your hands when climbing ladders. Use a "tag" line to convey items up and down
- Use cages or fall arrestors when climbing fixed ladders
- Use a step ladder tall enough for the job. Do not stand on the top step.
- Never lean out to the side of a ladder past your navel!

NIOSH has a ladder safety smartphone app available at:
http://www.cdc.gov/niosh/topics/falls/

Struck-By Hazards

In 2017, there were 695 occupational struck-by fatalities (https://www.bls.gov/news.release/pdf/cfoi.pdf). At hazardous waste sites, various types of equipment may be moving in proximity to the workers. To avoid being hit by moving equipment, stay alert to activities around you.

To keep drums from striking other workers, you should observe proper stacking procedures. Inspect pallets prior to use; do not use any that appears damaged or weakened.

Vehicle Safety

The following procedures for vehicular safety should be noted:

- Do not leave any unattended unit running
- Listen for vehicle back-up alarms/horns
- Transport equipment being loaded or unloaded should have brakes set and wheels chocked
- Heavy-equipment operators must use seat belts for the roll-over protection system to be effective
- Prevent potential carbon monoxide hazards by minimizing exhaust in closed or low areas

Steam

Steam from ruptured lines can cause severe burns. The steam, or the heat from it, may also react with other materials to compound the problem at sites.

It is possible that what appears to be steam may not actually be steam. Some chemicals may give off toxic clouds that appear steam-like. Also, gases escaping from a pressurized container may look like steam.

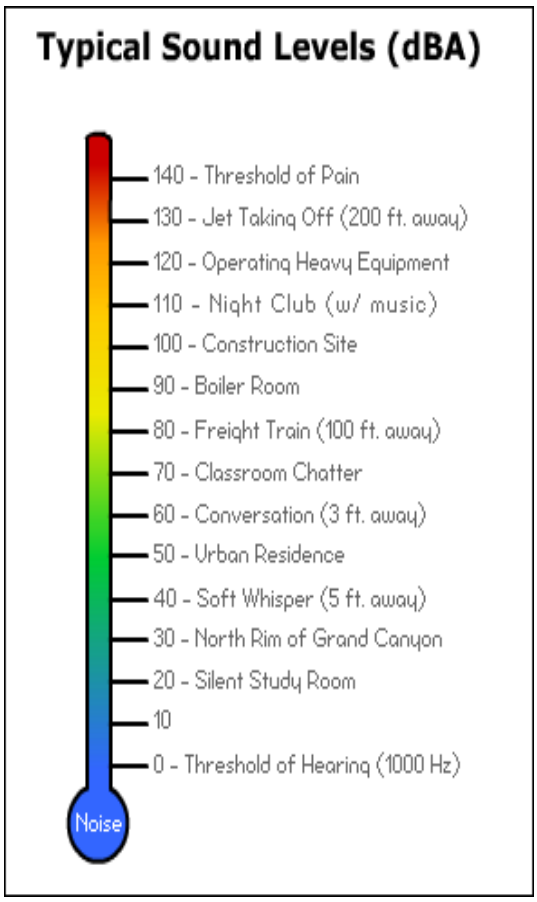
Always maintain a safe distance.

Ergonomic injuries

Injuries from overexertion, vibration, awkward posture, repetitive motion or heavy lifting may result from poor design of the job, making it difficult for workers to complete a task without undue stress. These musculoskeletal disorders (MSDs) or injuries affect several parts of the body including muscles, nerves, blood vessels, ligaments and tendons. See the figures in Toxicology and Health Effects.

Noise

At a hazardous waste site, there are many possible sources of noise. Short exposures to high noise levels can cause a temporary change in hearing or the sound of ringing in your ears. Repeated exposures over longer periods of time to noise can lead to permanent effects, including hearing loss. Exposure to high noise levels is also linked to high blood pressure, insomnia, headaches and psychological stress.



Loud noise in the workplace can interfere with communication and concentration resulting in lower productivity, accidents and injuries.

See the exposure levels here for operating heavy equipment and at a construction site. Notice that the values are shown in dBA, or decibels (dB) measured on the A-weighting scale. This scale mimics the human ear response to sound; it does not measure some of the low frequency sound, as the human ear does not pick up all low frequency sound. Occupational exposure to noise is measured on this scale. dB and dBA cannot be compared easily.

Other useful noise levels are:

Power tools	90-100 dBA
Impact wrench	105 dBA
Air gun	100-120 dBA
Air horn alert system	130 dBA

Over an 8-hour shift, OSHA allows a TWA exposure of 90 dBA. If the sound is louder, less time is allowed; for example, 4 hours is allowed at a TWA of 95 and 2 hours is allowed at a TWA of 100. If the TWA exceeds 85 dBA, a Hearing Conservation Program is required to monitor hearing, provide training and hearing protection. See 29 CFR 1910.95.

NIOSH and ACGIH recommend lower TWA exposures. NIOSH provides an app for noise measurement. See https://www.cdc.gov/niosh/topics/noise/app.html

Buildings (structural integrity and type of construction)

Often buildings on waste sites have been abandoned for some time. Potential hazards include:

- container and material storage, sometimes shifted from initial placement or with damaged packaging
- process/manufacturing equipment
- rotted structural supports, flooring, stairs
- animals or bird droppings

Enter buildings with caution and maintain communication with other personnel unless the integrity of the structure has been documented by engineering.

Falls from heights

Guardrails, safety netting, and/or personal fall arrest systems are used to protect against a fall from a height. If you are working on a construction site, fall protection must be used if you are working 6 feet above the surface or at any height if there are sharp objects (such as ends of rebar or metal debris). If using a scaffold in the construction industry, fall protection is required only at a 10 foot or greater height. However, for activities in general industry, fall protection is required when working four or more feet above the lower level.

Temperature Extremes

Heat

Working in hot environments, especially in protective equipment, puts extra physical stress on the body. Risk increases with increasing temperature.

It is important to know the signs of heat exposure:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat Stroke

These are described on an OSHA QuickCard that you can keep with you. See https://www.osha.gov/Publications/osha3154.pdf

To monitor the risk of heat-related illness, OSHA has a smartphone app. See https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html

Cold

Cold stress is less common but does occur during winter months. OSHA provides detailed approaches to minimize cold-related injury.

- Frostbite
- Hypothermia

See https://www.osha.gov/SLTC/emergencypreparedness/guides/cold.html

An additional hazardous situation is getting trapped in a vehicle during extreme weather. If traveling for work or to/from work during winter months ensure that someone knows where you are, have adequate fuel and stow warm clothing in the vehicle for emergency use.

Equipment maintenance

Maintenance activities may involve welding, cutting, brazing, or grinding, known as ‘hot work’. Ensure that protective measures are taken prior to starting this work, including a hot-work permit if needed.

Exercise - Hazard Recognition

You will be given several handouts for this exercise. This exercise is an opportunity to use resources and compare the information in each.

The Problem

Team members are developing information on materials received at the plant. One material is remover/thinner.

Directions. An SDS is shown on the following pages. Use this and other available resources; working in small groups answer the following questions. One person from the group should be ready to report back the responses.

1. What kind of information should be known about remover/thinner?

2. In the resources provided, what information can be found on the topics listed in Question 1?

3. Do all the sources contain information on the topic?

Safety Data Sheet

Printing date 06/21/2013 Reviewed on 06/21/2013

1. PRODUCT AND COMPANY IDENTIFICATION

· ***Product identifier***
· ***Trade name: REMOVER/THINNER 911***
· ***Article number:*** *911-1*
· ***CAS Number:***
107-98-2
· ***EC number:***
203-539-1
· ***Index number:***
603-064-00-3
· ***Relevant identified uses of the substance or mixture and uses advised against***
No further relevant information available.
· ***Application of the substance / the preparation*** *Laboratory chemicals*
· ***Details of the supplier of the safety data sheet***
· ***Manufacturer/Supplier:***

: Chemco
909 Chemway Ct.
Montgomery, AL
USA

Telephone	: +1 800-999-9999
Fax	: +1 800-888-8888
Emergency Phone # (For both supplier and manufacturer)	: (314) 776-6555
Preparation Information	: Chemco Product Safety – North America 1-800-777-7777

2. HAZARDS IDENTIFICATION

· ***Classification of the substance or mixture***
· ***Classification according to Regulation (EC) No 1272/2008***

GHS02 Flame
Flam. Liq. 3 H226 Flammable liquid and vapour.

GHS08 Health hazard
Repr. 1B H360 May damage fertility or the unborn child.

GHS07

Acute Tox. 4 H312 Harmful in contact with skin.
Acute Tox. 4 H332 Harmful if inhaled.
Skin Irrit. 2 H315 Causes skin irritation.
STOT SE 3 H336 May cause drowsiness or dizziness.

GHS Label elements, including precautionary statements
· ***Hazard pictograms***

· ***Signal word*** *Warning*
· ***Hazard statements***
H312 Harmful in contact with skin.
H332 Harmful if inhaled.
H315 Causes skin irritation.
H336 May cause drowsiness or dizziness.
· ***Precautionary statements***
P261 Avoid breathing dust/fume/gas/mist/vapours/spray.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P321 Specific treatment (see on this label).
P322 Specific measures (see on this label).
P405 Store locked up.
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

· ***Classification system:***
· ***NFPA ratings (scale 0 - 4)***
Health = 2
Fire = 1
Reactivity = 0

· ***HMIS-ratings (scale 0 - 4)***
Health = 2
Fire = 1
Reactivity = 0

3. COMPOSITION/INFORMATION ON INGREDIENTS

· ***Chemical characterization: Substances***
· ***CAS No. Description***
107-98-2 1-methoxy-2-propanol
· ***Identification number(s)***
· ***EC number:*** *203-539-1*
· ***Index number:*** *603-064-00-3*
· ***Dangerous components:***
1589-47-5 2-methoxypropanol ≤ 2.5%

4. FIRST AID MEASURES

· ***Description of first aid measures***
· ***General information:***

Symptoms of poisoning may even occur after several hours; therefore medical observation for at least 48 hours after the accident.
· ***After inhalation:***
Supply fresh air. If required, provide artificial respiration. Keep patient warm. Consult doctor if symptoms persist.
In case of unconsciousness place patient stably in side position for transportation.
· ***After skin contact:*** *Immediately wash with water and soap and rinse thoroughly.*
· ***After eye contact:*** *Rinse opened eye for several minutes under running water.*
· ***After swallowing:*** *If symptoms persist consult doctor.*
· ***Information for doctor:***
· ***Most important symptoms and effects, both acute and delayed*** *No further relevant information available.*
· ***Indication of any immediate medical attention and special treatment needed***
No further relevant information available.

5. FIREFIGHTING MEASURES

· ***Extinguishing media***
· ***Suitable extinguishing agents:*** *Use fire fighting measures that suit the environment.*
· ***Special hazards arising from the substance or mixture*** *No further relevant information available.*
· ***Advice for firefighters***
· ***Protective equipment:*** *Mouth respiratory protective device.*

6. ACCIDENTAL RELEASE MEASURES

· ***Personal precautions, protective equipment and emergency procedures*** *Not required.*
· ***Environmental precautions:*** *Do not allow to enter sewers/ surface or ground water.*
· ***Methods and material for containment and cleaning up:***
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
· ***Reference to other sections***
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7. HANDLING AND STORAGE

· ***Handling:***
· ***Precautions for safe handling***
Ensure good ventilation/exhaust at the workplace.
Prevent formation of aerosols.
· ***Information about protection against explosions and fires:***
Protect from heat.
Protect against electrostatic charges.
· ***Conditions for safe storage, including any incompatibilities***
· ***Storage:***
· ***Requirements to be met by storerooms and receptacles:*** *No special requirements.*
· ***Information about storage in one common storage facility:*** *Not required.*
· ***Further information about storage conditions:***
Keep receptacle tightly sealed.
Protect from heat and direct sunlight.
· ***Specific end use(s)*** *No further relevant information available.*

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

· ***Additional information about design of technical systems:*** *No further data; see item 7.*
· ***Control parameters***
· ***Components with limit values that require monitoring at the workplace:***
107-98-2 1-methoxy-2-propanol
REL ST: 540 mg/m³, 150 ppm
TWA: 360 mg/m³, 100 ppm
TLV STEL: 360 mg/m³, 100 ppm
TWA: 180 mg/m³, 50 ppm

· ***Additional information:*** *The lists that were valid during the creation were used as basis.*
· ***Exposure controls***
· ***Personal protective equipment:***
· ***General protective and hygienic measures:***
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the skin.
Avoid contact with the eyes and skin.
· ***Breathing equipment:***
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.
· ***Protection of hands:***
Protective gloves:
The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.
· ***Material of gloves***
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.
· ***Penetration time of glove material***
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
· ***Eye protection:*** *Goggles recommended during refilling.*

9. PHYSICAL AND CHEMICAL PROPERTIES

· ***Information on basic physical and chemical properties***
· ***General Information***
· ***Appearance:***
Form: *Fluid*
Color: *Colorless*
· ***Odor:*** *Alcohol-like*
· ***Odour threshold:*** *Not determined.*
· ***pH-value at 20 °C (68 °F):*** *4-7*
· ***Change in condition***
Melting point/Melting range: *-96.7 °C (-142 °F)*
Boiling point/Boiling range: *80 °C (176 °F)*
· ***Flash point:*** *110 °C (230 °F)*
· ***Flammability (solid, gaseous):*** *Not flammable.*
· ***Ignition temperature:*** *270 °C (518 °F)*
· ***Decomposition temperature:*** *Not determined.*
· ***Auto igniting:*** *Not determined.*

· ***Danger of explosion:*** *Product does not present an explosion hazard.*
· ***Explosion limits:***
Lower: *2.3 Vol %*
Upper: *~ 20 Vol %*
· ***Vapor pressure at 20 °C (68 °F):*** *12 hPa (9 mm Hg)*
· ***Density at 20 °C (68 °F):*** *0.962 g/cm³ (8.028 lbs/gal)*
· ***Relative density*** *Not determined.*
· ***Vapour density*** *Not determined.*
· ***Evaporation rate*** *Not determined.*
· ***Solubility in / Miscibility with Water:*** *Not miscible or difficult to mix.*
· ***Partition coefficient (n-octanol/water):*** *Not determined.*
· ***Viscosity:***
Dynamic: *Not determined.*
Kinematic: *Not determined.*
Organic solvents: *34.0 %*
VOC content: *34.0 %*
Density*: 997.9 g/l / 8.33 lb/gl*
Solids content: *66.0 %*
· ***Other information*** *No further relevant information available.*

10. STABILITY AND REACTIVITY

· ***Reactivity***
· ***Chemical stability***
· ***Thermal decomposition / conditions to be avoided:*** *No decomposition if used according to specifications.*
· ***Possibility of hazardous reactions*** *No dangerous reactions known.*
· ***Conditions to avoid*** *No further relevant information available.*
· ***Incompatible materials:*** *No further relevant information available.*
· ***Hazardous decomposition products:*** *No dangerous decomposition products known.*

11. TOXICOLOGICAL INFORMATION

· ***Information on toxicological effects***
· ***Acute toxicity:***
· ***LD/LC50 values that are relevant for classification:***
107-98-2 1-methoxy-2-propanol
Oral LD50 5660 mg/kg (rat)
Dermal LD50 13000 mg/kg (rabbit)
Inhalative LC50/4 h 6 mg/l (rat)
· ***Primary irritant effect:***
· ***on the skin:*** *Irritant to skin and mucous membranes.*
· ***on the eye:*** *No irritating effect.*
· ***Sensitization:*** *No sensitizing effects known.*
· ***Additional toxicological information:***
· ***Carcinogenic categories***
· ***IARC (International Agency for Research on Cancer)***
Substance is not listed.
· ***NTP (National Toxicology Program)***
Substance is not listed.

12. ECOLOGICAL INFORMATION

· ***Toxicity***
· ***Aquatic toxicity:*** *No further relevant information available.*
· ***Persistence and degradability*** *No further relevant information available.*
· ***Behavior in environmental systems:***
· ***Bioaccumulative potential*** *No further relevant information available.*
· ***Mobility in soil*** *No further relevant information available.*
· ***Additional ecological information:***
· ***General notes:***
Water hazard class 1 (Assessment by list): slightly hazardous for water
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
· ***Other adverse effects*** *No further relevant information available.*

13. DISPOSAL CONSIDERATIONS

· ***Waste treatment methods***
· ***Recommendation:***
Must not be disposed of together with household garbage. Do not allow product to reach sewage system.
· ***Uncleaned packagings:***
· ***Recommendation:*** *Disposal must be made according to official regulations.*

14. TRANSPORT INFORMATION

· ***UN-Number***
· ***DOT, ADR, IMDG, IATA*** *UN3092*
· ***UN proper shipping name***
· ***DOT, IMDG, IATA*** *1-METHOXY-2-PROPANOL*
· ***ADR*** *3092 1-METHOXY-2-PROPANOL*
· ***Transport hazard class(es)***
· ***DOT***
· ***Class*** *3 Flammable liquids.*
· ***ADR, IMDG, IATA***
· ***Class*** *3 Flammable liquids*
· ***Packing group***
· ***DOT, ADR, IMDG, IATA*** *III*
· ***Environmental hazards:***
· ***Marine pollutant:*** *No*
· ***Special precautions for user*** *Warning: Flammable liquids*
· ***Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code*** *Not applicable.*
· ***UN "Model Regulation":*** *UN3092, -METHOXY-2-PROPANOL, 3, III*

15. REGULATORY INFORMATION

· ***Safety, health and environmental regulations/legislation specific for the substance or mixture***
· ***SARA***
· ***Section 355 (extremely hazardous substances):***
Substance is not listed.
· ***Section 313 (Specific toxic chemical listings):***
Substance is not listed.
· ***TSCA (Toxic Substances Control Act):***
Substance is listed.
· ***Proposition 65***
· ***Chemicals known to cause cancer:***
Substance is not listed.

· ***Chemicals known to cause reproductive toxicity for females:***
Substance is not listed.
· ***Chemicals known to cause reproductive toxicity for males:***
Substance is not listed.
· ***Chemicals known to cause developmental toxicity:***
Substance is not listed.
· ***Carcinogenic categories***
· ***EPA (Environmental Protection Agency)***
Substance is not listed.
· ***TLV (Threshold Limit Value established by ACGIH)***
Substance is not listed.
· ***NIOSH-Ca (National Institute for Occupational Safety and Health)***
Substance is not listed.
· ***OSHA-Ca (Occupational Safety & Health Administration)***
Substance is not listed.
· ***Product related hazard information:***
The product has been classified and marked in accordance with directives on hazardous materials.
· ***Chemical safety assessment:*** *A Chemical Safety Assessment has not been carried out.*

16. OTHER INFORMATION

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.
· ***Department issuing SDS:*** *Safety Data Sheet Department*
· ***Contact:*** *Safety Department*
· ***Abbreviations and acronyms:***
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
VOC: Volatile Organic Compounds (USA, EU)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
Revision: 06.21.2013

Summary – Hazard Recognition

Health and safety hazards can be grouped into three main types: chemical, biological, and physical.

Chemical

- Flammable
- Toxic
- Carcinogens (cancer-causing)
- Corrosives
- Poisons

Chemical hazards can be recognized with information from six sources: Occupancy and Location; DOT Placards and Labels; Markings and Colors; Container Shapes and Sizes; Shipping papers and Safety Data Sheets (SDSs); and Senses.

Some of the systems used for labels and placards/markings and colors are the ERG (or DOT), NFPA-704, HCS2012, and the HMIS.

The shape of transport and storage containers is related to the contents. The shape may provide important information, especially when the labels and placards are not visible.

A safety data sheet contains information on health effects, physical and chemical properties, fire and explosion hazard, precautions for safe handling, and use of control measures.

Shipping papers document important information about the contents of the shipment.

Biological

- Infectious wastes
- Poisonous plants
- Fungi, yeasts
- Insects, snakes, animals

Recognizing biologic hazards requires careful observation. Only infectious wastes may be marked.

Physical

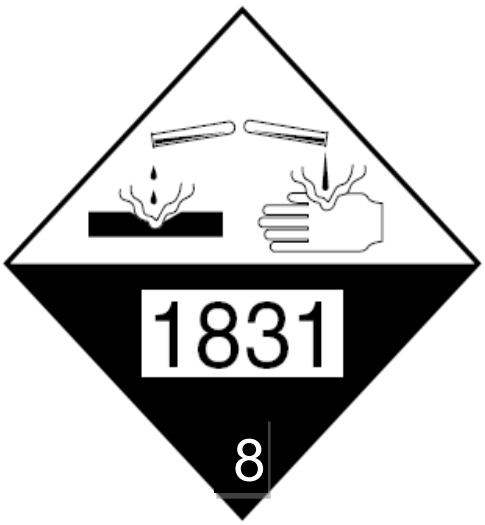
- Radiation
- Noise
- Slips, trips, falls
- Electricity
- Heat and cold
- Steam
- Confined spaces

Signage may alert you to physical hazards, especially radiation, noise, electrical or confined space; however do not rely on signage. Be alert for wet, uneven or unstable walking surfaces and emissions that may appear to be steam.

Review Questions

1. List major types of health and safety hazards.

2. On the placard provided, what information is shown?



3. What do the following pictograms mean?



_____ _____ _____

4. What do the following symbols indicate?

_____ _____ _____

5. Why is a container shape important?

6. List major types of information contained on an SDS.

7. Where are shipping papers kept in a truck when sitting in the driver's seat? When leaving the vehicle?

HAZARD CONTROL

This section introduces the types of hazard controls that may be implemented to protect your safety and health. Hazard controls may be broken down into three general categories: (1) engineering controls, (2) administrative controls, and (3) personal protective equipment. This section will introduce hazard control and show how it can be applied to certain situations you are likely to find at a TSD site. Specific methods of hazard control appropriate to this course will be developed in later sections of this manual.

Chapter Objectives

When you have completed this section, you will be better able to:

- Understand the necessity for and regulations supporting hazard control.
- Identify and explain how different types of engineering controls can protect worker health and safety.

Introduction

Hazard controls may be broken down into three general categories: (1) Engineering controls, (2) Administrative controls, and (3) Personal protective equipment.

Engineering controls are in place when automatic or permanent features have been designed into the work process to prevent or reduce employee exposure to hazards. Different types of engineering controls will be described in this section.

Administrative controls can take the form of detailed written procedures for work practices. These specified procedures (work practices) are designed to reduce or monitor health hazards or eliminate safety hazards. A later section of this manual will go into more detail concerning specific work practice controls that may be in operation in your facility.

Personal protective equipment should be used only if engineering or administrative controls are not feasible or fail to control the hazard adequately. Later sections of this manual will go into detail concerning the use of personal protective equipment.

Federal Regulations and Hazard Control

Hazard control requirements are found in both the RCRA regulations and OSHA standards. The intent of both is to protect worker health and safety, but there is not always one single regulation or standard that applies to every hazard you find.

There may not be an OSHA standard which applies to every health or safety hazard recognized at a TSD facility. In addition, even if there is a standard which does fit, there may not be a specific means to control that hazard. Just because a hazard is not specifically listed in the OSHA standards does not turn what you believe to be a hazardous situation into a non-hazard.

Example: OSHA does not have any standards relating to maximum levels a person can lift, although there are voluntary guidelines for lifting published by the National Institute for Occupational Safety and Health. Nevertheless, a worker can suffer serious physical harm, such as a serious back injury, from performing an unsafe lift. Just because there isn't an OSHA standard that covers this topic doesn't mean there is no hazard there. But there are effective means of hazard control that can reduce the hazards of unsafe lifting. These methods include using a mechanical lifting device such as a hoist or crane (an engineering control), using a drum cart or trolley, using the buddy system when lifting (an administrative control), and implementing two person lifting (a work practice control).

Health Hazards and Hazard Control

OSHA's hazard control approach to airborne health hazards is primarily based upon standards which are found in Tables Z-1 through Z-3 of 1910.1000. These tables establish Permissible Exposure Limits; and before any hazard control action is usually taken, the Permissible Exposure Limit (PEL) must have been exceeded. In other words, air monitoring results which demonstrate concentrations below the Permissible Exposure Limit do not require any further hazard control action, even though many employers may take some action regardless.

Other OSHA health standards include those which begin at 1910.1001 (Asbestos) through 1910.1047 (Ethylene Oxide). In addition to establishing a Permissible Exposure Limit, these standards also establish very specific methods of hazard control, including engineering and administrative controls.

Example: The OSHA Asbestos standard requires air monitoring in areas where asbestos removal activity occurs. If air monitoring determines that an action level, currently one-half of the Permissible Exposure Limit, has been exceeded, the employer must immediately take certain corrective action, including training and medical monitoring. The standard also requires that wet methods be used when removing asbestos regardless of the airborne concentration and prohibits the use of

compressed air in asbestos removal operations. The wet methods requirement is an administrative control, and the compressed air ban is an engineering control.

If the particular health hazard can be found in Sections 1910.1001 through 1910.1047, then your employer can utilize the specific hazard control mechanisms described in those standards. If the health hazard is listed in the Tables Z-1 through Z-3 in 1910.1000, then your employer must first do air monitoring and then compare the results with the established Permissible Exposure Limit. If that limit has been exceeded, then engineering or administrative controls are used to control the hazard.

If the air monitoring results are lower than the PEL, it does not necessarily mean that there is no hazard or that hazard control is unnecessary. All that an air monitoring result less than the PEL means is that, according to OSHA, the employer has no legal obligation to implement any control to reduce the airborne concentration.

Ways to Achieve Compliance

The following section of OSHA's 1910.1000 (e) delineates how compliance should be achieved.

To achieve compliance, administrative or engineering controls must first be determined and implemented **whenever feasible.** When such controls are **not feasible to achieve full compliance,** protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section (Section 1910.1000 (e), emphasis added).

According to this standard, remediation of the problem is a two-step process:

- **Step 1** Do air sampling and determine if the PEL has been exceeded.
- **Step 2** If the PEL has been exceeded, determine if engineering or administrative controls are feasible.

Feasible, according to OSHA case law, means both: (a) capable of being done, or technically feasible and (b) economically feasible, or that the cost of installing the hazard control in question is outweighed by the benefits of using it. For the proposed hazard control to be feasible, the answer to both (a) and (b) must be "Yes." If one or both are answered "No," then engineering or administrative controls are not mandatory.

<u>When the PEL is exceeded, but the proposed hazard control is not feasible. . .</u>

If this is the case, your employer is not legally required to implement engineering or administrative controls and may use respiratory and other personal protective

equipment instead. If feasibility was determined by cost, your employer may realize it may be much more effective in the long run to install engineering or administrative controls instead of relying upon respirators and PPE. This is particularly true in TSD facilities where accidental releases or spills of hazardous wastes may have to be reported. Investigations by federal agencies can result in large fines and penalties.

When the PEL has not been exceeded, but there is still thought to be a problem.

Workers and employers alike should be careful not to place too much faith on one single air monitoring result. Air monitoring results are like snapshots of an event on one particular day at one particular time period. If you return to the same scene at a different time or on a different day, the result could be higher or lower. In addition, incorrect monitoring procedures, failure to calibrate equipment, laboratory error, and a host of other problems may make the air monitoring results unreliable.

If the PEL has not been exceeded and you still believe there is a problem, you should bring the matter to the attention of your employer, at a safety meeting, through a safety committee, or through your employee representative and request additional air monitoring or other action. In addition, there are requirements of the HAZWOPER Standard—

> (p) (6), for example— that may work to correct some of these problems independently of air monitoring.

Hazard Control Requirements for TSD Facilities

The following specific requirements are found in the vertical HAZWOPER standard. Section 1910.120(p) requires that TSDFs must:

- Develop and implement a written safety and health program for employees. This program shall be available for inspection by all employees and their representatives.
- Implement a hazard communication program as part of the written safety and health program. This hazard communication program must meet the requirements of OSHA Standard 1910.1200.
- The employer must implement a medical surveillance program meeting the requirements of the Hazardous Waste Operations standard (1910.120 [f].).
- The employer must develop and implement a decontamination program which meets the provisions of 1910.120 (k).
- The employer must provide for initial training of at least twenty-four hours for all new employees and annual refresher training for all employees. There are provisions made for “grandfathering” employees who have had

equivalent initial training, but there are no exemption provisions from the refresher training.

According to 1910.120 (p)(1), the TSDF's written safety and health program must:

- Identify, evaluate, and control safety and health hazards for the purpose of employee protection.
- List emergency response practices and procedures pursuant to 1910.120 (p) (8).
- Include a site analysis, where appropriate.
- Characterize engineering controls and maximum exposure limits.
- Describe hazardous waste handling procedures and, where appropriate, discuss the use of new technologies, such as spill control methods, for handling of hazardous wastes.

Engineering Controls

Many types of engineering controls can exist within a facility. Examples of engineering controls range from providing ventilation in a delivery bay to remove carbon monoxide to providing air conditioning in the cab of a vehicle to prevent heat stroke.

The purpose of engineering controls is to design into plant processes or operations automatic and/or permanent hazard control features which do not rely totally on worker behavior.

The following types of engineering controls are most often found at TSD facilities.

Ventilation Controls

Engineering controls may provide for dilution ventilation, which dilutes the airborne concentration of the hazardous material with clean air. This type of control is only appropriate for less toxic materials.

Alternately, engineering controls may provide exhaust ventilation, which removes contaminated air as close to the source as possible; clean make up air is provided to replace the air that was removed.

In addition, engineering controls may provide for vent scrubbers, which remove contamination as air passes through them. Vent scrubbers may remove contamination by carbon absorption, neutralization, or incineration.

Process Controls

The purpose of process controls is to monitor process operations and sound an alarm or shut down the process if something abnormal is detected. Monitors are normally located throughout the process and are monitored from a central point called a control room.

Types of Process Controls in a TSD Facility

i. **High-level alarm** advises when a level, usually of liquid, has reached too high a point. Normally used in process and storage tanks.

ii. **Low-level alarm** advises when a level, usually of liquid, has reached too low a point. Normally used in areas where material is fed to the process and to protect the process.

iii. **Automatic shut-down** will stop the process or feed of material to the process when an abnormal condition is detected. Normally used with other types of process controls so when they detect abnormal conditions, it triggers shut-down. Uses include temperature controls, flow controls, atmospheric monitors, and similar critical operations.

iv. **Excess pressure venting** can be accomplished through relief valves, rupturing disks, explosion panels, or weak roofs. Designed to vent excess pressure if it builds up in process, in storage tanks, or as a result of explosion.

v. **Interlocks** prevent the process from operation if all conditions are not right. Uses include machine guards, ventilation, cooling systems, scrubbers, and similar devices.

OSHA Standard: Process Safety Management

Some operations at a facility with a TSD may be covered by the Process Safety Management of Highly Hazardous Chemicals, 29 CFR 1910.119. This standard requires hazard analyses and training that are outside the scope of this program.

Material Handling Systems

A material handling system is another type of engineering control. These systems are designed to reduce the workload on employees as well as limit their exposure to contaminants.

Closed systems are those where all hazardous materials are handled within pipes and closed tanks. A closed system allows for the least exposure to employees and is normally used for high-volume, continuous processes.

Open systems are those where hazardous materials are processed in open tanks or similar devices. Typical operations would be batch treatment, drum dumping, or similar operations. Open systems present more exposure than closed systems.

Mechanical handling is another type of material handling system in which the actual handling of the material is done by some type of machinery.

Examples of mechanical handling include:

- The use of forklifts with drum grabbers to handle drums.
- The use of conveyors to move drums or other containers through the process.
- The use of hoists/cranes for unloading large pieces such as transformers or vessels being landfilled.
- The use of earth-moving equipment with enclosed cabs to reduce exposure.

Administrative Controls

The purpose of administrative controls is to develop written procedures and practices which minimize and control worker exposure without, or in combination with, the use of engineering controls or protective equipment. The following examples of administrative controls could be in operation at a TSD facility. More detailed examples of administrative controls can be found in the “Work Practices” section of this manual.

Work Permit Procedure

A Work Permit Procedure is required for any potentially hazardous non-routine those, including tasks that diminish or completely cancel the effect of safety, fire protection or other protective equipment, and work areas. The permit is prepared by a competent individual, and it documents the risk and precautions to be taken.

Pipeline Breaking Procedure

The Pipeline Breaking Procedure is utilized with the Work Permit Procedure to prevent employee exposure to harmful pipeline contents, such as corrosives, flammables, combustibles, explosives, hot material, material under pressure, health hazard materials, and unknowns. The procedure is also used to reduce the risk of physical injury during line breaking.

Lock-Out Procedure

This procedure is utilized to prevent injury, illness, or property damage due to exposure to or the inadvertent starting of process and power equipment. See the Work Practices section of this manual for a more detailed consideration of lock-out.

Hot-Work Procedure

This procedure is utilized with the Work Permit Procedure to reduce the risk of injury and damage from fire or sparks that arise when hot work such as torch cutting, welding, or grinding is performed.

Confined-Space Entry and Rescue Procedure

A Confined-Space Entry and Rescue Procedure is utilized with the Work Permit Procedure to provide guidance, documentation, protection, and preparation for emergency to protect employees and others working in confined spaces. See the Work Practices section of this manual for a more detailed consideration of confined-space entry. The OSHA Confined-Space Entry requirements are found in 29 CFR 1910.146.

Other Administrative Controls

Other types of administrative controls include routine and non-routine inspections, preventive maintenance of equipment and facilities, and worker rotation. Medical surveillance is another type of administrative control that is discussed in another section of this manual.

Hazard Control Exercise #1

Case 1

Assume the Permissible Exposure Limit (PEL—OSHA's maximum allowable concentration for a substance—found in Tables Z-1 through Z-3 of 1910.1000) for acetone has been exceeded, according to air monitoring results. The process operation in this case involves using acetone as a cleaning agent. The proposed engineering control is to install a new ventilation system which will take out the acetone fumes and control the hazard to levels well below the Permissible Exposure Limit (PEL). Assume that the hood and exhaust ventilation system can be built. (There are no major obstacles, and parts are available.)

- What is required of the employer?

- What would be the benefits of the engineering control?

Case 2

Suppose that you utilize gas-powered lift trucks in your shipping and receiving areas. During winter months, the doors to the loading dock are kept closed as much as possible. When a full crew is working, the fumes are rather overpowering. The workers complain of headaches, dizziness, and drowsiness. You ask for air monitoring, and the results indicate the average daily concentration of carbon monoxide during this time is 25 ppm.

Suppose the Permissible Exposure Limit for carbon monoxide (8-hour Time-Weighted Average) is 50 ppm.

- Have you exceeded the PEL?

- If “Yes,” what sort of hazard control would you recommend? If “No,” what should you do?

- If you answered “Yes” to the previous question, list the possible benefits and costs of your proposed hazard control.

- Suppose that the air monitoring results indicated an eight-hour TWA concentration of carbon monoxide of 75 ppm. Would this result change any of your responses to the above questions? If so, how would they change?

Hazard Control Exercise #2

Instructions

Each one of the following three cases is actually a real incident that happened. You will read and discuss each of these cases in your group and attempt to arrive at answers for the following questions:

- What went wrong? Was it something somebody did or something that somebody didn’t do?

- What engineering controls can be used to prevent a recurrence of this incident?

- What administrative controls can be used to prevent a recurrence of this incident?

Your instructor will tell you when time is up on each case. When he or she calls time, you should move onto the next case, no matter where you are in your discussion.

Case 1

Two workers entered a newly constructed tank to repair a bulge that had formed after the flange of the manhole was welded to the tank. The plan was to enter the tank with a jack to force the flange of the manhole into place while a third worker heated the bulge in the tank from the outside. In order to do this, the two workers had to close the manhole; to improve the air within the tank, oxygen used for welding was blowing in through an opening in the tank. Through this opening, a worker on the outside noticed that the hair of one of the workers inside the tank was on fire. The cover was immediately removed, and one the workers managed to escape with his clothing burning rapidly. The second worker had already collapsed and remained unconscious inside the tank. The tank was turned upside down to remove this worker, but he later died. The worker who escaped was hospitalized for several months for serious burns. A rescuer was burned on the hands.

- What went wrong? Was it something somebody did or something that somebody didn't do?

- What engineering controls can be used to prevent a recurrence of this incident?

- What administrative controls can be used to prevent a recurrence of this incident?

Case 2

A 1,000 cubic meter liquid propane tank was emptied to check for stress cracking. The space was to be filled with water to expel the gas then drained so it could automatically fill with normal air. The container was presumably filled with water and drained. A gas analysis of the space showed an explosive gas-air mixture, and the process of filling the tank with water and draining was repeated and the gas test redone. The results showed that an explosive gas-air mixture remained. To speed up the process, a worker climbed into the cylinder and sprayed the interior with water for three hours and allowed the interior to air-dry. On the fourth day, a mechanic entered the tank and prepared the areas to be inspected for stress. Afterwards, another worker entered with a test device and a Katel lamp (220 volts, but not explosion proof).There was a sudden explosion, and a flame came out of the entry port. The individual testing the atmosphere suffered severe injuries from which he died six days later. Further investigation revealed that the tanks had been filled only 50% the first time and only 80–90% the second time.

- What went wrong? Was it something somebody did or something that somebody didn't do?

- What engineering controls can be used to prevent a recurrence of this incident?

- What administrative controls can be used to prevent a recurrence of this incident?

Case 3

An underground storage tank scheduled to be cleaned was blanked with nitrogen to prevent oxidation of the oil. The individual assigned to clean the tank dropped an air hose into the tank before entering. As he reached the bottom of the ladder, he passed out. His helper outside went in to help and, feeling faint, left without getting the first worker out. He went for assistance from the nearby maintenance shop. Three workers accompanied him and climbed down. All were overcome. After about 20 minutes, all four workers were recovered by the fire department. Fortunately, none was seriously injured because the air hose kept blowing air into the tank.

- What went wrong? Was it something somebody did or something that somebody didn't do?

- What engineering controls can be used to prevent a recurrence of this incident?

- What administrative controls can be used to prevent a recurrence of this incident?

Summary - Hazard Control

Hazard controls may be broken down into three general categories: (1) engineering controls, (2) administrative controls, and (3) personal protective equipment.

Hazard control requirements are found both in the RCRA regulations and OSHA standards. The intent of both is to protect worker health and safety. The OSHA requirements for hazard control at TSD facilities follow.

- Develop and implement a written safety and health program for employees. This program shall be available for inspection by all employees and their representatives.
- Implement a hazard communication program as part of the written safety and health program. This hazard communication program must meet the requirements of OSHA Standard 1910.1200.
- The employer must implement a medical surveillance program meeting the requirements of the Hazardous Waste Operations Standard 1910.120 (f).
- The employer must develop and implement a decontamination program which meets the provisions of 1910.120 (k).
- The employer must provide for initial training of at least twenty-four hours for all new employees and annual refresher training for all employees. There are provisions made for “grandfathering” employees who have had equivalent initial training, but there are no exemption provisions for the refresher training.

Examples of engineering controls in TSD facilities include the use of ventilation controls, process controls, and material handling systems.

Administrative controls include the use of written procedures for pipeline breaks, lock- out, hot work, and confined-space entry. (Note: the subject of standard operating procedures, or SOPs, will be covered in the next section.)

MONITORING

Monitoring the environment for hazardous substances should be a regular occurrence at a TSD facility. This section will review techniques to monitor the environment, focusing on the types which the TSDF worker will most likely encounter.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify why and how the work environment is monitored
- Identify some hazards that can be monitored
- Explain the different kinds of air sampling that might be done at a TSD facility
- Describe how sample results are reported and compare them to legal and recommended levels
- Identify some types of monitoring equipment that may be used at a TSD facility

Monitoring for Workplace Hazards

Monitoring provides important information about the presence of hazardous substances at a work site. Proper use of air-sampling equipment can provide information needed to protect life and property.

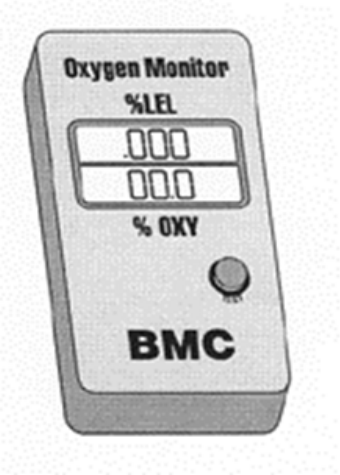
29 CFR 1910.120 (c) and (h) requires air monitoring:

- Upon initial site entry
- When work begins on a different part of the site
- When you start handling chemicals that weren't found before
- At the start of a different operation, such as opening drums instead of well drilling
- When you are handling leaking drums or working with liquid contamination, such as a spill or a lagoon

Monitoring is performed when there is a question as to whether employees may be exposed to hazardous substances; the results are used as one factor in selecting PPE.

The reasons for monitoring are:

- To detect whether potentially hazardous condition(s) exist, or a hazardous substance is present.
- To measure the concentration of hazardous substances.



LEL meter – used to DETECT

Solid sorbent tube, personal pump, lab analysis (MEASURE concentration)

Uses for Monitoring Data

Monitoring is done in order to:

- Determine the effectiveness of hazard controls, such as ventilation
- Determine whether hazardous materials are present during normal operations
- Determine possible immediate effects of hazards, especially conditions which are immediately dangerous to life and health (IDLH)
- Determine when sudden releases of toxic materials occur that would require a change in work practice or donning of a specific type of protective equipment
- Determine the levels of hazardous substance(s) remaining after a sudden release

Whenever a contaminant is detected, it is desirable to measure the concentration if possible and the result can be compared to occupational exposure limits.

Measurement of concentrations is necessary in order to:

- Determine worker exposure level
- Determine the extent of hazardous conditions
- Determine community exposure
- Assist in planning work activity, including PPE needed
- Provide records of exposure
- Provide a historical record to submit to regulatory agencies
- Determine whether there is a need for medical monitoring

Initial entry monitoring is designed to detect IDLH situations at representative areas of the site. Other situations to be identified as part of initial entry monitoring include possible overexposure to chemicals, dusts or radioactive materials, or other dangerous situations such as the presence of flammable or oxygen-deficient atmospheres.

Real-time monitoring will alert workers to hazardous conditions and should be conducted when an IDLH condition is suspected, flammable atmospheres, or indications that exposures may have increased above permissible or published exposure limits since the last monitoring. It is possible that exposures may have changed when:

- Work begins in a different area of the site or tasks change
- Contaminants other than those previously identified are being handled
- Chemical contamination is identified in the work area

The results of monitoring of employees with high exposures will be used to determine future sample collection and:

- If some workers exceed exposure limits, then the program is expanded to identify all overexposed workers
- The monitoring must be repeated if work activities or types of materials handled change

Basic principles for using monitoring equipment: No one monitor can detect all hazardous situations. Select the monitor with the correct sensors for the work area you are entering.

- Know how they work and how to use them
- Know the limitations (consult manufacturer data) of the monitor to be used
- Try to use more than one type of monitor to verify identification

Continuous monitoring helps the worker be aware of the concentrations of some hazards and changes that may occur as a result of the work activity itself or the wind or ventilation changing. Continuous monitoring is much like making a videotape of an event. Grab sampling, on the other hand, provides one single reading, like a snapshot of conditions, which may vary depending on conditions.

What Can Be Monitored in the Air?

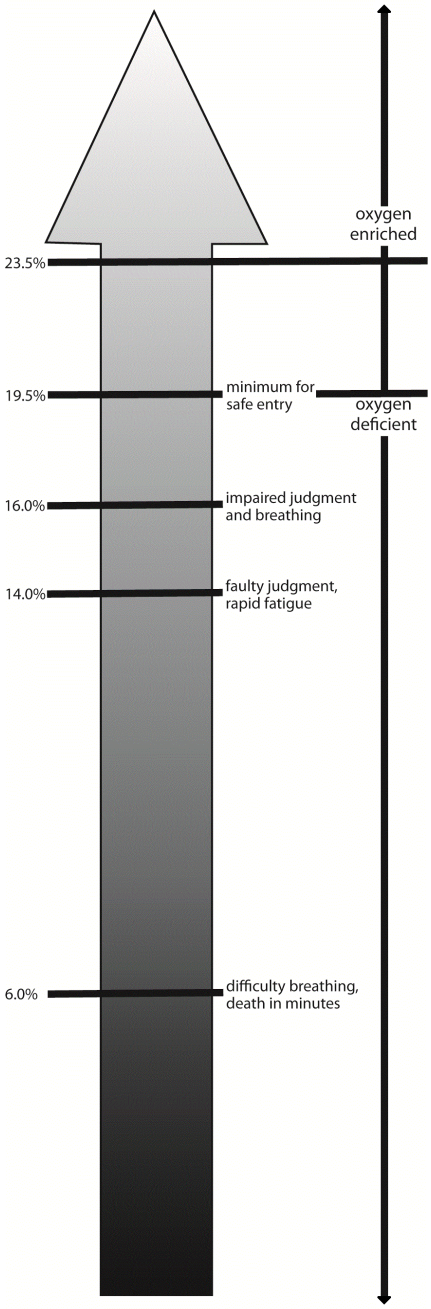
Air monitoring can be used to detect and measure many hazards, including:

- Oxygen Deficiency/Enrichment
- Fire and Explosion Hazards
- Toxic Chemicals
- Corrosivity
- Radiation
- Biological hazards

Oxygen-Deficient/-Enriched

Oxygen-Deficient

Without an adequate concentration of oxygen in the air, the worker is in an immediately dangerous to life and health (IDLH) atmosphere. Normal breathing air contains 20.9% oxygen. OSHA requires a minimum of 19.5% oxygen to be present; otherwise the atmosphere is considered oxygen-deficient. Confined spaces such as tanks, pits, silos, pipelines, boilers, vaults, and sewers are examples of possible oxygen-deficient work areas. Oxygen levels can be reduced during certain chemical reactions, rusting, or some bacterial action (fermentation). Oxygen-deficient atmospheres may cause a person to feel lethargic and potentially lose consciousness. OSHA requires supplied-air respiratory protection or SCBA in atmospheres below 19.5% oxygen.



Oxygen-Enriched

The atmosphere is defined as oxygen-enriched if it contains more than 23.5% oxygen. This situation poses a threat of explosion, especially if flammable materials are present. As a result, special procedures are necessary in the area.

Note: 1% concentration equals 10,000 parts per million (ppm). Oxygen (atmosphere) averages 20.9% or 209,000 ppm. Therefore, toxic concentrations of gases or vapors will not result in a change in oxygen concentration.

Fire and Explosion Hazards

Determining whether there is a possibility of fire or explosion is critical. Flammable and explosive atmospheres develop when reactions occur with oxygen in the air, evaporation of flammables, gas leaks, and dust accumulation. Potentially flammable atmospheres must be monitored frequently in accordance with the Emergency Response Plan (ERP). Protective clothing and respirators which protect the worker from toxic hazards provide little, if any, protection against fire or explosions.

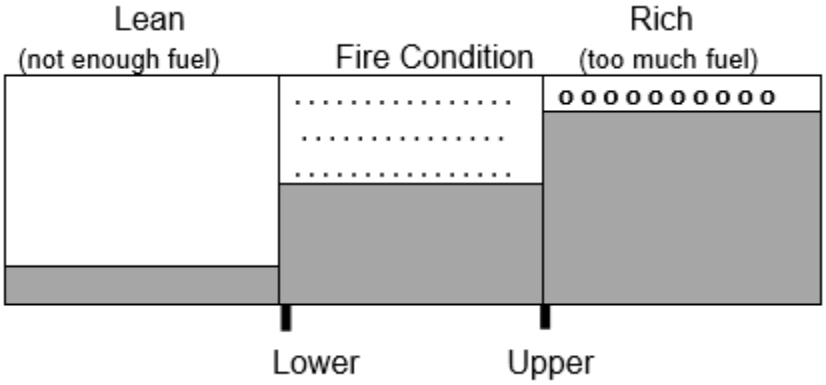
Explosive Limits

Monitoring results reported as percent can provide information about substances in the air which may potentially cause an explosion. For flammable vapors and dusts, explosive limits have been determined. Two limits are defined below:

Lower Explosive Limit (LEL) is the minimum concentration of a flammable gas in the air that can result in ignition. Concentrations below the LEL will not ignite. Below the LEL, the mixture is called “lean.”

Upper Explosive Limit (UEL) is the maximum concentration of a flammable gas in the air which can result in ignition. Concentrations above the UEL will not ignite. Above the UEL, the mixture is called “rich.”

NOTE: UEL and LEL are determined in a controlled lab situation. Changes in oxygen concentration will potentially affect the values.



Explosive Range is the concentration of a flammable gas in the air between the LEL and UEL. In this range, the substance will readily ignite if an ignition source is present.

Toxic Chemicals

Determining the specific hazard by monitoring the air is limited by the capabilities of the monitoring instrument(s) available.

For immediate results, direct reading instruments are used. These provide information about the presence (detect) and sometimes the concentration (measure) of the gas, vapor or dust hazard. They are generally used near active work or near the breathing zone of workers; this is referred to as area monitoring. Conducting personal monitoring of gas, vapor, or dust exposure requires a worker to wear a sampling device; generally the sample is sent to a laboratory to determine the concentration of specific materials in the air.

Corrosivity

Corrosives (acids or bases, having significantly low or high pH) can have adverse health effects, including damage to skin, eyes and the respiratory system. In addition, they can damage monitoring equipment and PPE. Corrosive compounds in the air can be detected using pH paper. If strong acids or bases are present, the pH paper will change color. There are chemical-specific monitors for some acids such as hydrochloric acid.

Radiation from Radioactive Substances

If the presence of radioactive waste is detected, adequate precautions can be implemented to prevent exposure. The presence of radiation usually requires special technicians (Radiation Safety Officers) to conduct monitoring. No single instrument can measure all forms of radiation accurately.

Biological Hazards

Workers may also be exposed to biological hazards such as bacteria, viruses, certain parasites, mold, and animal droppings. Specialized training and equipment are needed to detect and measure biological hazards. The presence of these agents will help determine the selection of PPE, as well as decontamination and disposal procedures. When it is suspected that biological hazards are present, specialists must be brought in to investigate.

Measures of Concentration

Concentration is the amount of substance contained in a certain volume of something else. Concentration of gases and vapors in air are usually measured in parts per million (ppm) or percent by volume of air.

1 ppm, 1 mg/m^3, or 1 f/cc are very dilute concentrations. Some chemicals are hazardous even at these low concentrations. Percent is used for higher concentrations; a concentration of 1% is 10,000 ppm.

Concentrations of particulates, dusts, and mists are usually measured in milligrams per cubic meter of air (mg/m3).

Fiber concentrations are measured in fibers per cubic centimeter (f/cc). A cc is about the size of a sugar cube.

Exposure Limits and Guidelines

Enforceable exposure limits are set by OSHA. NIOSH and non-governmental agencies (such as the American Conference of Governmental Industrial Hygienists [ACGIH]) have also established exposure guidelines. These guidelines and recommendations are not legally enforced. Several exposure limits are discussed below.

Permissible Exposure Limits (PELs)

Permissible exposure limits are legal exposure levels set by OSHA. Employers must keep exposures below the PELs. Values are shown in 29 CFR 1910.1000 and higher numbers in the 1000s; for example, 29 CFR 1910.1052 is methylene chloride.

Results of exposure monitoring can be requested under the OSHA Standard "Access to Employee Exposure and Medical Records" (1910.1020). Records that workers can request include environmental information or personal medical records. According to OSHA 1910.1020(e)(1), "Whenever an employee or designated representative requests access to a record, the employer shall assure access is provided in a reasonable time, place and manner, but in no event later than fifteen working days after the request is made." The employer can comply by either making a copy of the requested record at no cost to the employee, allowing the employee to use the employer copy machine to copy the requested record or by allowing the employee an opportunity to inspect the record.

Threshold Limit Values (TLVs)

Threshold limit values (TLVs) are recommendations for exposure limits which are prepared by the ACGIH, a private, non-governmental agency. TLVs, which are not legally enforceable, do include updates of some levels each year. They are usually more protective (lower) than PELs. TLVs are not listed in the NPG, and the full listing and basis for the concentration are not available for free. The TLV is listed in safety information from chemical suppliers.

Most PELs and TLVs are determined as average exposures over an 8-hour work shift. Some PELs and TLVs have a "skin" description, which means that the material is readily absorbed through the skin.

Recommended Exposure Levels (RELs)

Recommended exposure levels (RELs) are set by NIOSH. RELs are not legally enforceable. Like TLVs, RELs are generally more protective than the legally-enforceable PELs.

Short-Term Exposure Limits (STELs)

These exposure limits are set by ACGIH and OSHA. The STEL is a maximum average concentration a person may be exposed to over a short period of time, usually 15 minutes. It is legally enforceable if set by OSHA. See 29 CFR 1910.1000, Table 22. STEL is sometimes abbreviated further to ST.

Ceiling Limits (C)

The **ceiling limit** (C) is an exposure level set by ACGIH, OSHA, and NIOSH which should not be exceeded at any time. It is legally enforceable if set by OSHA.

Skin, Sensitizer, and Carcinogen Notations

ACGIH uses “notations” to alert you to particular hazards. If a chemical can be absorbed through the skin, the word *skin* is shown in the TLV listing. Chlordane is one example.

Exposures that may result in sensitization are identified with the letters *SEN*. Maleic anhydride is an example of a sensitizer.

The cancer-causing potential of a material is indicated by the letter *A* followed by a number ranging from one to five. *A1* is a confirmed human carcinogen. *A2* is a suspected human carcinogen.

A3 is a confirmed animal carcinogen with unknown relevance to humans. *A4* is not classified as a human carcinogen. *A5* is not suspected as a human carcinogen. For many compounds, no designation is provided because of inadequate data. The TLV booklet has a more detailed explanation of each category.

Time-Weighted Averages (TWAs)

Most PELs and TLVs are 8-hour, time-weighted average concentrations. The purpose of this type of measurement is to determine the average exposure over a typical 8-hour work shift. An example of how the TWA is calculated as follows:

Time-Weighted Averages Calculated

An employee is exposed to acetone at 60 ppm for 6 hours and 12 ppm for 2 hours. What is the TWA?

$$TWA = \frac{(Exposure_1 \times Time_1) + (Exposure_2 \times Time_2) + \ldots}{(Time_1 + Time_2 + \ldots)}$$

$$TWA = \frac{(60\ ppm \times 6\ hrs) + (12\ ppm \times 2\ hrs)}{(6hrs + 2\ hrs)}$$

$$TWA = \frac{(360 + 24)\ ppm\ hrs}{8\ hrs}$$

$$TWA = 48\ ppm$$

Compare this result with the current OSHA PEL for acetone of 1000 ppm.

- Has it been exceeded?
- Was it exceeded for any portion of the time sampled?
- Is there a REL, ST or C designation in the *NIOSH Pocket Guide to Chemical Hazards*?

Important Points to Remember About Exposure Limits and Guidelines

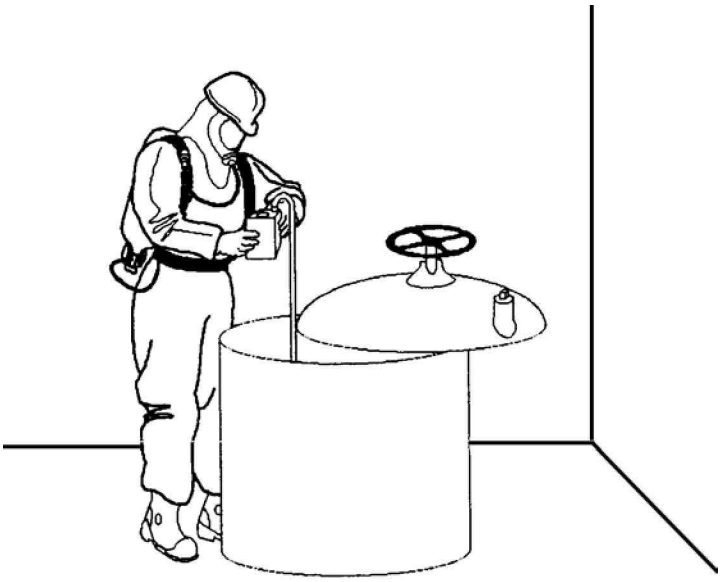
The following ideas are important when thinking about exposure limits.

- Most PELs and TLVs are 8-hour average work exposures; however, most emergencies don't last this long.
- STELs are set for very few compounds
- Measuring exposure during an emergency requires preplanning so emergency equipment is available and ready for use.
- Results of exposure monitoring can be requested under the OSHA standard on access employee exposure and medical records (29 CFR 1910.120).

Types of Air Monitoring

Air samples may be collected by placing monitoring devices directly on the worker (personal monitoring) or by placing a monitoring device in the area where people may work (area monitoring). Monitors (personal or area) with alarms can be set up to alert workers to unusual or unexpected concentrations of substances in the air.

Real-time monitoring is a type of area monitoring which provides a direct reading of air contamination at the moment it is being used. Other types of area monitors collect samples which are sent away for analysis by a lab.



Real-Time, Area Monitoring at a Process Tank

Personal Monitoring

Personal monitoring is done to determine the quality of the air the worker is breathing or would breathe if not protected. Personal air samples are usually collected by placing a battery-operated air pump on the wearer's belt and clipping a collection tube or filter on his/ her collar near the nose, an area known as the breathing zone. Air from the environment is pulled into the collection tube or filter where the contaminants are trapped. The collection tube or filter is sent to a laboratory for analysis.

Another method of collecting personal air samples is through the use of a passive dosimeter. This device is a chemically sensitive badge clipped to the work's collar which collects a sample without using a pump.

Advantages of personal air monitoring include:

- It provides the most accurate measurement of a worker's actual exposure
- The results can be converted to a TWA and compared with the OSHA PEL and ACGIH TLV levels
- It can be used during an emergency response to document exposure throughout the event

Disadvantages of personal air monitoring include:

- It requires laboratory analysis of the sample, which may take 1–14 days
- It provides no data concerning peak or ceiling exposures if collected over several hours
- It generally requires that the exact chemical in the air be known
- It requires preparation so the equipment is ready at any time to be used for monitoring during an emergency response

<u>Wearing a Sampling Device</u>

- The monitor should be worn according to the instructions that are given
- Wearer should request the results of the test using the OSHA Access to Employee Exposure and Medical Records Standard, 1910.1020. (Management must provide these results, if requested.)
- Results can be compared with PELs and TLVs
- The wearer should keep the results and/or give them to a physician

Real-time Monitoring

Real-time monitoring provides an immediate measurement of substance in the air. It can be done with a variety of equipment. The equipment selected at any facility will normally depend upon the potential hazards present. The real-time monitors are often referred to as direct-reading instruments. Various types can detect gases, vapors, dusts, flammable atmospheres, oxygen, radiation, heat, and noise.

Advantages of real-time monitoring include:

- It allows information to be immediately available at the scene
- It is available for a wide range of potential hazards
- It measures chemicals that might cause acute health effects and IDLH situations
- It allows response teams to identify potentially high levels of toxic and flammable materials
- It helps determine whether the atmosphere within a confined space is safe for entry (not oxygen- deficient, flammable, or toxic)

Disadvantages of real-time monitoring include:

- It may not be sensitive enough to detect low levels of contaminants. (A reading of *zero* may mean contaminants are present but at levels below the detection level of the instrument.)
- Most of these instruments cannot identify a specific contaminant or distinguish one contaminant from another
- Those instruments equipped with alarms may give a false alarm. (Note: Any alarm should be considered real until further investigation is conducted.)
- It may give an inaccurate reading because of background levels or the presence of chemicals other than the one being sampled
- Instruments may require factory maintenance

What Can Be Monitored in Soil, Water or on Surfaces?

Evaluation of contaminants in media other than air may be performed. Assessment of water, soil, and surface contamination may be conducted. In addition, corrosivity and compatibility tests may be conducted.

See manufacturer literature for the range environmental monitoring equipment. For specific protocols, search the EPA website.

Soil Sampling

Soil samples may be collected at a site, or on neighboring property to determine if waste has migrated and been released to the soil. Laboratory analysis of soil samples will indicate if there is contamination and the depth and area of the contamination. Contamination by solids, liquids and vapor may be evaluated.

Water Sampling

Sampling and laboratory analysis of effluent groundwater and water from wells, ponds, and streams may be performed at a site to determine whether wastes (examples: metals, biologic, organic compounds) are present or have migrated off-site.

Wipe (Swipe) Testing for Surface Contamination

Surface contamination is evaluated by collecting a sample by passing a filter or wipe across a surface according to a specified procedure and then submitting the sample to a laboratory for analysis. Swipes are often used to evaluate metals and radiation hazards. Contamination of PPE or human skin can also be evaluated by wipe testing.

Drum Sampling

Drum sampling is performed at some TSD facilities to identify or verify the contents of drums or tanks. Usually, a sample is taken with a glass rod called a “thief” by inserting the rod into the drum, placing one’s thumb over the upright end, and withdrawing the rod. The sample captured by the rod is then released into a sample bottle and sent for analysis. Other instruments used for drum sampling may include coliwasa, bailer, and peristaltic pumps. When sampling unknowns or flammables, use bonding and grounding procedures.

Compatibility Testing

Tests performed in a laboratory are used to determine whether the hazardous materials can be mixed (compatible or incompatible) or packed together for processing (lab packs).

Compatibility software programs have been developed by the U.S. EPA, Army Corp of Engineers, and other groups. These approaches to compatibility assessment are qualitative. Compatibility testing is essential to avoid emergency situations from mixing two incompatible materials.

Overall Guidance

Site management is responsible for selecting equipment appropriate for routine sampling and anticipated emergencies. Manufacturers provide information about equipment used and its limitations. NIOSH (National Institute of Occupational Safety and Health) and the EPA (Environmental Protection Agency) also provide information about equipment.

Real-time monitoring with direct-reading instruments provides an immediate result and can be done with a range of devices depending on the information required. If the exposure of a worker is to be evaluated, personal monitoring is conducted; the sample may be sent to a laboratory and therefore may not be available immediately.

Some general considerations when selecting/using monitoring equipment follow:

- The unit should be intrinsically safe. (It will not produce sparks that could trigger an explosion.) Check the label and the manufacturer guide.
- Most direct-reading instruments are designed to detect or measure only one contaminant or group of contaminants.
- There are no instruments which can sample all toxic substances.
- Equipment should be easy to transport and operate in the field under changing conditions and be decontaminated after use as needed.
- Instruments should operate properly at temperatures which are anticipated during site activities.
- Instrument should be easy to observe/operate while wearing PPE
- Instrument training should be provided through routine “hands-on” practice.
- Many sampling instruments have rechargeable batteries that typically last longer than 8 hours when new and fully charged. Operation may reduce the

battery life. Cold temperatures also reduce battery duration of use; never store fully charged equipment in a cold location prior to use.

- Some equipment can be operated with non-rechargeable batteries that can be an option when working in the field.
- For rechargeable batteries, periodically discharge the battery fully and recharge to prevent 'battery memory'.
- Many instruments do not reach the highest readout instantaneously. For chemical sensors, the time to reach 90% of the actual concentration is referred to as T90 and is typically in the range of 15 seconds to 2 minutes.

Detailed information on air monitoring must be included in the company ERP to ensure adequate training, appropriate use, and proper storage and maintenance of equipment. Before you conduct monitoring:

- Receive training in use of instrument and procedure
- Follow the procedure
  - Where to sample
  - Record keeping
  - Report results
  - Report unexpected events

Selecting Monitoring Equipment

Site management is responsible for selecting equipment appropriate for sampling. Manufacturers should provide information about the uses and limitation of their equipment. NIOSH (National Institute of Occupational Safety and Health) and the EPA (Environmental Protection Agency) also can provide information about equipment.

Some general considerations when selecting monitoring equipment follow:

- The unit should be intrinsically safe. (That is, it will not produce sparks that could trigger an explosion.) Check the label and the manufacturer's guide to make sure.
- Most instruments are designed to sample only one contaminant. There are no instruments which can monitor all toxic substances.
- Equipment should be easy to operate in the field under changing conditions
- Instruments should operate properly at temperatures which are anticipated
- Training should be available which gives users a routine chance to practice with the equipment "hands-on."

Sampling and Calibration Protocols

Site management is responsible for the proper use and calibration of all sampling equipment.

Protocols that describe these activities will help to ensure accurate monitoring programs.

- Sampling personnel must be trained in proper calibration procedures.
- Sampling strategies should be developed to provide accurate and reliable results.
- Instrumentation maintenance protocols should be designed to ensure that reliable equipment is available at all times.
- All protocols should be in written form with signatures of responsible parties and effective dates.

Some general considerations during preplanning follow.

- Monitoring equipment appropriate for anticipated hazards should be selected by plant management
- Members of the emergency response team who are expected to use the equipment must be trained in its use
- Emergency response team members should practice using the equipment during emergency response drills
- Equipment must be properly maintained and stored so it is ready for use during an emergency
- Spare parts should be available to repair the equipment in case it is damaged during response activities
- Someone on each shift should be trained to make emergency repairs

Before you sample...

For any sample collection, first make sure you have been trained in the methods and the use of the equipment. It is also important to be trained to recognize problems during sample collection and who to alert if you need assistance.

Below are several considerations for use of instruments during exposure monitoring:

1. Calibrate

Check with the safety officer to be sure that it has been properly calibrated. Calibration involves exposing the instrument to a known concentration of a compound and testing for the proper response. It is important that all instruments be calibrated on a regular basis. Some direct-reading instruments are compatible with a docking station interface (consult manufacturer's data for more information).

2. Be conservative.

If the instrument gives an unexpectedly high response, assume that it is correct. If the reading is suspiciously low, assume that there may be an instrument problem.

3. A zero reading does not mean clean air.

Always remember that a reading of zero does not mean that the air is clean. Some highly toxic materials are not detected by common direct-reading instruments. A reading of "zero" may mean contaminants are present but at levels below the detection capability of the instrument.

4. Read even a small response as positive.

Any response, even a small one, on a direct-reading instrument should be interpreted as indicating a potentially dangerous situation. It is far safer to assume that if the instrument can detect a chemical, the concentration may be high enough to pose a health threat.

5. Use multiple instrument types.

Whenever possible, use more than one type of direct-reading instrument. Remember that each type of instrument has different capabilities, so a reading of zero on one instrument could turn out to be a high reading on another instrument.

6. Have maintenance guidelines been followed?

All equipment is supplied with a recommended maintenance schedule. Follow it. Should any indication of malfunction be noted during routine checks or usage, report it to the safety officer or other designated person.

Monitoring Instruments

TSDF employees frequently use real-time monitors. Instruments are selected to measure the specific potential hazards at each facility. This section outlines the general uses of some commonly used instruments. Management should assure that workers are trained to use the equipment available at the plant.

pH paper

When exposed to a chemical, pH paper changes color.

Use:

Measure presence of corrosive substance

Read-out:

Observed color matched to chart

Notes:

- When pH paper changes color in the presence of corrosive vapors, the color change is easy to interpret. The color change may be harder to interpret when testing liquids.
- Hydrocarbons, which are neutral, may appear to change the color of the paper. In this case, the border between the wet and dry sides of the paper will be straight. If the border is jagged, multicolored, and the liquid seems to be wicking through the pH paper, the liquid is actually corrosive.
- The result may be difficult to interpret depending on the chemicals that are present; for example, in the presence of hydrocarbons, use of pH paper may provide an inaccurate result.
- When using the wetted pH paper for corrosive vapor detection, a neutral reading should not give you a sense of security. Other hazards may be present.
- pH paper can be attached to a stick or an extension tool when approaching an unknown environment, such as during hazard assessment.
- Utilize two pieces of pH paper (one wetted and one dry). The wetted paper reacts more quickly than the dry paper especially for low levels of a chemical in the air. The wetted pH paper is used for detecting corrosive vapor and dry is used to dip into liquids.

NOTE: The presence of strong oxidizers may change the colors and give false results.

Oxygen and Combustible Gas Meters, and Combination Meters

Oxygen Meter

Use:

- To sample oxygen concentration, particularly near and in confined spaces

Read-out:

- Usually 0%–25% oxygen concentration.
- At greater than 23.5% oxygen, the explosion hazard increases.
- The normal oxygen concentration is 20.9% - any deviation from this is abnormal and should be investigated as to why there is a change. (Theoretically, a 0.1% decrease in oxygen due to displacement of the air by another chemical is indicative of a concentration of approximately 5,000 ppm of other chemicals –replacing 1/5 of O_2 and 4/5 of N_2).
- At less than 19.5% oxygen, do not enter without an SCBA or SAR.

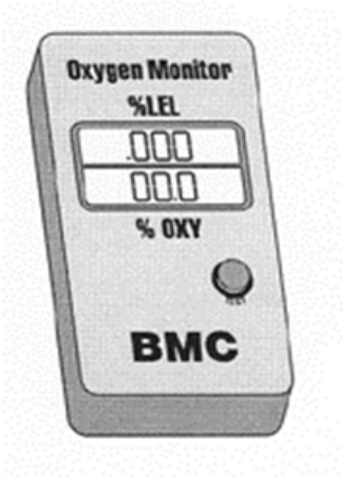
Notes:

O2 sensors

- Need about 2-3 minutes to warm up
- Continuously react with the air
- Contain electrolyte solution
- Operating range: -5° to 120°F
- Affected by temperature and pressure
- High carbon dioxide levels may affect reading
- Typically the meter calibrates for oxygen during each startup
- Requires maintenance (Life of sensor is approximately 2 years under normal use)
- Acid vapors shorten the life of the electrochemical sensor
- Condensation and/or absorption may occur in long probes
- User must be trained

Tip: At -5°F to 32°F sensor reaction time slows and eventually will freeze at extreme temperatures

Combustible-Gas Indicator (CGI)/ LEL Meter/Explosion Meter



Use:

- To measure flammable vapor concentration in percent, particularly near and in confined spaces
- General purpose for most combustible hydrocarbons
- Responds to all combustibles present

Read-out:

- % LEL (sometimes referred to as Lower Flammability Limit, or LFL).
- A reading above 10% should be considered a potentially explosive atmosphere. (Know what to do when a potentially dangerous reading is noted—for example: leave the area, notify supervisor). For added safety, many companies use lower values such as any positive reading, or 5%. The primary reason for this is for a flammable chemical that is also toxic. A low meter reading, or no reading at all, could still be a dangerous environment.
- Accurate over most of its range

Notes:

- Requires periodic calibrations. Normal practice is at least every 30 days.
- Relatively unaffected by temperature and humidity
- Does not respond the same to all vapors
- Oxygen must be measured first. Many combustible-gas instruments require sufficient oxygen (consult manufacturer's manual) in order to determine LEL.
- User must be trained.
- Calibration should be checked or done before each use, as per the manufacturer's requirements. Recommendations vary by manufacturer, but before each use is best practice. It is a good idea to check calibration after using an instrument to verify good data and confirm the sensor was not compromised or injured.
- Should be bump tested to ensure that all sensors are operating before each use
- Nonspecific. Reflects total combustibles present. The specific flammable(s) is not identified. The %LEL is read as if the flammables were the calibration gas. (If a single flammable is present, the manufacturer may provide correction factors.)

- Not recommended for chlorinated hydrocarbons or tetraethyl lead-containing compounds
- Avoid exposing sensors to these poisons (lead compounds, compounds with sulfur, silicones, phosphates and phosphorous) and inhibitors (hydrogen sulfide, halogenated hydrocarbons).

Example:

LEL of methane is 5% by volume
100% LEL = 5% VOL = 50,000 PPM (ignite)
10% LEL = 5,000 PPM Alarm
1% LEL = 500 ppm (LEL 1)
449 PPM $\Rightarrow$ meter displays 0

Example:

calibrated with methane, used in an atmosphere known to only contain pentane reading of 5%

pentane correction factor is 2.0

→actual value is 10% of the pentane LEL

Tip: The common LEL meter is calibrated to read 100% at the LEL of the calibration gas. A small % reading on the meter, while indicating a low risk of fire/explosion at the meter may indicate a potentially toxic concentration. For methane a reading of 5% on the meter indicates a methane concentration of 0.25% or 2,500 ppm.

Important background: LEL sensor technology is typically either catalytic bead on a wire or infrared (IR). The flammable is burned at the bead, increasing the resistance in the wire; the resistance is adjusted for air temperature using a Wheatstone bridge and converted to a reading of LEL. Therefore, oxygen is needed for the meter to function; typically 14% is the minimum required (see manufacturer specs). The IR sensor does not require oxygen for operation.

Problem:

At an abandoned paint factory that is now a waste site, monitoring of a leaking drum of toluene results in an LEL reading of 8% 30 feet from the drum. The calibration gas was methane. Using the toluene correction factor of 1.3, answer the following:

What is the LEL % for toluene?
What is the ppm?
What type of respiratory protection should be used?

Combination Instruments

The meter shown above for combustible gases is also used to measure oxygen. This is a common combination. Combination real-time monitors for oxygen and flammability (LEL, explosivity, combustibility) are approved for use in flammable environments where the oxygen does not exceed 20.9%, unless tested and approved for use in high-oxygen environments. An alternative is to have sample tubing (probe) to draw the air into the meter that is positioned at a location with acceptable oxygen concentration. The length of the sample tubing will vary for each meter, but typically ranges from 30 to 100 feet. Common problems with drawing samples through tubing include condensation of vapors, and absorption onto the tubing.

Three or more hazards can be measured with other combination meters. These multi-gas instruments, which may be called 3-gas or 4-gas meters or something similar, are used to measure oxygen and combustibles and other gases such as carbon monoxide and/or hydrogen sulfide. They are often used to test the atmosphere before entry into a confined space.

Notes:

- The chemical sensors respond to a specific chemical or class of chemicals. Interferences are usually limited (refer to manufacturer literature).

- In addition to temperature, a limitation of these electrochemical sensors is that use in high concentration atmospheres may us up all the reactivity of a cell in a single measurement, rendering the sell useless until there has been time (hours) for the cell to re-stabilize.

  Example:

  While investigating the source of CO in a warehouse demolition, putting the CO monitor near the exhaust of the pay loader may ‘blow it away’ and require replacement or recalibration of the sensor.

Colorimetric Detector Tubes (Dräger, MSA, Sensidyne, RAE)

A colorimetric detector tube is a glass tube containing chemically treated granules that change color when air contaminated with a specific gas or vapor passes through the tube. A tube is selected for the specific contaminant of interest. When the detector tube is used, the ends are broken off and the tube is inserted into a bellows or piston pump. An arrow on the tube indicates which end of the tube to insert into the pump orifice. A predetermined volume of air is pulled through the pump. The contaminant of interest reacts with the chemical in the tube. This reaction produces a stain in the tube with a length proportional to the concentration of the contaminant. Reagent changes include color intensity, length of change and change of color. Compare color to unused tube as changes can be very subtle.

Use:

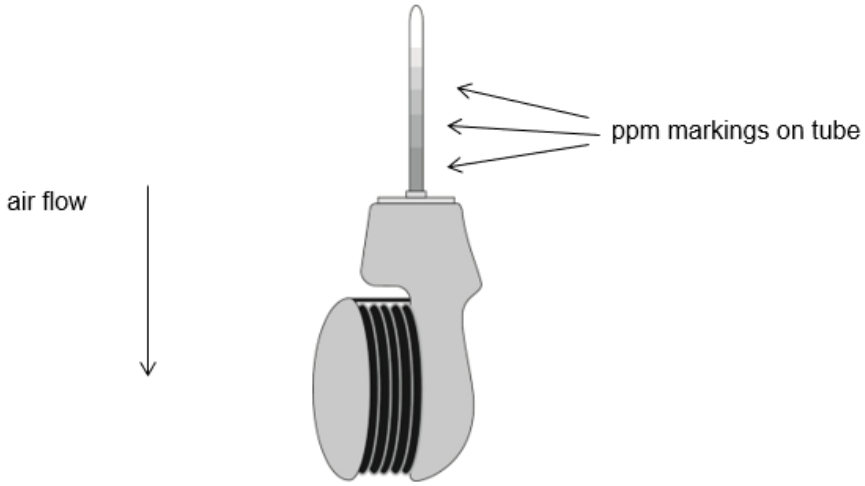
- Measure gas or vapor concentration
- Identify chemical family of contaminant using manufacturer decision charts and tables.

Read-out:

- Concentration in ppm, mg/m3 or percent is indicated by color change or length of color stain.

Notes:

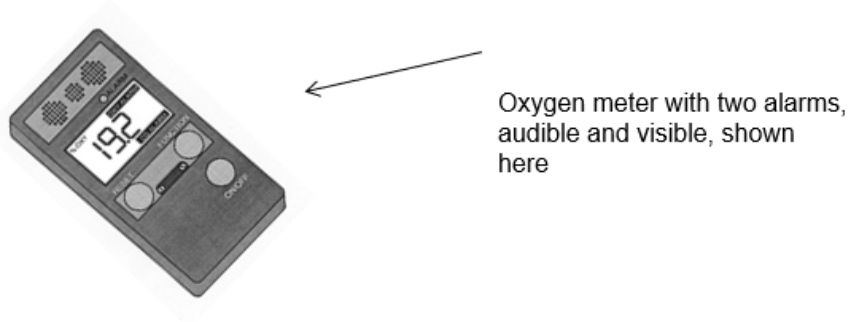
- Not very accurate—within 25% of the real value at best
- Pump must be checked for leaks and calibrated
- Tubes have a limited lifetime so the expiration date on the container should be checked before use
- User must be trained in reading the scales on the tubes used
- User must follow specific pump-stroke requirements and all other directions
- Interferences are possible; not very specific
- May be misread if the sample-taker is color blind
- Specific temperature and humidity ranges shown in directions
- Tube heaters are available from some manufacturers
- Tubes may be marked with number of required pump strokes



Tip: The Dräger Chip Measurement System (CMS)® includes a chip for the chemical of interest. The measurement is complete and digital result read on the screen in 30 seconds to 5 minutes, depending on concentration and chip type. Note that there are not as many chemicals available in the CMS as there are when using single colorimetric tubes.

Personal Alarms

Monitors worn on the belt or in a pocket are used to detect a specific level of a contaminant and sound an alarm to exit the area. Worker in areas where there may be an oxygen deficiency or exposure to carbon monoxide or hydrogen sulfide are among those who may use personal alarms.



Use:

- To detect gas or vapor compared with a pre-set concentration in any workspace
- Alert workers to levels of contaminants to which they should not be exposed

Read-out:

- Audible alarm and sometimes visible alarm and/or display of concentration (examples: ppm or %)

Notes:

- Inaccurate readings may be given if there are interferences
- Battery-operated
- Wearers must be trained in actions to take if the alarm sounds

Hydrocarbon Detectors

The total amount of all detectable flammable organic compounds can be measured using a device with either a Flame Ionization Detector (FID) or a Photoionization Detector (PID). These devices are used to measure exposure to solvents, fuels and volatile organic compounds (VOCs) in the work area; results are compared with exposure guidelines.

Photoionization Detectors (PID)

In PID instruments, ultraviolet radiation is used to ionize (break apart the molecules) gases and vapors. The current produced is proportional to the number of ions and is a measure of concentration.

The energy needed to ionize a compound is its characteristic "ionization potential" (IP), expressed in electron volts (eV). Ionization potentials for selected materials are shown below.

Chemical	IP (eV)	Chemical	IP (eV)
Hydrogen cyanide	13.9	Hydrogen sulfide	10.5
Methane	13.0	Hexane	10.2
Chlorine	11.5	Acetone	9.7
Benzene	9.2	Phenol	8.5

Use:

- To sample toxic and some flammable vapor concentration, particularly near and in confined spaces
- Detects organic and some inorganic gases such as Ammonia, Arsine, Phosphine, Hydrogen Sulfide, Bromine, and Iodine (0.1 – 10,000ppm) (most 1-2000 ppm.)
- Can alert to areas of concern or contamination and be used to find leaks.

Readout:

- Concentration in ppm

Notes:

- Ability to detect wide variety of chemicals in small amounts
- Does not destroy sample
- Quick response
- Can operate in low-oxygen environment
- Detects only those compounds with ionization potentials less than the energy of the lamp
- Response affected by composition of mixed gases
- Only quantifiable if measuring a known substance
- Lamps affected by high humidity, high levels of methane and dust
- Does not detect methane, CO, CO_2, or SO_2
- Cannot separate mixtures
- Other voltage sources may interfere
- Requires calibration (usually with isobutylene)
- User must be trained
- Must know lamp voltage and correction factor (CF)
- Requires regular maintenance

Flame Ionization Detectors (FID)

In FID instruments, the gases and vapors are ionized (molecules broken apart) in a flame. A current is produced which is proportional to the number of carbon atoms. The current is converted to a measure of concentration.

Use:

- To detect many organic gases and vapors
- Can see chemicals with higher IP than PID (more accurate) (1.0-100,000ppm)
- Only organics

Readout:

- ppm

Notes:

- Requires gas chromatography option to identify and measure specific compounds
- Does not detect inorganics
- Affected by low temperatures, high contaminant concentrations, and oxygen-deficient atmospheres
- Must be calibrated
- User must be trained
- Requires maintenance and leak checks
- Must be intrinsically safe if used where explosive atmospheres may exist; some models are not intrinsically safe
- Flame out in high wind
- Only carries limited amount of hydrogen
- Destroys sample
- Needs O_2 to operate

Other Monitoring Instruments

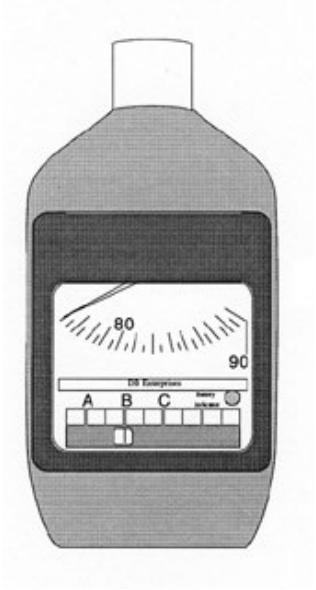
There are other, more specialized direct-reading sampling instruments, such as photo ionization detectors. These instruments require detailed training for operation and use.

Radiation Exposure Monitoring

No single instrument is appropriate for measuring all forms of radiation. In facilities where radiation sources are present, a specific program should be in place. This program will detail how monitoring devices were selected, the type of hazard, and control methods. Area monitors (for example, the Geiger-Mueller tube and Cutie pie) are available. Personal monitors include the film badge and thermo luminescence detectors.

Noise Monitoring

A Sound Level Meter (SLM) is a direct-reading instrument. Some models have additional features such as:



- measure sound in small bands across the entire spectrum of sound, called octave bands
- data-logging for future analysis

Use:

To monitor noise exposure in the area

Read-out:

Decibels (dB) usually on the A scale (dBA)

Notes:

- A-Scale used for occupational exposure
- A-Scale developed to mimic the way the human ear responds to noise
- Requires calibration before and after each use
- Some instruments require manually changing the range of noise that can be measured
- Battery must be checked before use
- General-purpose meters are designed to measure continuous noise only (sounds which last at least 1 second)
- Personnel must be trained to use the instrument

Exercise - Monitoring

For one or more of the instruments described above, you will demonstrate use and complete Performance Checklist (s). Be prepared to discuss findings and ask any questions about the instruments used.

Monitoring Exercise Data Sheet **Name** _____

Type of equipment _____

Brand of equipment _____

Purpose of equipment _____

Sample No. _____ Reading (in units) _____ Distance (in units) _____

Sample No. _____ Reading (in units) _____ Distance (in units) _____

Sample No. _____ Reading (in units) _____ Distance (in units) _____

Sample No. _____ Reading (in units) _____ Distance (in units) _____

Sample No. _____ Reading (in units) _____ Distance (in units) _____

Sample No. _____ Reading (in units) _____ Distance (in units) _____

What are the limitations of this equipment?

Date _____ Instructor's Signature _____

Monitoring Exercise Data Sheet **Name** _____

Type of equipment _____

Brand of equipment _____

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Sample No. _____ Reading (in units) _____ Distance (in units) _____

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Sample No. _____ Reading (in units) _____ Distance (in units) _____

What are the limitations of this equipment?

Date _____ Instructor's Signature _____

Summary - Monitoring

Reasons for monitoring are:

- To detect whether potential hazardous conditions exist
- To measure the concentration of hazardous substances

Air monitoring can be used to detect and measure many hazards, including:

- Oxygen Deficiency/Enrichment
- Fire and Explosion Hazards
- Toxic Chemicals
- Corrosivity
- Radioactivity

Terms to know: PEL, TLV, REL, STEL, ceiling limit, TWA

Full-shift monitoring results are averaged out over an 8-hour work day. This is called a time-weighted average (TWA). Time-weighted averages do not give information on peak exposure. OSHA requires employers to keep air contaminants at or below the Permissible Exposure Limits (PELs). Results of personal monitoring can be compared with OSHA's PELs or recommendations for exposure (such as those set by ACGIH).

There are two types of air monitoring:

- **Personal monitoring** is used to measure the amount of a toxic chemical in the air to which a worker is exposed. This type of monitoring may be done at a response, but often is not feasible.

- **Real-time monitoring** gives you a direct reading of air contamination at the time of use. Direct-reading instruments may be used to detect IDLH conditions, flammable vapors, oxygen, and other toxic materials. This type of monitoring is most frequently used during emergencies as information is needed immediately.

Gases and vapors are generally measured in ppm; mists and dusts are measured in mg/m3, and fibers in f/cc. Personal sampling (when a worker wears a small pump all day and the sample is taken in the breathing zone) gives the best information on a worker's exposure.

Review Questions

1. What are the types of monitoring that might be done?

2. What is the difference between a STEL and a TWA?

3. Match the following.

gas/vapor	f/cc
fiber	mg/m^3
dust/mist	ppm

4. What instruments are used to test air in a confined space?

5. Imagine that a combustible-gas indicator gives a reading of 0%. What are the possible reasons for this reading?

Personal Protective Equipment (PPE) Introduction

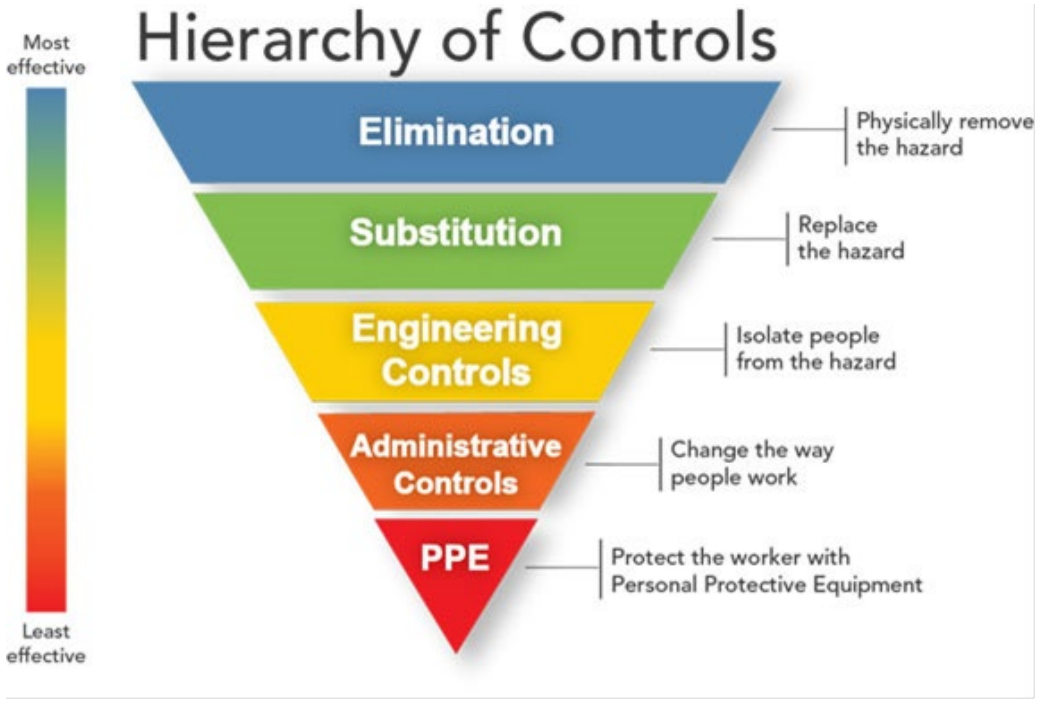
The purpose of PPE is to shield or isolate workers from the chemical, physical, and biological hazards that may be encountered at a TSD facility.

Careful selection and use of adequate PPE should protect the respiratory system, skin, eyes, ears, face, hands, feet, and head. OSHA requires that the selected personal protective equipment must fit the worker who is utilizing it; this can be accomplished by having several sizes. For example, not everyone can wear the same size of gloves; different sizes of coveralls are needed for a person who is 6 feet tall and a person who is 5 feet tall, even if the waist sizes are the same.

In those cases where it is required, the employer must provide and pay for personal protective equipment. The exception is that the employer is not required to pay for PPE that can be used away from the worksite, such as prescription safety glasses and some safety shoes.

In this chapter, respiratory protection, chemical protective clothing and other PPE are covered.

Personal protective equipment is the last choice in the Hierarchy of Controls to prevent exposure.



Source: https://www.cdc.gov/niosh/topics/hierarchy/default.html .

This scheme illustrates that the best and surest approaches to control hazards is to eliminate the exposure or substitute a less toxic material or hazardous process.

The prevention strategies rely on modifying the process (use a robot to explore a possible hazard), contain (build a box), removing through ventilation, a change in work practice that must be done diligently (day after day by everyone) or use of personal protective equipment (may not be 100% effective even when used diligently; requires proper selection, training, cleaning and maintenance).

Work practice controls are often described in written procedures (called administrative controls and include Standard Operating Procedures) that detail how work is to be done or the duration that someone can work in a particular area. For example, an administrative control for emergency response is an Emergency Response Plan that details the various procedures needed from initial assessment to response to termination; confined space entry permitting is a specific administrative control that might be used during a response.

What part of the Hierarchy of Controls is illustrated by the following?

- Closing a lab where there has been a spill to the floor
- Buddy system
- Fire suppression

Respiratory Protection

Respiratory protection is required in TSD facilities in which adequate protection cannot be provided through engineering or administrative controls. This section includes a discussion of the different levels of respiratory protection and information on how to use the different levels. At the end of this section you will have an opportunity to put on, wear, remove, and inspect respiratory protection.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify situations where respiratory protection is needed
- Identify types and features of respirators used to protect against exposure to hazardous materials
- Identify limitations of different types of respirators
- Identify the key components of a respiratory protection program

Use of Respirators

Respirators provide vital protection against chemicals and oxygen-deficient atmospheres. Employers must provide workers with appropriate respirators and training for their use if respirators are needed for usual work tasks or for emergency-response activities. OSHA Standard, 29 CFR 1910.134 requires that a written respiratory protection program be developed by the employer if workers may be required to wear respirators, or if respirators are available for voluntary use.

Respirators are used to help protect the workers' health. Respirators help to prevent toxic chemicals or dusts from entering the lungs. Some types of respirators provide air so that workers can survive in hazardous atmospheres. Different types of hazards require different types of respirators. A number of factors should be considered when selecting a respirator. Consideration of the following questions during preplanning and risk assessment will lead to answers that are useful for respiratory selection.

- Is there enough oxygen in the atmosphere (19.5% to 23.5%)?
- What are the hazardous substances to which the worker may be exposed?
- Is the atmosphere immediately dangerous to life and health (IDLH)?
- What is the concentration of the substance in the air?
- What is the maximum permissible exposure limit (PEL or STEL) for the substance?

Other considerations for selecting respirators for emergency response include:

- Communication needs
- Use in confined space
- Use in extreme temperatures
- Skin/eye contact hazards

Types of Respirators

Two basic types of respiratory protection are:

Air-Purifying Respirator (APR) protects against toxic dusts, gases, and vapors by removing the contaminant from the air before it enters the lungs. APRs include negative pressure and Powered Air Purifying Respirators (PAPR).

Atmosphere-Supplying Respirator (ASR) provides breathing air from a source independent of the work environment. ASRs include supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA).

Air-Purifying Respirators

Air-Purifying Respirators (APRs) are used to protect against specific dusts and toxic chemicals. They work by removing the contaminant by filtering, adsorbing, or reacting with the airborne contaminant air before it is inhaled. If APRs are used:

- all toxic substances must be identified
- the concentration must be known throughout the response by monitoring
- the respirator and cartridge must be selected to protect against those specific chemicals
- the oxygen concentration must be greater than or equal to 19.5%
- APRs are not used in atmospheres Immediately Dangerous to Life and Health (IDLH)

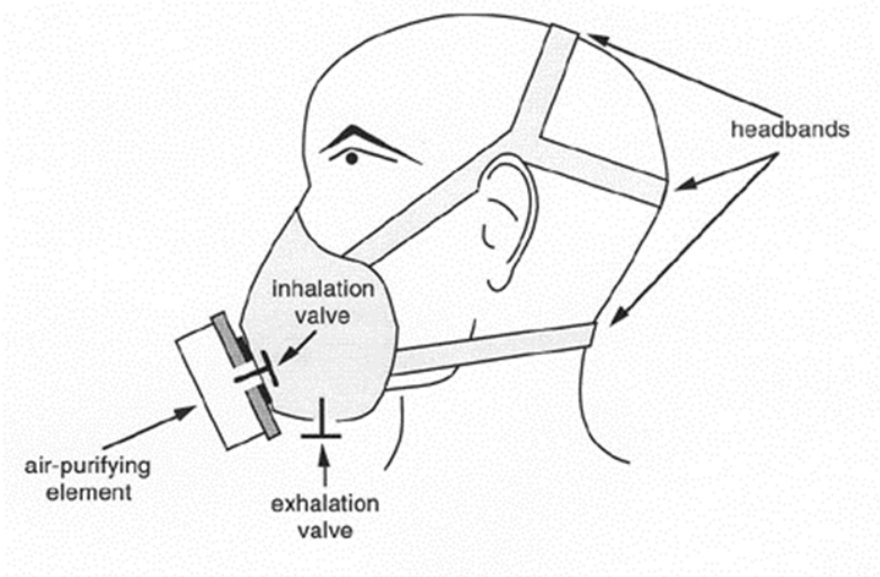
APRs can be reusable or single use. Reusable APRs consist of a facepiece with an exhalation valve and one or two filtering cartridges through which the air enters. The most widely used facepieces are full-face or half-mask. Full-face and half-mask respirators are illustrated below. Single-use types are typically filtering-facepiece respirators, often known as dust masks.

APRs cannot be used in an IDLH atmosphere.

Full-face Air Purifying Respirator

Half-face Air Purifying Respirator

Operation of a Reusable Air-Purifying Respirator



Air enters through the cartridges and exits through an exhalation valve. Note the proper placement of the headbands for a half-mask respirator. Reusable half-mask respirators without the head harness (only two single straps) must not be used.

Cartridges and filters for protection from chemical and particle exposure

Two types of air-purifying elements are used with APRs:

- **Chemical cartridges** are used to protect against certain vapors and gases.
- **Particulate cartridge filters** are used to protect against dusts, mists, and fumes.

Cartridges are selected for specific exposures which are expected. Factors that affect APR use include the size of the particles, concentration of the substance, and type of filter used. There is no appropriate protective cartridge filter for some environments; examples include oxygen displacement, or the concentration exceeds APR guidance. APRs are not recommended by NIOSH for known or suspected carcinogens.

Cartridge colors designate what type of particulates or chemicals are filtered. OSHA regulation 29 CFR 1910.134 dictates the colors that may be used. The table below lists OSHA-approved color and protection combinations.

Contaminants to be Protected Against	Color Assigned[1]
Acid gases	White
Hydrocyanic acid gas	White with 1/2-inch green stripe completely around the canister near the bottom
Chlorine gas	White with 1/2-inch yellow stripe completely around the canister near the bottom
Organic vapors	Black
Ammonia gas	Green
Acid gases and ammonia gas	Green with 1/2-inch white stripe completely around the canister near the bottom
Carbon monoxide	Blue
Acid gases and organic vapors	Yellow
Hydrocyanic acid gas and chloropicrin vapor	Yellow with 1/2-inch blue stripe completely around the canister near the bottom
Acid gases, organic vapors, and ammonia gases	Brown
Radioactive materials, except tritium & noble gases	Purple (magenta)
Pesticides	Organic vapor canister & a particulate filter
Multi-Contaminant and CBRN agent	Olive
Any particulates - P100	Purple
Any particulates - P95, P99, R95, R99, R100	Orange[2]
Any particulates free of oil - N95, N99, or N100	Teal

[1]Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

[2]Orange shall be used as a complete body or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

Chemical Cartridges

How do you tell if the cartridge needs to be changed? The respirator standard, 1910.134(d)(3), requires that respirators used to prevent gas or vapor exposures be equipped with an indicator showing that the cartridge (certified by NIOSH for the contaminant) has expired; this is called an End-of-Service-Life Indicator (ESLI). It is rare to find an ESLI on a cartridge. If the cartridge approved for a specific gas/vapor exposure has no ESLI, then the employer must use objective data to determine a change schedule and describe it in the written respiratory protection program; expected concentration, humidity, temperature and work rate are important inputs to calculation of a breakthrough time. Should you detect the contaminant before the time that the cartridge is expected to reach breakthrough, notify the supervisor immediately and change the cartridge. For dust, a wearer may also notice that it is more difficult to breathe as the filter becomes loaded.

The person responsible for establishing a change-out schedule for chemical cartridges shall consider temperature, humidity, contaminate concentration, and work rate. For some chemicals at high concentrations, the change-out schedule may be so frequent as to make the use of air purifying respirators impractical.

Particulate Cartridges/Filters

There are nine classes of particulate filters which are broken down into three series: N, R, and P. Each series (N, R, and P) is available at three levels, based on their efficiency for filtering out the most difficult size of particulate: 95%, 99%, and 99.97%.

N series	No oil
R series	Oil resistant, one shift only
P series	Oil proof, reusable

The filters should be changed when the breathing resistance increases, or the filter is dirty, wet or damaged. Employer guidelines may be more specific.

Other Reusable APRs

Gas masks are a special type of APR that consists of a full-facepiece and a canister containing sorbent material. These units typically protect against organic vapors, acid gases, ammonia, and certain combinations. Gas masks usually have more purifying elements in the canister than the chemical cartridges described above.

Another special type of APR is a **Powered Air-Purifying Respirator** (PAPR); air is pulled through the chemical cartridges or filters and blown into the facepiece, as shown on the right. The units use a powered fan to achieve the airflow through filters or cartridges to the facepiece. The type of air purifying element must match the contaminant(s) to which the workers are being exposed. PAPRs consist of a hood or helmet, or tight-fitting facepiece, filter and/or cartridge, and power source.

PAPR selection includes special consideration of the atmosphere where it will be used. As an air-purifying respirator, the oxygen concentration must be at least 19.5%; however, due to the power source, it is necessary to consider whether the atmosphere is combustible or flammable due to oxygen concentration (not greater than 23.5%) or the presence of a flammable chemical. Consult the supplier regarding planned use and guidance on the need for intrinsically safe units.

Limitations for are shown in the written respiratory protection program.

PAPRs cannot be used in an IDLH atmosphere.

Atmosphere-Supplying Respirators (ASR)

ASRs may have air supplied from a remote source (supplied air) or from a bottle or tank carried by the user (self-contained) as described below.

Supplied-Air Respirators (SAR)

A supplied-air respirator (SAR) provides at a minimum Grade D breathing air to the worker from a stationary tank or other source through a supply line that cannot exceed 300 feet in length. When using an SAR, the worker must wear (not carry) an escape bottle containing a minimum of 5 minutes of air. This escape bottle, or egress unit, is required to allow time to escape if the air supply is interrupted.

There are three classifications of supplied air respirators:

- Hose mask with blower (Type A)
- Hose mask without blower (Type B)
- Airline respirators (Type C)

Airline respirators must operate in either **continuous-flow** or **pressure-demand** mode. In continuous-flow mode, air is always flowing, even when the wearer is not inhaling. In pressure-demand mode, a constant positive pressure is maintained inside the facepiece; air flows when the positive pressure in the facepiece is reduced as the wearer inhales. A third mode of operation is **demand mode**, in which air only flows when the pressure inside the facepiece becomes negative due to the wearer inhaling. Demand mode provides the least protection, because contaminants can leak into a poorly sealed facepiece when the pressure becomes negative. NOTE: Not allowed when the concentration is unknown or IDLH conditions.

Compressors used to supply air must meet special requirements. Compressor exhaust and lubricants must not contaminate the air supplied. Compressor air intakes must be located in a contaminant-free area.

Self-Contained Breathing Apparatus (SCBA)

A self-contained breathing apparatus is an atmosphere-supplying respirator where the breathing air is designed to be carried by the user. A self-contained breathing apparatus is used when extremely toxic chemicals are present, in an oxygen-deficient atmosphere, or when the contaminant or concentration is not known. SCBAs are typically used in emergency response situations.

SCBAs consist of:

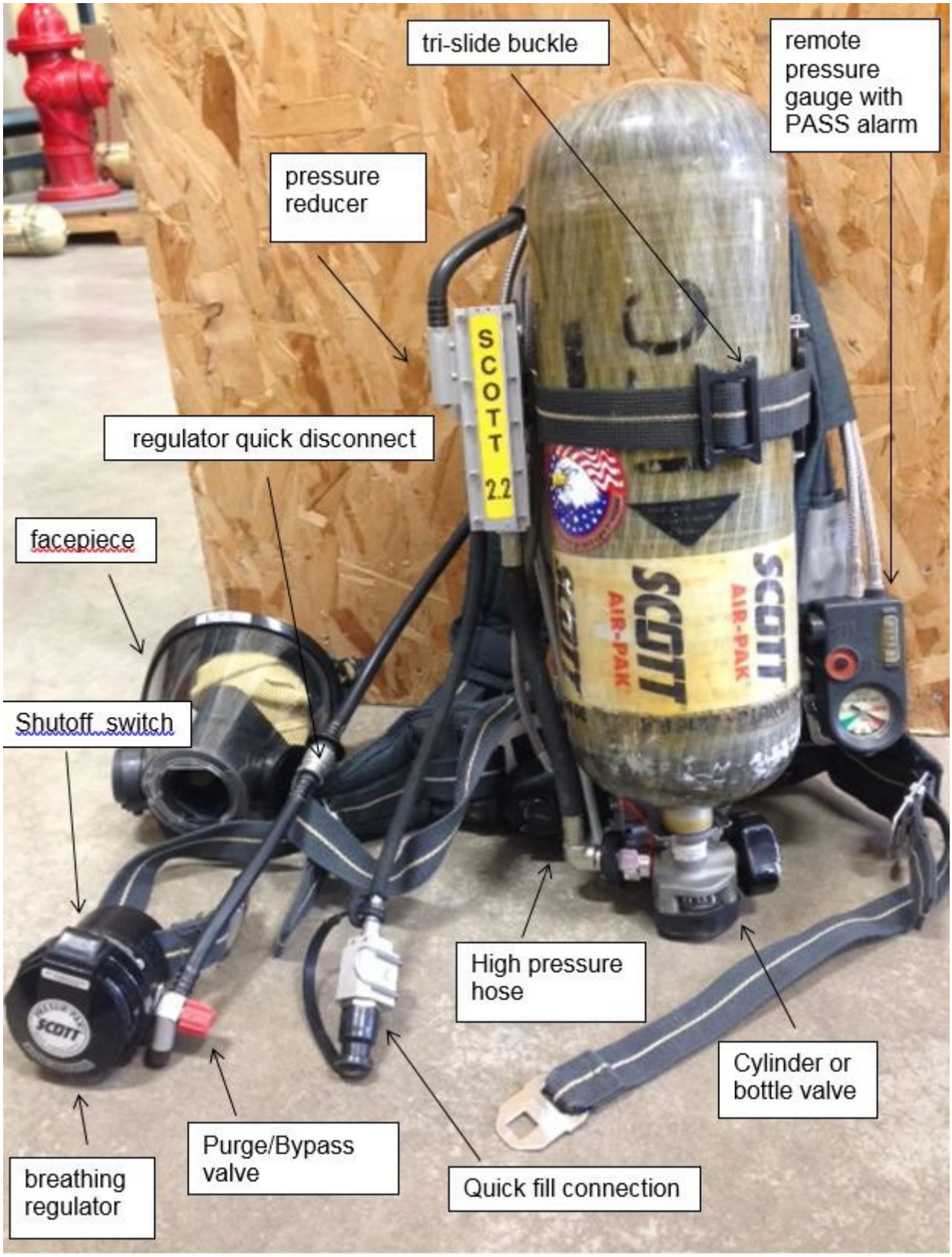
- **Bottle (tank or cylinder)** contains compressed breathing air (2216 psi-5500 psi)
- **Harness** secures cylinder and connects user to apparatus
- **Gauge** displays current cylinder pressure
- **Safety/by-pass valve** by-passes the regulator in case of malfunction of the regulator. The by-pass valve should be open only when needed
- **Pressure regulator(s)** provide reduced pressure air during inhalation
- **Full facepiece** isolates user's face from exterior environment

The SCBA is equipped with an alarm to warn the wearer when air in the tank falls below a specified capacity (note that the 2013 edition of NFPA 1981 specifies a 33% capacity alarm; NIOSH specifies 25%). Most SCBAs operate in an open-circuit mode; that is, the exhaled air is vented to the atmosphere and not re-breathed.

SCBAs and cylinders differ by manufacturer and type. You must be trained in the manufacturer's instructions and checkout procedures before using any SCBA. These units should be NIOSH certified for IDLH, full facepiece and with a minimum duration of 30 minutes or combined with SAR with auxiliary SCBA escape bottle. An SCBA can operate in either demand mode (less protective) or pressure-demand mode. SCBA cylinders may be constructed of steel, aluminum, or composite materials. These have varying service lives and hydrostatic testing requirements. Users should familiarize themselves with their specific cylinders. A positive-pressure SCBA or positive-pressure airline respirator equipped with an escape air supply must be used when exposure levels are likely to present an IDLH situation or impair the ability to escape**.**

The equipment should be donned according to the manufacturer's recommended procedures. Periodic training and practice are especially important for workers who may use this equipment infrequently.

When the contaminant is unknown, wear a pressure-demand SCBA with a full-facepiece, or a pressure-demand SAR with a full-facepiece in combination with an auxiliary pressure-demand SCBA or 5-minute escape bottle. Auxiliary SCBA must provide air for sufficient time to permit escape to safety if needed.


tri-slide buckle
remote pressure gauge with PASS alarm
pressure reducer
regulator quick disconnect
facepiece
Shutoff switch
High pressure hose
Cylinder or bottle valve
breathing regulator
Purge/Bypass valve
Quick fill connection
SCOTT
AIR-PAK
2.2

Rebreather

A rebreather apparatus may be used in specialized applications by workers. These units are useful because in each breath, only about 4 percent of the oxygen in inhaled air is used.

Single Use Particulate Respirators (Also referred to as Filtering Facepiece Respirators)

A single use particulate respirator is a paper filter that is held to the face by two straps and fit to the nose by a self-molding metal strip. These may have an exhalation valve but do not use filter cartridges. They do not provide a high level of protection, but will decrease the inhalation of dusts and mists. They generally provide no protection against gases or vapor exposures. (Some specialized single-use respirators have been approved by NIOSH to remove “nuisance” or very low levels or organic vapors or acid gases.)

An example of a single use respirator is the N95:

- N→ not resistant to oil
- 95→removes 95% of airborne particulate

The percent of particulate removed assumes a very good seal between the face and the mask.

Respirator Fit

A respirator is effective only if there is a good seal between the facepiece and the wearer's face. Therefore, all persons wearing respirators must first be fit tested. Fit testing includes qualitative or quantitative testing, as well as routine positive- and negative-pressure fit checks.

Because human faces come in many different shapes and sizes, each manufacturer has several facepiece sizes. The purpose of fit testing is to find the manufacturer/size combination which offers adequate protection. Factors such as weight loss or gain, dentures, dental work, or facial injury can change the shape of the face, thus potentially changing the fit and efficiency of the respirator. If any of these factors exist, retesting is required.

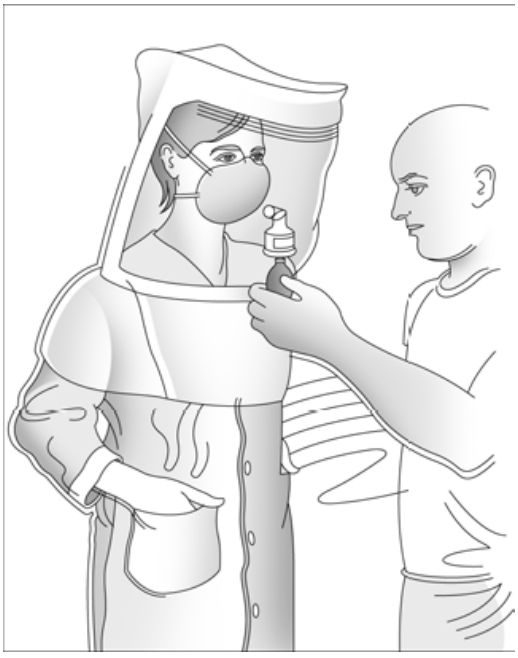
Annual Fit Tests

Two types of fit testing, **qualitative** and **quantitative,** may be used to determine the size and model of respirator that an individual should wear as well as how good the face-to-facepiece seal is. These tests must be repeated annually to document respirator effectiveness. Fit tests **shall not** be performed if facial hair is present in the seal area of the respirator. (OSHA 29 CFR 1910.134)

Qualitative Testing

Purpose: Checks effectiveness of preventing substances from entering the facepiece.

Method: While the individual is wearing a respirator, a test substance is released, as shown on the right. The test substance could be smelly (banana oil), sweet (saccharin), bitter (Bitrex) or an irritant (special smoke tube). The wearer should not be able to detect the substance while performing a series of prescribed tasks.



Requirements: This test or its equivalent is required by OSHA at least once a year.

There are several important cautions to qualitative fit testing:

- Some of the test substances may irritate the eyes or cause coughing
- A sensitivity test is first performed to determine the individual is capable of sensing the test solution

- Fit testing is often done in “ideal” environments. The fit may change after wearing the respirator several hours or during strenuous activity.
  Must be used only when the ratio of the concentration outside to the concentration inside the facepiece is less than or equal to 100; this is called the Fit Factor

Quantitative (Numerical) Testing

This test measures the fit factor (FF), a comparison of the concentration of a substance outside of the mask to the concentration of a substance inside of the mask, or a loss of vacuum between the outside and inside of the mask. The FF is useful in determining whether the respirator will effectively protect the wearer from exposure. A disadvantage to this test is that special equipment and specially trained personnel are needed to administer it.

Purpose: Measures effectiveness of the respirator in preventing a substance from entering the facepiece.

Methods: There are two methods for quantitative fit testing based on the fit testing device.

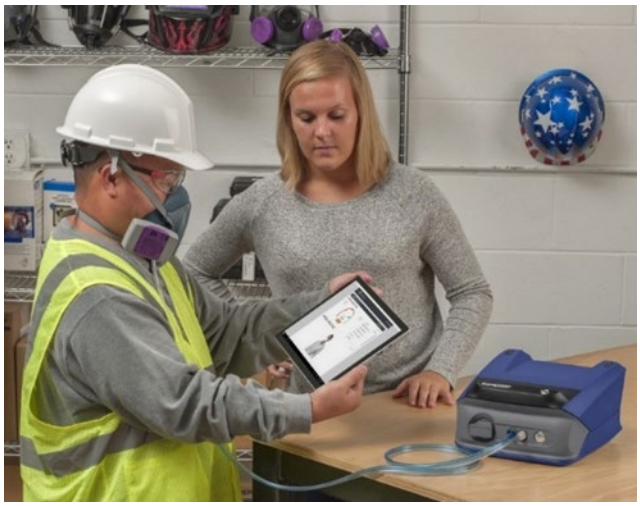


Photo courtesy of TSI Inc. to MWC

1. While an individual wears a respirator modified with a probe, the concentrations of particulates in the air inside and outside of the respirator are measured, as shown above. The test is repeated while the person performs specific tasks (speaking, running in place, etc.) that may affect fit.

2. While an individual wears a respirator connected to a fit testing device, a vacuum is drawn in the mask to assess the seal for leaks. Then the user removes and re-dons the mask and the test is repeated twice.

Requirement: This test is mandated when a fit factor of 500 is required.

Routine User Checks

Two types of checks, **positive**- and **negative**-pressure checks, should be done each time a respirator is donned and before each use in the field to check the seal of the respirator. They do not replace yearly fitting but provide a routine assessment as to whether the fit is still adequate.

Positive-Pressure Check

Purpose: Checks the facepiece components for leaks at valves or other points. NOTE: Not all respirators allow easy access to the exhalation valve for this test.

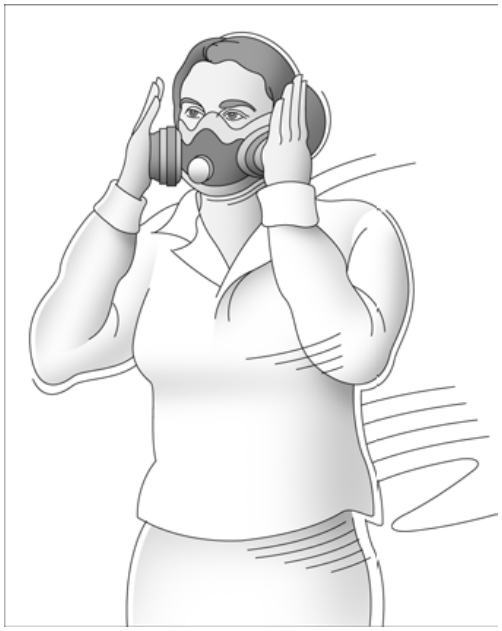
Method: Close off the exhalation valve (if possible) and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test. This is only performed if the cover can be manually removed.

Requirement: Shall be done before each use.

Negative-Pressure Check

Purpose: Checks the facepiece-to-face seal.

Method: SCBA wearer disconnects the regulator and places hands over the hole for the regulator connection and inhales. APR wearer places hands over cartridges and inhales, as shown on the right. No outside air should be felt leaking into the facepiece.



Requirement: Shall be done each time the respirator is donned (first use, break, lunch).

Positive- and negative-pressure checks can be done quickly and easily in the field. If the wearer is unable block the holes or cartridges with their hands, additional measures may need to be performed to accomplish the blocking requirement to detect the leaks.

Assigned Protection Factors

Respirators are selected by using Assigned Protection Factors (APFs). The higher the APF, the more protective the respirator is. A protection factor has been determined in the laboratory at NIOSH for each type of respirator (APR, PAPR, SCBA, etc.) and mask (half- or full-face). Protection factors also exist for combinations of the above respirators. For example, an SAR with a full-face mask and an auxiliary SCBA equals 10,000.

The following table shows Assigned Protection Factors (APFs):

Type of Respirator	Quarter mask*	Half mask	Full facepiece	Helmet/Hood	Loose-fitting facepiece
1. Air-purifying Respirator	5	10	50	-	-
2. Powered Air-purifying Respirator (PAPR)	-	50	1,000	25/1,000	25
3. Supplied-air Respirator (SAR) or Airline Respirator					
• Demand mode	-	10	50	-	-
• Continuous flow mode	-	50	1,000	25/1,000	25
• Pressure-demand or other positive-pressure mode	-	50	1,000	-	-
4. Self-contained Breathing Apparatus (SCBA)					
• Demand mode	-	10	50	50	-
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)	-	-	10,000	10,000	-

*Quarter masks are rarely used and are not presented here.

See https://www.osha.gov/laws-regs/standardinterpretations/2002-05-30 for additional information about this table.

Never assume you will get this much protection. Quantitative fit testing provides a measure of the maximum protection you can expect. Less protection may occur during actual work activities.

The use of these APFs presumes that the facepiece has been properly selected to provide the best possible fit. These factors do not apply for persons with facial hair as it interferes with the seal of the facepiece. A person with facial hair that interferes with the fit is required to utilize a hood type system and the APF for that is low (see table).

Fit Factor Calculation

Selection of respirators includes calculation of the fit factor by dividing the known chemical concentration by the APF. The resulting value is compared with the occupational exposure guideline used by your employer.

$$\frac{measured\ chemical\ concentration\ (ppm)}{APF} = parts\ per\ million\ (ppm)$$

If the calculated ppm is higher than the exposure guideline, then that type of respiratory protection would be inadequate. If the calculated ppm is lower than the exposure guideline, then that type of respiratory protection should be sufficient, provided that the measured concentration will not increase, and provided that the measured chemical concentration is below the IDLH concentration, if using an APR.

Sample Fit Factor Calculation:

Cyclohexene released from a faulty valve has resulted in a loss of about 480 gallons in the transfer building. The first entry team wore SCBAs and stopped the release. The safety and health officer monitored the concentration and found 400 ppm at the entrance. This is not a TWA, but a single measurement on a direct-reading instrument. The OSHA PEL is 300 ppm for an 8-hour work shift; it is expected that the cleanup by the responders will take four hours. Because engineering controls cannot be implemented, respiratory protection must continue to be used. What type of respiratory protection would provide adequate protection against this contaminant?

Formula: $\frac{measured\ chemical\ concentration\ (ppm)}{APF} = ppm$

First, use the table of APFs to see if a half-face APR can be used:

$$\frac{400\ ppm}{10} = 40\ ppm$$

The resulting answer is 40 ppm, which means that 40 ppm of cyclohexene could be present inside the facepiece of a properly fitted respirator. A concentration of 40 ppm is less than the OSHA 300 ppm PEL, so this type of respiratory protection would be adequate, especially since the duration of work is less than eight hours. However, the safety and health supervisor questions the fit for all workers as it is very hot in the transfer building. Does a full-face APR provide better protection?

$$\frac{400\ ppm}{50} = 8\ ppm$$

The resulting answer is 8 ppm. A properly fitted full-face APR would protect better than the half-face APR.

NOTE: This solvent is an eye irritant. How does this affect respirator selection? What protection is needed to prevent eye irritation? How does the temperature affect selection?

If the concentration of the contaminant in the workplace changes, another calculation of fit factor would need to be done to see if the respirator is still protective at the new concentration (if higher) or the cartridge change-out schedule is altered (lower).

Medical Fitness to Wear a Respirator

Before a worker receives clearance to wear a respirator, a medical evaluation must be performed by a physician or other licensed health care professional (PLHCP). The evaluation helps ensure that the employee is physically capable of working with the added stress of a respirator. Any follow-up evaluations and testing will be determined by the PLHCP.

Some medical conditions which may prevent respirator usage include:

- Lung disease
- Claustrophobia
- Severe high blood pressure
- Heart disease

Other conditions that should be considered when wearing a specific type of respirator include:

- Contact lenses
- Eyeglasses
- Moustache that may interfere with fit
- Perforated tympanic membrane (ruptured eardrum)

Changes in weight or dental work may alter the fit of a respirator and require a new fit test.

Special eyeglass kits are available for use with full-facepiece respirators.

Cleaning, Storage, Inspection and Maintenance of Respirators

Proper inspection, maintenance, and storage are essential to ensure that the respirator is always ready for use. The OSHA respirator standard requires employers to provide for the cleaning and disinfection, storage, inspection and repair of respirators used by employees. Always consult manufacturers' recommendations for use, care and maintenance as well.

Cleaning respirators

Appendix B-2 to 29 CFR 1910.134 requires the following respirator cleaning procedures. Manufacturers' recommendations may be used as an alternative, if they are at least as effective as those specified here:

A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure- demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.
B. Wash components in warm (43 deg. C [110 deg. F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.
C. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain.
D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:

1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter (approximately 20 drops) of laundry bleach to one liter of water (about a 1000:1 dilution) at 43 deg. C (110 deg. F); or,
2. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters (about 16 drops) of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45% alcohol) to one liter of water (about a 1250:1 dilution) at 43 deg. C (110 deg. F); or,
3. Other commercially available cleansers of equivalent disinfectant quality when used as directed if their use is recommended or approved by the respirator manufacturer.

E. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.
F. Components should be hand-dried with a clean lint-free cloth or air-dried.
G. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.
H. Test the respirator to ensure that all components work properly.

Respirators must be cleaned and disinfected after each use, unless they are being used routinely and exclusively by the same employee. In that case, they must be cleaned and disinfected as often as needed to be sanitary.

Respirator Storage

OSHA requires that all respirators be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and that they must be packed or stored to prevent deformation of the facepiece and exhalation valve.

Inspection

Respirators must be inspected before and after each use and checked at least monthly, even if the respirator has not been used. A company policy may include more frequent inspections. OSHA requires that inspections include:

- A check of respirator function
- Tightness of connections
- The condition of the various parts including, but not limited to, the facepiece, head straps, valves, connecting tube, and cartridges, and canisters or filters
- A check of elastomeric parts for pliability and signs of deterioration.
- In addition to the above, self-contained breathing apparatus must be inspected monthly

Air cylinders must be maintained in a fully charged state and be recharged when the pressure falls to 90% of the manufacturer's recommended pressure level. The employer must determine that the regulator and warning devices function properly.

NOTE: Cold temperatures may result in pressure below 90%, even if the cylinder is full.

Maintenance

OSHA requires that defective respirators be removed immediately from service and repaired/adjusted or discarded.

Repair program guidance follows:

- Repairs or adjustments must be made only by trained persons using the manufacturer’s NIOSH-approved parts.

- Repairs must be made according to the manufacturer’s recommendations and specifications.

Critical parts including reducing and admission valves, regulators and alarms may only be adjusted or repaired by the manufacturer or a technician trained by the manufacturer.

Consult the site-specific respiratory protection program for detailed requirements.

Minimum Requirements for a Respiratory Protection Program

OSHA requires that employers who make respirators available to their employees have a written respiratory protection program with work-specific procedures. The program must be evaluated and updated as necessary. Programs shall be updated as requirements change and/or modifications occur that reflect changes in the workplace. OSHA requires the use of NIOSH-approved respirators. Approval numbers will be clearly written on all approved equipment, as shown on the next page, or on written materials shipped with the respirator. Respirators manufactured after 2008 are marked with an approval designation known as a "TC" number. [Example: TC #XXX-XXXX].

A respiratory protection program must include the following points:

- Medical evaluations of employees required to use respirators
- Fit testing procedures for tight-fitting respirators
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators
- Training of workers in the respiratory hazards to which they may be potentially exposed during routine and emergency situations
- Training of workers in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance
- Procedures for regularly evaluating the effectiveness of the program

The employer must designate a program administrator who is qualified to oversee the respiratory protection program and to conduct the required evaluations of its effectiveness. Respirator training and the required medical evaluations are provided to the employee at no cost. The respiratory protection program also may include:

- Provision for corrective lenses in full-facepiece respirators using a spectacle kit that clips into the facepiece or is permanently mounted in the facepiece
- Restriction of use of contact lenses. (See ANSI Z87.1)
- Communication needs
- Guidelines for use in dangerous atmospheres, including confined spaces
- Guidelines for use in extreme temperatures

The respiratory protection program will include a description of who is responsible for the various aspects of the program including selection, periodic and routine fit testing, inspection, cleaning, repair, and maintenance. Persons using respirators under unusual

conditions (e.g., a high concentration of acid vapor) should review special requirements with supervisors or the employee safety and health representatives. For a sample respiratory protection program, see: http://www.osha.gov/dcsp/compliance_assistance/sampleprograms.html#RespiratoryProtection.

Effective training must be provided at least annually by the employer for all employees who are required to use respirators (see 1910.134(k)). This training must be understandable to the participant.

Based on the training, the employer shall ensure that each employee can demonstrate knowledge of at least the following:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator
- Limitations and capabilities of the respirator
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the seals of the respirator
- The procedures are for maintenance and storage of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- The general requirements of the respiratory protection standard

Respiratory Protection Lab

During this lab you will have the opportunity to fit-test and wear an air-purifying respirator. You will also review respirator cleaning and inspection procedures.

At each lab station you will use a checklist to guide you through the activities. After you have completed the assigned tasks at each station, complete the checklist and have it signed by the station leader.

Respiratory Protection Lab Performance Checklist Fit-Testing an APR

Name _____

Buddy's name _____

1. Please check any of the following items that you wear:

Prescription glasses Beard

Dentures Contact lenses

2. Did you do a negative pressure fit check? Yes No

3. Did you do a positive pressure fit check? Yes No

4. Did you go into a test chamber? Yes No

If yes, which type of chamber?

"Banana oil" Smoke Both Other _____

5. What brand and size of air respirator do you wear?

Brand Size

6. Please list the brands and sizes of respirators you tried that could not pass the fit test.

Brand Size

Brand Size

Brand Size

Brand Size

7. Did you wash your respirator during this lab? Yes No

If yes, check the supplies that you used.

Towelette Wash basin Other _____

8. How long did you wear the respirator? _____ minutes

Instructor Signature _____ Date _____

Respiratory Protection Lab Performance Checklist Inspecting and Cleaning Respirators

Name _____

Buddy's name _____

Daily Maintenance of your Respirator:

1.	Did the instructor tell you how to wash your respirator?	Yes	No
2.	Did you clean your respirator?	Yes	No
3.	Did you see a disassembled respirator and all its parts?	Yes	No
	If yes, did someone in the lab reassemble the respirator?	Yes	No
4.	Did someone in your lab inspect a respirator?	Yes	No
5.	Were defects found during inspection?	Yes	No

If yes, describe the defects.

Instructor's Signature _____ Date _____

Respiratory Protection Lab Performance Checklist Wearing an Air Line With Escape Unit

Name _____

Buddy's name _____

1. Did the station leader demonstrate how to set up and use the unit? Yes No

2. Did the station leader demonstrate how to switch to the five minute escape bottle?

Yes No

3. Did the trainees in the lab wear an egress unit? Yes No

4. Did you wear the unit? Yes No

5. Did a trainee who wore the egress unit switch to the 5-minute escape bottle?

Yes No

Please indicate which level of protection is provided by an air-line egress unit.

A B C

Instructor's Signature _____ Date _____

Summary – Respiratory Protection

Different types of hazards require different types of respirators. A number of factors should be considered when selecting a respirator. Situations which may require the use of respiratory protection include:

- Oxygen deficiency
- Hazardous substances in the air
- Atmosphere immediately dangerous to life and health (IDLH)
- Confined space entry
- Skin/eye contact hazard

Air-purifying respirators (APR) and self-contained breathing apparatus (SCBA) may be used by workers to prevent toxic materials from entering the body.

APRs consist of a facepiece with exhalation valve and one or two filtering units through which the air enters.

SCBAs consist of a facepiece and supply of air, gauge, and safety valve. If air-line respirators are used during an emergency, an escape unit must also be worn.

A respirator should be selected for use after either qualitative or quantitative fit testing. Before each use, positive- and negative-pressure user checks are done by the wearer. Persons assigned to wear a respirator must be examined by a physician to ensure fitness. Care of respirators includes diligent cleaning, disinfecting, and storing. Units should be inspected before and after each use, or monthly if not used routinely. A written program is required in any workplace where respirators are or may be used. Special considerations in use of respirators include the need for corrective lenses, communication requirements, and use in dangerous atmospheres.

Important acronyms include:

- APR - Air-Purifying Respirator
- SCBA - Self-Contained Breathing Apparatus
- ASR - Atmosphere Supplying Respirator
- PAPR - Powered Air-Purifying Respirator
- IDLH - Immediately Dangerous to Life and Health

Review Questions

1. List several situations in which respiratory protection would be required.

2. What are the limitations of APRs?

3. What are the limitations of SCBAs?

4. Why are routine positive-and negative-pressure user checks important?

5. Why are medical exams required for persons who use respirators?

6. List parts of a respirator that should be checked before and after each use.

7. Why is proper storage of respirators important?

8. List items that must be included in a written respiratory protection plan.

Chemical Protective Clothing

Chemical-protective clothing (CPC) includes suits, aprons, gloves, safety goggles, and face shields. This provides an important barrier between chemicals or other hazards in the environment and your body. Although CPC and respirators cannot provide protection from all exposures, when properly selected and worn, the combination can limit harmful exposures. This section includes the use, selection and application of levels of protection as designated by EPA and OSHA.

You will don and doff Personal Protective Equipment (PPE).

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify general types, uses and limitations of chemical-protective clothing (CPC)
- Identify the EPA/OSHA levels of personal protective equipment (PPE)
- Identify the general guidelines for selection of CPC and demonstrate selection for a scenario
- Demonstrate the donning and doffing of CPC provided
- Identify the procedures for inspection, maintenance, and storage of CPC

Personal Protective Equipment

Personal protective equipment (PPE) includes respirators, chemical protective clothing, boots, gloves and hearing protection; the full ensemble of PPE is selected to protect workers from a number of hazards including

- Chemical contact with skin and eye
- Physical hazards
- Respiratory hazards

PPE is effective only when properly selected, maintained, and worn during emergency response activities. The Emergency Response Plan (ERP), required by HAZWOPER, must include a description of PPE (chemical-protective clothing and emergency equipment).

OSHA standards specifically for PPE include:

- 1910.95 Hearing Protection
- 1910.132 General Requirements—Full-Body Protection
- 1910.133 Eye and Face Protection
- 1910.134 Respiratory Protection
- 1910.135 Head Protection
- 1910.136 Foot Protection
- 1910.138 Hand Protection

Chemical-Protective Clothing

Chemical-Protective Clothing (CPC) consists of special clothing worn to prevent chemicals from contacting the body. CPC generally includes eye/face protection, aprons, boots, gloves, and suits/coveralls. CPC is used to protect workers from both chemical and physical hazards. The proper use of CPC can prevent or reduce exposure to a hazard. CPC is an important part of a worker's personal protective equipment (PPE).

The materials used to construct CPC are chemical-resistant, which means they act as a barrier to keep chemicals from coming in contact with the wearer's skin. Different materials provide protection from different types of chemicals. It is important to select CPC which is designed to protect against the specific chemical or type of chemical that may be encountered during an emergency response. Otherwise, you might not be protected, even when you think you are.

Personal Protective Equipment Program

A written personal protective equipment program is required by OSHA as part of the employer's Emergency Response Plan. PPE must be selected to protect employees from known or likely potential hazards. The proper selection of PPE is based on many factors, including potential hazards, layout of the scene and surrounding activities.

PPE must be properly selected and used to be effective.

Examples of improper selection

- Goggles, when whole body splash is likely
- Gloves known to swell when wetted with solvent that must be cleaned up

Examples of improper use

- Respirator 'stored' below the chin
- Continuing to work with a tear in CPC suit

What examples of improper selection or use have you seen?

The PPE program must address:

- Selection, based upon anticipated hazards (See 29 CFR 1910.132 Appendix B for guidance)
- Use and limitations
- Work task duration
- Maintenance and storage
- Decontamination and disposal
- Training and proper fitting
- Donning and doffing procedures prior to, during, and after use
- Inspection procedures
- Evaluation of program effectiveness
- Special limitations during temperature extremes, heat stress, and other appropriate medical considerations

When model procedure descriptions provided by the manufacturer will be followed exactly, they may be incorporated into the PPE Program as is.

Appropriate PPE must be purchased as part of preplanning, and it must be selected and properly used during initial size-up and response activities. The size-up should provide sufficient information to select PPE to protect personnel from overexposures to chemicals. During size up and other initial actions, responders may wear a high level of protection. With the information gathered, including air monitoring, a decreased level of respiratory protection may be ordered by the person in charge and following the ERP for the response activities. All PPE selected and used must meet OSHA requirements where applicable (1910, Subpart I and 1910.120).

Types of Chemical-Protective Suits

Chemical-protective suits are of two general types: totally encapsulating and partially encapsulating.

Totally Encapsulating Chemical-Protective Suit (TECP): Provides head-to-toe coverage to protect the wearer from chemicals. These suits have special seams and zippers to prevent chemicals from leaking into the suit. These suits have a face shield which is made as part of the hood. They are very bulky to wear, and the wearer can

become very hot while working. TECPs are the only vapor-resistant suits. TECP suits protect workers from hazards which are identified during initial hazards and risk assessment. TECP suits must pass specific positive-air pressure tests and be capable of preventing inward test gas leakage of more than 0.5%. Specific information about pressure tests can be found in OSHA 1910.120, Appendix A.

Partially Encapsulating Chemical-Protective Suit (PECP): Provides less protection from chemicals and may or may not have face shields. These suits are used when less skin protection is needed. The hood can either be part of the suit or detached. This type of CPC may include suits which look like totally encapsulating suits but will not pass a pressure test. A large variety of PECP designs is available.

Disposable suits that provide limited protection from chemicals can be used in conjunction with these chemical-protective suits. These disposable suits can be worn either on top of other suits to protect them or inside protective suits to protect the wearer from chafing, to limit contamination of personal clothing or to provide added protection during decon.

Selection of CPC and other PPE

Generally, one person or the health and safety group is responsible for the selection and purchase of protective equipment; however, it is important for everyone to understand the considerations which go into the selection. The selection process should be detailed in the employer's PPE plan. Questions about PPE selection should be addressed to the person responsible for the selection.

A hazard assessment with a survey of the facility is part of pre-emergency planning at fixed sites and will include a list of potential emergency releases or events. This list is used in planning for required PPE.

Hazards to take into consideration include:

- Impact
- Fire
- Compression (roll-over)
- Penetration/ puncture hazards
- Heat/cold
- Combustible/Harmful dust
- Light (optical) radiation
- Biologic agents
- Sources of electricity
- Sources of motion or impact
- High temperatures
- Chemicals

The type of chemical-protective suits selected will depend on the type and nature of potential exposure. For example, totally encapsulating suits may be required for persons approaching a perc release at a faulty valve; less protection is required for those involved in maintaining site security during the response. Generally, the level of protection provided will be re-evaluated as additional information is gained. Guidelines for selection of PPE, including CPC suits, are presented in the following table.

CPC Selection Guidelines - Always follow manufacturer's recommendations

Chemical resistance: Different materials are resistant to different chemicals. Management should provide CPC which will provide protection against the chemicals likely to be encountered. This rule is true for whole-body as well as hand and foot protection.

Physical integrity: Construction of the suit is important for the proper functioning of the CPC. Seams and zippers should provide solid barriers to chemicals and should be constructed to prevent seam tears and rips during use

Resistance to temperature extremes: Heat and cold can adversely affect CPC. Clothing which will be worn in cold temperatures could crack or become ineffective against chemicals. Likewise, heat can destroy the chemical resistance of clothing or even melt it.

Ability to be cleaned: Clothing must be able to be cleaned and decontaminated after each use. If this is not possible, the clothing must be disposed of after use.

Cost: Initial and ongoing costs of purchasing PPE can be important considerations for management. However, buying less expensive, inferior products that do not adequately protect the wearer can be more expensive in the long run due to medical costs, lost work time, or, at worst, loss of human life.

Flexibility: Materials need to be flexible enough for the wearer to move and work safely. Overly rigid suits can result in unnecessary accidents from slips, trips, and falls. Gloves which are too rigid may create gripping problems that may lead to other hazards.

Size: CPC should be available in a variety of sizes to accommodate the height and weight of the worker. Suits that are too small will tear easily and provide no protection. Suits that are too large will make walking and/or working difficult. Safety boots that are too big will create both tripping and comfort problems.

Design: CPC should be designed so that all required respiratory PPE can be used at the same time. Some styles/designs require assistance to don/doff.

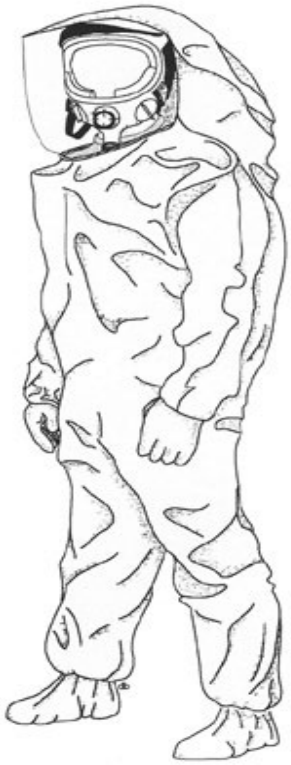
Levels of PPE (see 29 CFR 1910.120, Appendix B)

Level A

Level A is the highest level of protection which can be worn.

What Is Level A Protection?

The following list constitutes Level A equipment; it may be used as appropriate:



- Positive-pressure, pressure-demand, full-facepiece SCBA or positive-pressure, supplied-air to full-facepiece with escape SCBA (NIOSH-approved)
- Totally encapsulating chemical-protective suit (TECP) (gas tight or vapor tight)
- Inner and outer chemical-resistant gloves
- Disposable protective suit, gloves, and boots (depending on suit construction, may be worn over totally encapsulating suit)
- Coveralls*
- Long underwear*
- Hard hat (under suit)*
- Chemical-resistant boots with steel toe and shank.
- Cooling system (ice vest, water/air circulation)*

*Optional as applicable

Note: Suit must be properly equipped with a pass-through airline connection, referred to as an airline egress if using an SAR.

When Is Level A Protection Needed?

Level A protection is required when:

- The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and respiratory system.
- There is potential for splash, immersion, or exposure to vapors, particulates, or gases that are harmful to the skin or may be absorbed through the skin.
- Confined space entry may be involved and the need for Level A cannot be ruled out (but explosion hazard has been ruled out).
- The skin absorption hazard may likely result in immediate death or serious illness/injury or impair the ability to escape.

Typical Uses of Level A at TSD Facilities

Level A is used for on-site activities such as tank/tanker leaks, major spills, and similar incidents. Remember: Additional training may be required if you are a member of an emergency response team. Sometimes Level A is used in the treatment of extremely hazardous wastes or in the utilization of hazardous procedures or processes.

Level B

Level B is used when maximum respiratory protection is desired, but the skin/eye hazards do not require Level A.

What Is Level B Protection?

The following constitutes Level B equipment; it may be used as appropriate.

- Positive-pressure, full-facepiece SCBA or positive-pressure, pressure-demand, supplied-air to full-facepiece with escape SCBA (NIOSH approved)
- Hooded chemical-resistant clothing OR total encapsulating chemical suit (not gas tight or vapor tight)
- Inner and outer chemical-resistant gloves
- Outer chemical-resistant boots with steel toe and shank
- Boot covers: outer, chemical-resistant (disposable)*
- Hard hat*
- Face shield*
- Cooling system (ice vest, water/air circulation)*

New Level B chemical-resistant clothing is designed to go over the SCBA. If appropriate for the potential exposures, this CPC should be used to protect the SCBA and prevent its contamination. In this case, the Level B ensemble will resemble a Level A ensemble, but the suit is not vapor-tight.

*Optional as applicable

When Is Level B Protection Needed?

Level B protection is required when:

- The highest level of respiratory protection is needed but a lower level of skin protection (than Level A) is acceptable
- The substances have been identified
- A SCBA is required
- Less skin protection is needed (vapor and gases are not believed to be present at high levels harmful to skin or capable of being absorbed through intact skin)

Typical Uses of Level B At TSD Facilities

Level B protection may be used in emergency response where a lower level (than Level A) of skin protection is needed. Remember: Additional training may be required to do emergency response.

Level B protection may be required in the routine handling and processing of some materials. In addition, some types of facility maintenance tasks may necessitate the use of Level B protection.

Level C

Level C provides less skin and respiratory protection than Level A or B.

What Is Level C Protection?

The following list constitutes Level C equipment; it may be used as appropriate.

- A full-face or half-face air-purifying respirator (NIOSH-approved)
- Hooded chemical-resistant clothing
- Inner and outer chemical-resistant gloves
- Coveralls*
- Boots (outer), chemical-resistant steel toe and shank*
- Boot covers: outer, chemical-resistant (disposable)*
- Hard hat*
- Escape mask*
- Face shield*

*Optional as applicable

When Is Level C Protection Needed?

Level C provides protection when:

- The concentration(s) and type(s) of airborne substance(s) are known and the criteria for using an air-purifying respirator are met.
- Direct contact with the hazardous substance will not harm the skin or the substance will not be absorbed through any exposed skin.
- Air contaminants have been identified, concentrations measured, and an air-purifying respirator is available with an acceptable protection factor
- An adequate level of oxygen (≥ 19.5%) is available and all other criteria for the safe use of air-purifying respirators are met.

Typical Uses of Level C At TSD Facilities

Level C may be needed for the unloading and loading of hazardous waste or other hazardous chemicals. Workers who are part of the process operations or material handling operations may also be required to wear Level C. Those workers doing certain maintenance activities will need to wear Level C. In addition, those workers who are involved with quality control sampling may be required to use Level C protection.

Level D

This level offers no respiratory protection and low skin protection.

What Is Level D Protection?

The following list constitutes Level D equipment; it may be used as appropriate:

- Coveralls (work uniform)
- Chemical-resistant boots or shoes with steel toe and shank
- Hard hat*
- Gloves*
- Outer, chemical-resistant boots (disposable)*
- Safety glasses or chemical splash goggles*
- Escape mask*
- Face shield*

*Optional as applicable

When Is Level D Protection Needed?

Level D is required when:

- Minimal protection from chemical exposure is needed. It is worn to prevent nuisance contamination only
- The atmosphere contains no known hazards that require skin or respiratory protection
- Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals

Typical Uses of Level D at TSD Facilities

Level D protection is worn by personnel who may be exposed only to nuisance contamination while working with hazardous materials. Typically, workers involved with support activities such as equipment supply, maintenance, off-site vehicle operation, or supervision/management will wear Level D. Level D may appear similar to “typical work clothes.” Differences include the chemical-resistant boots with steel shanks.

A general rule for which level of protection to use is:

“The less you know, the higher you go.”

Remembering Levels of Protection

A helpful way to remember the levels of protection is:

Level A - ”A”ll Covered, gas/mist tight

Level B - ”B”reathing Air, splash protection

Level C - ”C”artridge Respirator or air purifying respirator

Level D – “D”on’t Expect Protection”, regular work clothes

Note: Levels A and B suits must be tested. See:

- 29 CFR 1910.120, Appendix A - PPE Test Methods
- ASTM F23.50.01, Practice for Pressure Testing of TECP
- NFPA 1991, Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies (EPA Level A)
- NFPA 1992, Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies (EPA Level B)
- ANSI/ISEA-101-1996, Limited-Use and Disposable Coveralls - Size and Labeling Requirements
- Chemical-Resistant Clothing: ASTM F739, Permeation; ASTM F903, Penetration

Characteristics and Properties of CPC

PPE is effective only if it is properly selected, worn, and maintained. Standard Operating Procedures (SOPs) for PPE are included in the ERP. SOPs are employer-specific versions of the more general Standard Operating Guides (SOGs) often used in training. SOGs are written instructions and are a form of administrative control.

- Whenever possible, a variety of suit sizes should be on hand to fit the various sizes of personnel
- Adhesive on tape not approved by the manufacturer may cause degradation of the suit and the warranty may be voided
- Materials used to make most suits do not “breathe.” Rapid heat and moisture build-up will occur in the suit during use

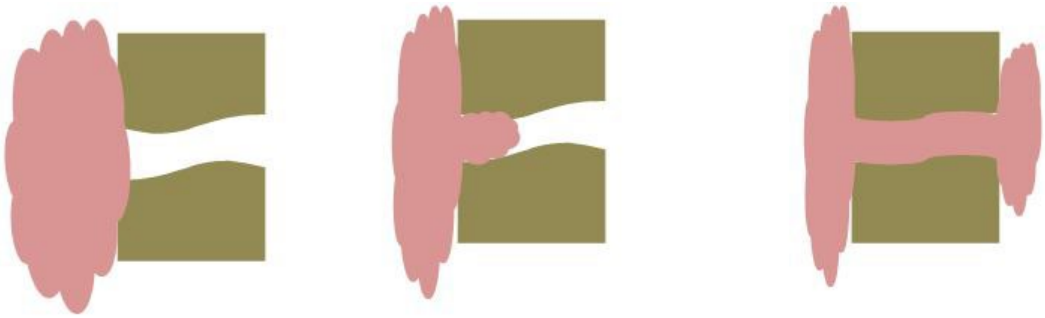
- All suits have limits as to the temperature at which they can be worn without damage. This information may be particularly important for emergency response activities. Check the manufacturer's data.
- Most suits offer no fire protection and in some cases increase the possibility of injury because they will melt and may burn

Penetration, Degradation, Permeation

Chemicals can reduce the effectiveness of CPC garments through penetration, degradation, or permeation.

NOTE: Mixtures of chemicals may behave differently from the components.

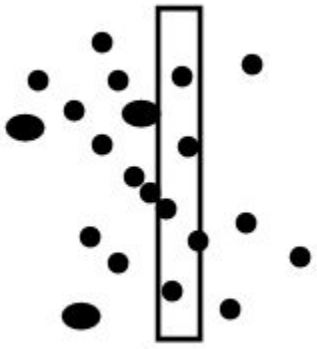
Penetration is the flow of a chemical through zippers, stitched seams, or imperfections in the material.



Degradation is a reduction in one or more physical properties of a protective material due to contact with a chemical, use or ambient conditions such as sunlight or cold. This may be seen by swelling or 'gumminess' of the material, discoloration or loss of strength.

Permeation is the process by which a chemical moves through a material on a molecular level. The rate of permeation is dependent on six major factors:

- Contact time
- Material thickness
- Concentration
- Temperature
- Physical state of chemicals
- Size of the contaminant molecules and pore space



A general rule of thumb is that the permeation rate is inversely proportional to the thickness (2 x thickness = 1/2 x permeation rate). Other important factors are chemical concentration, contact time, temperature, material grade,

humidity, and solubility of the material in the chemical. Consult the manufacturer for more information.

Chemical-Resistant Materials

The following is a list of some commonly used chemical-resistant materials and their advantages and disadvantages. Materials for chemical protection may be blended or laminated and require manufacturer's data when determining proper selection(s). This list should not be used to select materials; manufacturer's guidelines and other references should be consulted.

Butyl Rubber

Use Mainly in encapsulating suit, but some gloves, boots, and splash gear.

Advantages Good for bases and many organics. Very resistant to gas/vapor permeation. Readily releases contamination. Good heat and ozone resistance.

Disadvantages Poor for aliphatic and aromatic hydrocarbons, gasoline, halogenated hydrocarbons, and abrasion resistance. More expensive than PVC or neoprene.

Chlorinated Polyethylene (CPE)

Use Only in fully encapsulating suits

Advantages Good for aliphatic hydrocarbons, acids and bases, alcohols, and phenols. Resists abrasion and ozone.

Disadvantages Poor for amines, esters, ketones, and halogenated hydrocarbons. Becomes very rigid when cold.

Natural Rubber

Use For boot covers because of durability and for disposable inner and outer gloves.

Advantages Good for bases, alcohols, and dilute acids. Inexpensive. Flexible.

Disadvantages Poor for organic chemicals. Ages (affected by ozone).

Neoprene

Use In all types of protective clothing.

Advantages Better than polyvinyl chloride (PVC) for organics. Durable. Abrasion- and cut-resistant.

Disadvantages Not as good as PVC for acids and bases. Poor for chlorinated aromatic solvents, phenols, and ketones. More expensive than PVC.

Nitrile Rubber

Use In gloves and boots and one encapsulating suit.

Advantages Made specifically for petroleum products. Abrasion- and cut-resistant. Flexible. Good for bases, peroxides, PCBs, phenols, and alcohol.

Disadvantages Poor for aromatic and halogenated hydrocarbons, amines, ketones, and esters. Loses flexibility in cold weather.

Polyurethane

Use In boots and splash gear.

Advantages Good for bases and organic acids, oils, and alcohols. Abrasion-resistant. Flexible (especially in cold weather).

Disadvantages Poor for inorganic acids and other organic solvents.

Polyvinyl Alcohol (PVA)

Use For gloves only.

Advantages Excellent (the best) for oils, aromatic solvents, and chlorinated hydrocarbons. Ozone-resistant.

Disadvantages Degraded by water. Not flexible. Expensive.

Polyvinyl Chloride (PVC)

Use All types of protective clothing.

Advantages Excellent for acids and bases. Very durable. Relatively inexpensive.

Disadvantages Poor for chlorinated and aromatic solvents. Difficult to decontaminate.

Viton

Use In fully encapsulating suits and gloves.

Advantages Good for most organics including chlorinated hydrocarbons. Fair durability. Good for acids. Good for decontamination. Good for physical properties.

Disadvantages Poor for oxygenated solvents—aldehydes, ketones, esters, and ethers. Expensive.

Teflon

Use In fully encapsulating suits.

Advantages Excellent chemical resistance against most chemicals.

Disadvantages Limited permeation test data. Expensive.

Nomex

Use For flame retardant PPE and a base fabric for some suits.

Advantages Fire-resistant. Durable.

Disadvantages Readily penetrated.

Tyvek®

Use Predominantly for coveralls.

Advantages Dry particulate and dust protection. Disposable, lightweight, and inexpensive.

Disadvantages Penetrable if not chemically treated. Poor durability.

Polyethylene (coated Tyvek®)

Use Predominantly for coveralls, but also gloves and booties. It can be worn over CPC to prevent gross contamination of non-disposables.

Advantages Good for acids and bases, alcohols, phenols, and aldehydes. Good for decontamination (disposable) and lightweight.

Disadvantages Poor for halogenated hydrocarbons, aliphatic and aromatic hydrocarbons. Not very durable. Easily penetrated (stitched seams).

Polyethylene/Ethylene vinyl alcohol (PE/EVAL) – 4H® or Silvershield®

Use Gloves, aprons, sleeves and booties

Advantages Good for alcohols, aliphatics, aromatics, chlorines, ketones and esters, economical

Disadvantages Poor fit of gloves impacts dexterity, easily punctured.

Trellchem®

Use Fully encapsulating and partially encapsulating suits

Advantages Resistant to a wide range of chemicals, some models also including chemical warfare agents, abrasion resistance and flame resistance.

Disadvantages Stiff and bulky, expensive

Tychem®

Use Fully encapsulating and partially encapsulating suits, coveralls and hoods

Advantages Resistant to a wide range of chemicals. Some models also resist chemical warfare agents, puncture and abrasion, heat, arc flash and flame.

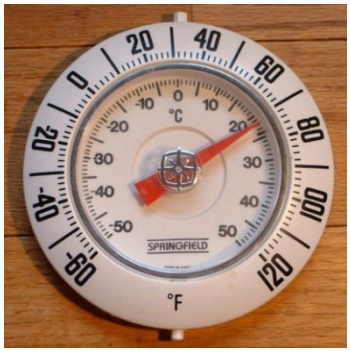
Disadvantages Expensive, stiff and bulky

See resources from manufacturers when selecting CPC. The rating for a material does not necessarily predict performance of a garment; thickness, formulation, substrate and manufacturing process can all affect the product performance.

Precautions When Wearing CPC

Every level of chemical-protective clothing has limitations. The following precautions should be considered:

- Hearing and speaking to be heard may be difficult in CPC with respiratory protection. It is important to establish other ways to communicate with each other. Hand signals or audio signals such as horns, sirens, and whistles can be used to communicate. Communication can also be improved by using two-way radios, such as a portable radio with microphone or radio with a microphone and speaker combination attached to the full-face respirator. Remember, any radio must be intrinsically safe to prevent an ignition hazard. Be aware of potential traffic areas.
- Due to the size, weight and design of some suits, motion is restricted, especially when climbing, working in tight areas, or using hand tools.
- Look for signs of heat stress (dizziness, headache, nausea, perspiration ceases), especially at temperatures over 70ºF.



- Always wear the correct size of footwear in order to prevent accidents. You should also make certain that the soles provide a proper grip for the surfaces that you will be encountering. Steel shanks, toes, and shin guards help to prevent puncture wounds and/or crushing injuries.
- Disposable booties may be slippery. Use caution when walking to prevent slips and falls.
- Care should be taken when donning and doffing inner and outer gloves. When donning gloves, make sure that no cracks or tears are present. When doffing gloves, take care not to spread contamination.

- All joints such as suit-to-boots and suit-to-gloves in Levels B and C protection should be secured with tape that is compatible with the CPC; see manufacturer recommendations. Fold the end of the tape back under to make a tab for easy removal. Use special care when removing tape.
- Goggles and eye/face protection may become clouded due to moisture condensation during use. Follow manufacturer recommendation regarding use of products such as anti-fog film or spray on protective eye/face gear. Similarly, follow manufacturer instructions regarding clearing away any fog that may form on the inside of the face shield of a fully encapsulating suit.
- Be sure you are adequately hydrated prior to and after use of CPC.
- Avoid placing your hands or knees on the ground to prevent contamination by chemicals and abrasion to the suit material. Avoid sitting on anything sharp in suits.

- When removing a suit, open and fold down onto itself as it is removed to prevent contamination of internal clothing.
- Suits have weak seams, especially if they are disposable. Be careful not to strain and split them. If splitting occurs, report it and follow the appropriate SOP (standard operating procedure).
- Use caution when suits are used in potential fire areas. If fire occurs, get out of the area.
- When dressing out with a team be careful to coordinate your dressout at the same speed and level as your team/buddy. The longer you are dressed out, the more stress is being put on your body.
- Completion of dressout should be delayed until ready to conduct your assigned duty/response activity.

Inspection, Maintenance, and Storage of CPC

It is important to inspect CPC, for evidence of chemical damage. CPC that is torn, degraded, or otherwise non-functional will not offer adequate protection to the wearer. The PPE program should describe or reference SOPs for CPC inspection, maintenance, and storage. The inspection SOP is used when CPC is:

- Received from the distributor
- Issued to workers
- Put into storage
- Taken out of storage
- Used for training
- Used for an emergency response
- Sent for maintenance
- Returned from repair or service

An inspection checklist should be developed for each item. Factors to consider are:

- Cuts, holes, tears, swelling, and abrasions in seams of fabric
- Weakness in zipper or valve seals
- Signs of contamination such as discolorations or visible chemical residues
- Signs of malfunctioning exhaust valves

Note: CPC may be contaminated or degraded even though there are no visible signs.

Proper maintenance can prevent CPC deficiencies and prolong its life. A detailed SOP must be developed by the employer and followed rigorously. All maintenance must be performed by trained personnel.

Proper storage is important in order to prevent CPC failures. The written SOP should describe storage before the CPC is issued to the worker, as well as storage after use, Check the manufacturer data for specific temperature and humidity storage requirements, shelf life, cleaning instructions, and any expiration date.

Exercise - Levels of PPE

This exercise will allow you to apply knowledge gained from this section to a "real-life" situation. The exercise involves determining what level of PPE would be required for different situations. Although you will usually be provided specific PPE selected by the health and safety officer, this exercise gives you an opportunity to determine the basic level of protection which is needed. For each situation, state the appropriate level of PPE and the reason for your decision.

- At a paved storage area on the plant grounds, a truck has overturned, spilling unknown materials onto the ground. The material is vaporizing. You do not have any monitoring equipment. What level of protection should you wear to clean up the small spill?

- Chlorine cylinders are being off-loaded from a semi onto the loading dock. What level of protection should be worn?

- You will be involved in periodic cleaning of an area in which a caustic mist will be present at low levels. What type of eye/face and whole-body protection should be worn?

- You are scheduled to clean an empty culvert where oxygen concentrations have measured 18% in the past. What level of PPE should be worn?

- You are assisting the safety coordinator with monitoring air concentrations around phenol tanks, and you are told to draw the necessary safety equipment from storage. There have never been any leaks in the past. What safety equipment should you gather?

- You are moving several five-gallon containers of hydrochloric acid, and in the past, small spills and splashes have occurred. What level of PPE should be worn?

Summary – Chemical Protective Clothing

PPE includes respirators, chemical-resistant suits, boots, gloves, chemical goggles and face shields and hearing protection. PPE is required by OSHA regulations and protects workers from:

- Chemical contact with skin and eyes
- Physical hazards
- Respiratory hazards

Level A provides the most protection and includes:

- A positive-pressure, full-facepiece SCBA or supplied-air respirator with an escape unit
- A totally encapsulating chemical-resistant suit
- Inner and outer chemical-resistant gloves
- Chemical-resistant boots with steel toe and shank

Level B includes:

- A positive-pressure, full-facepiece SCBA or supplied-air respirator with an escape unit
- Hooded, chemical-resistant clothing or TECP non gas-tight suit
- Inner and outer chemical-resistant gloves

Level C includes:

- Full- or half-face air-purifying respirator (APR)
- Hooded, chemical-resistant clothing
- Inner and outer chemical-resistant gloves
- Chemical-resistant boots with steel toe and shank

Level D includes:

- Coveralls
- Chemical-resistant boots with steel toe and shank

PPE must be properly cared for and maintained. Wearers should know the requirements of PPE. Written programs about selection, care, and use of PPE should be included or references in the Emergency Response Plan.

Review Questions

1. List four examples of PPE.

2. List three situations at your facility that require PPE. What level of protection (A, B, C, D) is required for each?

3. List some precautions to take while wearing CPC.

4. When should PPE be inspected?

5. When should PPE be replaced?

PPE - Other Protective Gear

PPE for hazardous materials workers includes respirators, chemical-resistant suits, boots, gloves, eye protection and hand protection.

PPE is required by OSHA regulations for protection from:

- Chemical contact with skin and eyes. (suits, aprons, gloves, goggles, face shield)
- Respiratory hazards (respirator)
- Physical hazards. (boots, hard hat, gloves, sleeves, thermal protection, hearing protection)

Chapter Objectives

When you have completed this section, you will be better able to:

- Identify OSHA requirements and other guidelines for hearing, eye/face, head and foot, hand/arm protection
- Describe special protective clothing

In addition to RPE and CPC, other types of PPE may be required in an emergency response. OSHA standards for additional PPE include:

- 1910.95 Hearing Protection (fire truck siren can exceed 100 dB)
- 1910.132 General Requirements: Personal Protective Equipment
- 1910.133 Eye and Face Protection
- 1910.135 Head Protection
- 1910.136 Foot Protection
- 1910.137 Electrical Protective (gloves and sleeves)
- 1910.138 Hand Protection

With the exceptions of hearing protection and electrical protection, these protective devices are required in one or more of the Levels of Protection (A, B, C, D).

Specialized clothing to protect against high temperatures or arc flash is available. Training in the selection and use is outside the scope of this program.

While OSHA provides testing requirements for hazardous materials suits, the testing protocols for head, shoe and eye/face protection are published by independent groups. The selection and training of hearing protection is detailed by OSHA in 29 CFR 1910.95. When needed, several choices must be available to workers.

Summary – Other Protective Gear

Eye, face, hand, head and hearing protection are covered by specific OSHA regulations.

Review Question

Other than RPE and CPC, what other protective gear is required in one or more of the levels of protection?

DECONTAMINATION

Decontamination is an important set of procedures designed to protect TSDF workers, other people, and the environment from exposures or contamination by hazardous materials. Nonemergency response TSDF employees should understand the decontamination process and its importance, as well as how to decontaminate the type of personal protective and other equipment they are likely to use in non-emergency situations. TSDF employees who are not designated and trained as emergency responders are not generally involved in decontamination procedures of more comprehensive safety and personal protective equipment.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Describe the necessity and importance of proper decontamination methods
- Identify methods to prevent contamination of personnel, PPE, equipment and the environment
- Identify basic decontamination methods

Introduction

Decontamination is the process of removing and/or neutralizing contaminants that may have accumulated on PPE, personnel, and other equipment. Proper decontamination is a critical element in the control of hazards which helps ensure the health and safety of workers.

Proper decontamination procedures:

- Control hazards
- Protect workers from exposure to hazardous materials
- Prevent continued contamination and permeation of the hazardous material into PPE, other equipment, and tools
- Protect personnel outside the response area by minimizing the transfer of harmful materials into clean areas
- Prevent mixing of incompatible materials
- Prevent uncontrolled transfer of contaminants to the community

At a TSD facility, decontamination may be as simple as handwashing or involve scrubbing of PPE after an exposure. The need for decon is documented in the safety and health plan; details of the decon procedures are also listed there. If a multi-station decontamination/ doffing plan is needed, more specific decontamination procedure training will be needed than that provided by this course.

Emergency response activities may require more complex decon procedures. These are conducted by those who have operations-level (24 hours) of emergency response training.

Pre-Planning for Decontamination

Decontamination is the process of removing and/or neutralizing contaminants that may have accumulated on PPE and equipment. Proper decontamination or replacement of protective clothing or equipment is critical in controlling hazards and ensuring the health and safety of workers. The need for decontamination is documented in the employer's emergency response plan (ERP) as required in 1910.120(q) (2)(vii). The detailed plan is developed, communicated to responders and other workers, and implemented before workers or equipment enter the hazmat area.

Decontamination plans include the following:

- A description of the location and layout of potential decontamination stations for the response
- A list of the decontamination equipment needed for the possible hazards (for example, water for removal and brushes for scrubbing)
- The appropriate PPE for persons assisting with decontamination
- Appropriate procedures for specific materials that may be encountered in the plant
- Methods and procedures for preventing contamination of clean areas
- Methods and procedures for minimizing contact with contaminants during removal of PPE
- Safe disposal methods for clothing and equipment that are not completely decontaminated
- Revisions whenever the type of personal protective clothing or equipment changes, the conditions change, or the hazards are reassessed based on new information

If commercial laundries or cleaning establishments receive contaminated clothing or equipment, they must be informed of potential harmful effects of exposure to the contaminant(s).

Where the decontamination procedure specifies regular showers and change rooms outside of a contaminated area, they must be provided according to the requirements of 29 CFR 1910.141. If water cannot be used due to temperature conditions, then other effective cleansing means must be provided and used.

Following the plan results in these outcomes:

- Protects workers from exposure to hazardous substances and contaminated equipment
- Prevents continued permeation of the hazardous substance into PPE
- Contamination of other PPE, equipment or tools
- Limits transfer of harmful substances to employees in clean areas
- Prevents the mixing of incompatible substances during decon
- Prevents the transfer of contaminants outside the response area
- Ensures routine critique and revised as necessary

The following examples illustrate situations when decontamination should be utilized:

- When PPE becomes contaminated
- Before workers go from a “dirty” to “clean” work area
- Before workers, eat or drink, smoke, or use restroom facilities
- Before contaminated response emergency vehicles or equipment leave the response site
- Before process equipment in the area of the response is put back into service

Limiting Contamination

The primary goal is to avoid employee contamination by minimizing contact with hazardous materials. Specific procedures are used to prevent personal contamination. For example, procedures during donning PPE will minimize the potential for contact with a hazardous material, such as:

- Inspecting PPE before each use to ensure it is in proper condition
- Closing zippers, buttons, and snaps fully
- Tucking gloves over or under the sleeves will be specified in the SOP for any task where gloves and sleeves are overlaid to prevent contaminants entering between the two
- Wearing a third pair of tough outer gloves

- Putting legs of outer clothing over boot tops
- Place any head covering that is not attached to a suit, outside the collar
- Taping all junctures with tape adhesive compatible with suit materials to help prevent contaminants from entering inside gloves, boots, and zippers

Other precautionary measures can help reduce the amount of contamination during response activities, such as:

- Using work practices that minimize contact with hazardous substances
- Avoiding puddles, plumes, or areas of obvious contamination
- Minimizing contact with surfaces potentially contaminated with hazardous substances
- Using remote devices such as robots and cameras
- Covering monitoring and sampling instruments (plastic bags with openings for sensors or intake ports), following manufacturer recommendations for preventing contamination to instruments and decontaminating those instruments after use
- Covering equipment and tools with a coating which can be stripped away as one step in decontamination
- Wearing disposable outer garments
- Using disposable equipment where appropriate

When Decontamination May Be Required

There will be different risks of contamination associated with the different types of TSD facilities. Your company's specific safety and health plan should specify when, where, and how decontamination should occur. Decontamination may be required in the following situations:

- When PPE or clothing becomes contaminated
- Before personnel leave the work area or facility
- Before workers eat, drink, smoke, apply cosmetics, or use restroom facilities
- Before and after opening pipelines, pumps, tanks, or similar equipment
- After emptying storage or transport containers
- Prior to transport trucks leaving the facility
- Prior to other equipment leaving the facility

The spread of contamination after the response is limited by actions including:

- Using methods to verify effectiveness of decon
- Decon containers and supplies that will be re-stowed
- Proper disposal of all wastes - tools, disposables, solutions

Decontamination Procedures and Follow up Steps

All workers, clothing, equipment, and sample containers leaving contaminated areas must be decontaminated to remove any hazardous materials that may have adhered to them.

Decontamination can be accomplished by:

- Physically removing contaminants
- Chemically removing contaminants
- Rinsing off contaminants
- Disinfecting and sterilizing (infectious materials)
- Combining the above methods

The selection of method(s) is based on the contaminants, the materials to be deconned and other factors, and is described in the ERP. Manufacturer recommendations for decon methods and materials should be consulted during the process of developing the Decon SOP and the follow up actions needed to support decon.

The most common decon set-up at a TSDF are separate clean and dirty areas in a locker room. Employees enter and remove their street clothes, then don a work uniform/PPE before starting work. At the end of their shift, they enter a “dirty” area where a decon SOP is carried out, including doffing their work uniform, a shower, and then donning their street clothes.

Physical Removal

Some contaminants stick to the surface of PPE and equipment and can be removed by scraping, brushing or wiping, adsorbing or absorbing, vacuuming, or use of pressurized air jets. These methods are referred to as dry decon, as solutions are not used. One reason to select dry decon is temperature—when appropriate for the contaminants, dry decon may be preferred to limit the risk of hypothermia.

Care is needed during removal by scraping, brushing or wiping to not degrade the PPE and to minimize the spread of contamination into the air. Any adsorbent or absorbing material(s) used in dry decon must be compatible with the contaminant to be removed. When using pressurized air, the pressure should be regulated to prevent injury to the

person being deconned and to protect the PPE; a pressure reducer is installed in the line, as needed.

Chemical Removal

Removing contaminants with a chemical requires special planning and training. The solution must be chemically compatible with the PPE and equipment being cleaned. Some specific methods of chemically removing contaminants include halogen stripping, neutralization, oxidation/reduction, and thermal degradation. If contaminated materials are transferred outside the zone for chemical decon, the SOP will include handling, packaging, transfer and unpacking procedures.

Rinsing off Contaminants

A soap and water solution is most frequently used to help remove contaminants. The soap may be referred to as a surfactant.

Rinsing is an important method. Multiple rinses with clean solutions will remove more contaminants than a single rinse with the same volume of solution. The most common type of removal is a water rinse with or without soap, either pressurized or by gravity flow. Chemical leaching, extraction, evaporation, vaporization, and steam jets may be used for specialized applications.

Disinfecting and Sterilizing

Disinfectant methods are used to deactivate infectious agents. Examples of methods are dry heat, gas/vapor, irradiation, bleach solution and steam sterilization; specialized procedures and training are required. Disposable PPE is often selected for use with infectious agents in order to minimize need for decon. If contaminated materials are transferred outside the zone for these decon methods, the SOP will include handling, packaging, transfer and unpacking procedures.

Notes

Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Care must be taken to prevent inhalation of the evaporating chemicals.

Dust and vapors that cling to PPE and equipment may become trapped in small openings, such as the weave of the fabric, and can be removed with water or a liquid rinse.

Removal of tightly-adhering contaminants such as glues, cements or resins may be improved by solidifying, adsorption or absorption (powdered lime, kitty litter, clay,

charcoal, poly fibers, or other materials); melting or freezing (dry ice or ice) may be used on PPE after removal, if compatible with the manufacturer instructions.

Decontamination of Equipment and Breathing Apparatus

Decontamination of equipment is an important method of controlling the spread of hazardous substances and preventing deterioration of the equipment.

Monitors - If monitoring equipment becomes contaminated, it will require special cleaning. The manufacturer or local/regional government agencies can provide information on proper decontamination methods.

Tools - Metal tools should be cleaned, as appropriate, by chemical or physical means. EPA regional laboratories may be consulted for specific methods to decontaminate tools. Wooden tools and tools with wooden handles are difficult to decontaminate because they absorb chemicals. Wooden tools should be discarded if contamination is suspected.

Respirators and SCBAs - Certain parts of contaminated respirators and SCBAs, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush depending on the contaminant. Regulators must be maintained according to the manufacturer's recommendations. Persons responsible for decontaminating respirators should be thoroughly trained in respirator maintenance. The safety and health plan must detail the methods to be used to decontaminate respirators and SCBAs.

Preventing Spread of Contamination

Contaminated wash and rinse solutions must be contained by using step-in containers to hold spent solutions or other methods of containment. Tools that were used in a contaminated area should not be brought into clean areas without proper decontamination. Heavy equipment, such as fork lifts or trucks, may need to be decontaminated before servicing or before leaving the site. Special decon bays are usually constructed to facilitate decon in all types of weather and to capture any solutions or rinsate or contaminants displaced into the air.

Disposal of Contaminated Materials

All contaminated material and equipment used for decontamination must be disposed of. Clothing, tools, buckets, brushes, and any other contaminated equipment must be secured in drums or other containers and properly labeled. The spent solutions must be transferred to drums which are appropriately labeled and disposed of according to local, state, and federal regulations.

Evaluating the Effectiveness of Decontamination

Decontamination methods vary in effectiveness to remove different substances. The effectiveness of any decontamination method should be assessed during development of the ERP and when new information is available. If contaminated materials are not being removed or are penetrating protective clothing, the decontamination program must be revised. The following methods may be useful in assessing the effectiveness of decontamination.

Visual Observation

There is no reliable test to immediately determine how effective decontamination is. In some cases, effectiveness can be estimated by visual observation.

In natural light, any discoloration, stain, corrosion, visible dirt, or alteration to fabric surfaces may indicate that contaminants have not been removed. However, not all contaminants leave visible traces or effects; many contaminants can permeate clothing and are not easily observed.

Ultraviolet Light

Certain contaminants, such as polycyclic aromatic hydrocarbons, which are common in many refined oils and solvent wastes, fluoresce and can be visually detected when exposed to ultraviolet light. Ultraviolet light can be used to observe contamination of skin, clothing, and equipment; however, certain areas of the skin may fluoresce naturally, thereby introducing uncertainty into the test. In addition, use of ultraviolet light can increase the risk of skin cancer and eye damage; therefore, a qualified health professional should assess the benefits and risks associated with ultraviolet light prior to its use.

Wipe Sampling

Wipe testing provides after-the-response information on the effectiveness of decontamination. In this procedure, a dry or wet cloth, glass fiber filter paper, or swab is wiped over the surface of the potentially contaminated object and then analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be sampled separately. Skin contamination may also be evaluated using wipe samples.

Cleaning Solution Analysis

Another way to test the effectiveness of decontamination procedures is to analyze for contaminants in the used cleaning solutions. Elevated levels of contaminants in the final rinse solution may suggest that additional cleaning and rinsing are needed.

Testing for Permeation

Testing for the presence of permeated chemical contaminants requires that pieces of the protective garments be sent to a laboratory for analysis.

Summary - Decontamination

Decontamination procedures are very important in preventing the spread of contaminants into clean areas. Proper procedures (SOPs) for decontamination must be operational before any personnel or equipment enters areas where there is the potential for exposure. Precautions should be taken to prevent contamination of personnel and expensive equipment such as monitors. Methods to decontaminate personnel, PPE, and other equipment will vary depending on the type of facility and the contaminants involved.

Basic methods include:

- Rinsing or dissolving
- Scraping, brushing, and wiping
- Evaporating then rinsing
- Using surfactants, like soap
- Disinfecting chemically
- Combining the above methods.

Decontamination of equipment and respirators may require special attention. EPA regional laboratories or the manufacturers of equipment (monitors or tools) can provide information on special decontamination methods that may be necessary. Persons responsible for decontaminating respirators should be thoroughly trained in respirator maintenance. All materials that were used in the process of decontamination should be considered contaminated and disposed of properly.

Review Questions

1. Why is it important to decontaminate personnel, PPE, and other equipment?

2. How can contamination be prevented?

3. What are some basic decontamination methods?

WORK PRACTICES

Some common work practices for TSDF workers are outlined in this section. Safe work practices are vitally important to protect the worker's health and safety. Standard Operating Procedures (SOPs) are written instructions for safe work practices and are a form of administrative control.

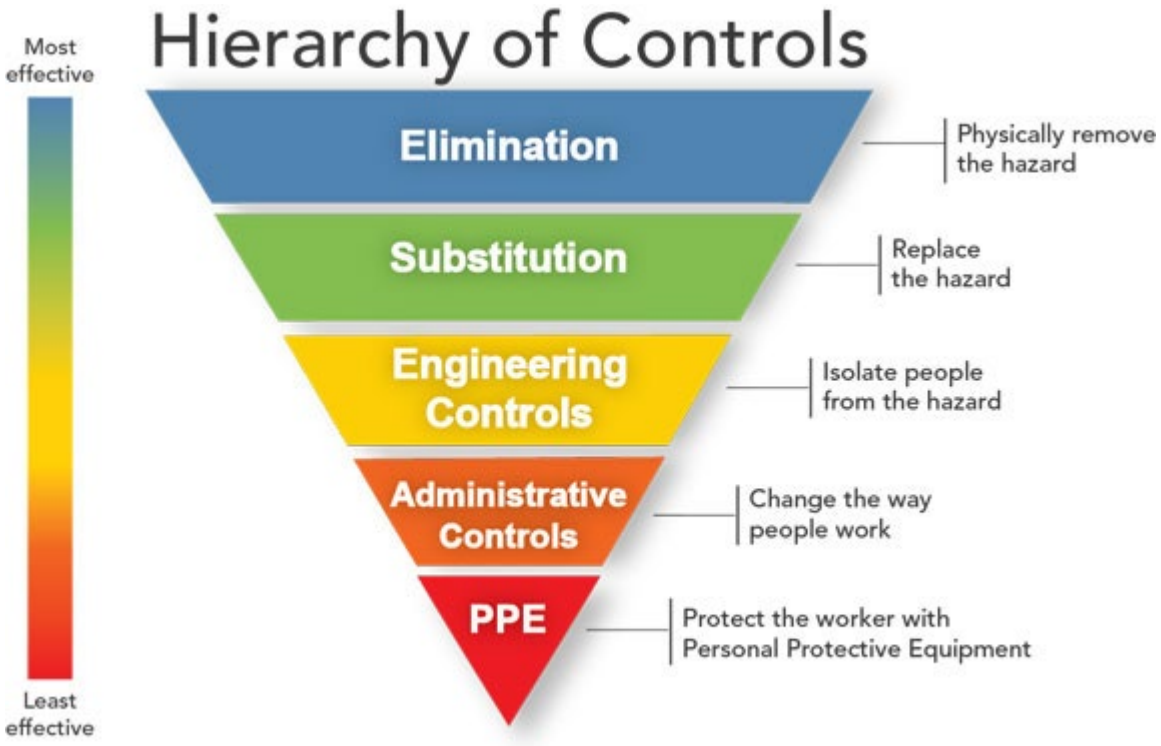
Chapter Objectives

When you have completed this chapter, you will be better able to:

- Describe how safe work practices are required by both OSHA and the EPA through their respective regulations.
- Define the term Standard Operating Procedure and understand how SOPs are necessary to reduce the risk of injury.
- Identify SOPs relevant to major activities commonly performed at a variety of TSD facilities.

Hierarchy of Controls

The hierarchy of controls refers to the preferred methods of hazard control. Traditionally, in order from most-preferred to least-preferred, they are:



source: https://www.cdc.gov/niosh/topics/hierarchy/default.html

It is not possible to eliminate all hazards at a TSDF. However, a range of controls can be employed.

Eliminate

Disconnecting power at an abandon building at the waste site (eliminating electrical hazards) is one example. Eradication of poisonous plants, and venomous snakes are additional examples.

Substitute

Using a 'green' pesticide made from household chemicals to eradicate poison ivy is one example. Using soap and water instead of a solvent-based liquid for hand cleaning is another example of substitution.

Modify

When confined space entry activities are changed to use work practices that do not require personnel to enter the space, the procedure has been modified. Sending a robot to collect soil samples potentially contaminated with radioactive sludge is a modification (compared with sending a person).

Contain

Enclosing a noisy operation is an example of containing the hazard. When a dusty material transfer operation cannot be controlled, moving the operator to an isolated control area contains the hazard in an unoccupied workspace.

Ventilate

Removing solvent vapors with mechanical exhaust at a transfer point of liquids containing a toxic solvent is an example of ventilation.

Work Practice Change

Adding a sign-off during excavation to ensure that trenching has been done according to guidelines is a change in the work practice.

Personal Protective Equipment

When the above controls are not possible, personal protective equipment is used. For example, Level B is required to protect from solvent-contaminated soil during drum staging.

Hazard controls are further defined as Engineering or Administrative.

When engineering controls are used to control hazards, a piece of technology is used to reduce exposure. Examples include having an air-conditioned control rooms for chemical operators to reduce employee heat exposure and shielding to reduce radiation exposures. When use of confined space entry permitting process is the only way of accomplishing a task, a ventilation fan is used to provide fresh breathing air inside the confined space, helping to reduce the risk. Ventilation is a commonly-used engineering control.

Administrative controls are policies and practices written before the work begins to minimize exposure to chemical and physical hazards. Examples include industrial hygiene monitoring programs, medical surveillance programs, confined space entry and

hot-work permits and policies, and lock-out procedures. Other examples are work plans limiting the duration of exposure (e.g., to noise and radiation), developing a written plan describing the maintenance of protective clothing, and implementing specific work practices which reduce or prevent exposure. All of these controls are examples of a universal Standard Operating Guideline (SOG). At your worksite, hazards are addressed with site-specific Standard Operating Procedures (SOPs).

Standard Operating Procedures

Standard Operating Procedures (SOPs) are carefully planned and detailed written work instructions intended to provide workers with necessary guidelines to carry out work tasks safely. Some SOPs are used in routine plant operations; others provide guidelines for actions that should and should not be taken during an emergency.

In this program we may use the term Standard Operating Guide (SOG) - generic guidance on how to do a task.

Routine SOPs

Workers are guided by company-specific SOPs while performing their regular work tasks. Examples of some areas covered by SOPs are:

- Confined space entry
- Lock-out
- Fire prevention

Some of these SOPs will also be helpful to the emergency responder.

Confined Space Entry Procedures

A confined space generally has three distinct properties which set it apart from other areas and dramatically increase the risk of injury or illness.

Properties of Confined Spaces

- Is large enough and so configured that an employee can bodily enter and perform assigned work
- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry
- Is not designed for continuous employee occupancy

Some common confined spaces that are found at TSD facilities include, but are not limited to:

- Ditches, culverts, and ravines
- Excavations and trenches
- Tank cars
- Vaults
- Sewer systems with manhole entrances
- Vats
- Tanks

The OSHA Permit-Required Confined Space Entry Standard (29 CFR 1910.146) requires that the employer survey all confined spaces and designate those for which a permit is required. Remember that in an emergency, the hazards of a space may change. For example, a ditch not usually containing any hazard could be a catch basin for spilled material. Although not designated a permit-required confined space, it has become one as a result of the release.

A permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

- Contains or may contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section
- Contains any other recognized serious safety or health hazard

All personnel must be informed of the hazards before entry.

Entry into confined spaces poses many dangers. Chemical vapors can accumulate quickly in confined spaces. A confined space might also contain a material that could trap a worker or a moving part that could trap or injure. Entry into confined spaces may block your view of what else is happening around you.

Lack of natural ventilation makes it easier for toxic or flammable materials to accumulate. Something as simple as rusting metal or the operation of fuel-powered engines can deplete the existing oxygen supply. Decaying organic materials such as plants or animals can create hydrogen sulfide gas.

Many toxic gases don’t have any warning properties, so workers about to enter the confined space have no way of knowing what hazards they might face without first

testing the air. The most common confined space injuries are asphyxiation from lack of oxygen, being overcome by very high concentrations of toxic vapors, or rapid skin absorption of organic solvents.

Other common confined space hazards involve explosions or fires. Getting in and out of a confined space can cause injuries and hinder rescue efforts in emergencies. Responders who may be required to rescue victims must be provided training in the types of spaces at the facility and perform a simulated rescue annually.

Several steps must be taken to make work safer in confined spaces. Careful advance planning for confined space entry can help minimize the risk of injury. This advance planning must include the following points:

- Identifying confined spaces. (Determine which require a permit to enter.)
- Developing written standard operating procedures (SOPs)
- Arranging for and strategically locating adequate supplies of air-supplying respirators and protective and life-saving equipment
- Training personnel who must enter permit-required confined spaces to deal with emergency events
- Training personnel how to monitor and properly safeguard the space before and during entry
- Posting a qualified and trained safety attendant who is ready to provide assistance, if required, outside the confined space entrance at all times
- Training personnel to recognize when the hazards of a confined space may have changed

The hazards of confined space entry are further reduced by:

- Monitoring confined spaces before entry and during work for oxygen deficiency and flammable or toxic atmospheres. Monitoring must be conducted throughout the space, not just at the entry point.
- Providing appropriate ventilation before and during the work.
- Complying with the permit and logging system. Under this system, confined space entry is permitted only after information about oxygen and toxic and flammable vapor levels has been collected. The permit must be signed by a properly trained supervisor. No personnel can enter the confined space without a signed entry permit. Permits are valid only for a specific date, time, and place.

A confined space entry standard operating procedure (SOP) minimizes danger by trying to control factors that may cause or contribute to accidents or emergencies through

careful monitoring, training, and planning. These required SOP's are an administrative control.

The confined-space entry program must be in writing. The initial training of attendant, entrant, supervisor, and rescue workers is detailed; and documentation of annual retraining for these individuals is detailed. All procedures to be used during activities related to the entry are included. The program must include a description of procedures to:

- Prevent unauthorized entry
- Identify/evaluate hazards prior to entry
- Provide means/practices for safe entry
- Provide equipment for testing, monitoring, ventilating, communication, PPE, lighting, barring and shielding, safe access/egress, and rescue and emergency
- Evaluate conditions during operations
- Provide at least one attendant
- Provide adequate response capability
- Designate roles and responsibilities
- Summon rescue/emergency personnel
- Carry out the permit system
- Coordinate operations if multiple employers are represented
- Provide for conclusion of entry
- Review operation
- Review program
- Provide Training

Important examples of pre-entry, entry, and post-entry procedures are:

<u>Pre-Entry Procedures</u>

- Install signs and barricades, and secure the perimeter.
- Isolate space from unauthorized personnel.
- Obtain and fill out a confined-space permit.
- Test and continually monitor the atmosphere.
- Ventilate and retest space.
- Use retrieval lines with harness.

Entry Procedures

- Chief entry worker makes initial atmospheric tests within space, with oxygen levels always being measured first. Attendant remains outside at all times and records atmospheric readings on the confined-space permit.
- Attendant maintains continuous communication (visual or radio) with entrant worker(s).
- Retrieval lines are manned outside by rescue personnel or tied off at a secure fixture. A mechanical retrieval system must be available for spaces over 5 feet deep.
- A harness and retrieval line must be worn, unless it creates a hazard or can not be used to effectively extricate a person from outside the space.
- Protective equipment must be appropriate for the hazards.
- Entrants and attendants have authority to evacuate the space.

Post-Entry Procedures

- If any problems were encountered, have follow-up critique to resolve.
- Check all equipment; repair as necessary and store.
- Complete report.
- Permits must be kept for 1 year and reviewed. Annually, the entire program should be reviewed and updated.

Lock-out Procedures

Lock-out procedures are used to prevent injury during the repair of mechanical equipment. The equipment is locked out of operation so that it will not be turned on by someone who is unaware of the activity of another worker.

Know the site lock-out procedure before attempting any operation.

Never assume a machine, circuit, or pipe is locked out just because it should be.

When in doubt, lock it out!

Common examples of equipment requiring lock-out include the following:

- Electrical junction boxes
- Pipes with liquid, steam, etc.
- Mechanical equipment with moving parts (grinders, crushers, pulverizers, hydraulics)
- Spring-loaded or -activated devices

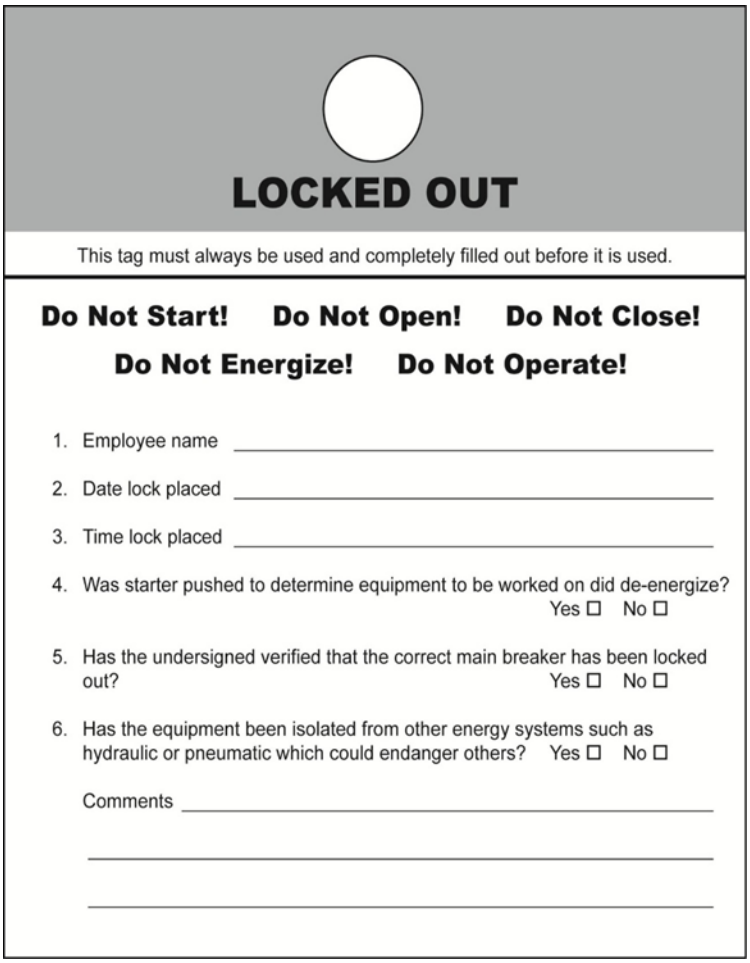
The risk of ignition of flammable materials and electrocution is lessened by locking out an electrical circuit. Locking out a steam or hot water pipe may cut off a transmission path for vapors or fumes and prevent burns or accidental contact with the contents of the piping system.

Lock-out requirements are described in 29 CFR 1910.147, The Control of Hazardous Energy (Lock-Out/Tag-Out).

The following list identifies the minimum recommended procedures for lock-out.

- Get lock-out approval/permit (lock-out tag).
- The first person to work on a piece of equipment should be sure the primary power source is turned off and install a personal lock with a lock-out clamp. This clamp must be installed so that the disconnect cannot be turned on with the clamp and lock in place. The switch is then activated to see if the circuit is truly de-energized. (This will also bleed off any stored energy.)
- Each person who works on the equipment must go through the standard process described above.
- Each person must remove his or her lock after completing the job and all personnel are out of the danger area. After the last lock and clamp are removed, the warning tag can be removed and the equipment re-energized.
- A lock must be removed only by the person who installed it. Any exceptions are detailed in the SOP and must be included in the site-specific training.
- Critique any problems and revise the SOP.
- Annually, review and update the SOP if needed

Example of a Lock-Out Tag



LOCKED OUT

This tag must always be used and completely filled out before it is used.

Do Not Start! Do Not Open! Do Not Close!

Do Not Energize! Do Not Operate!

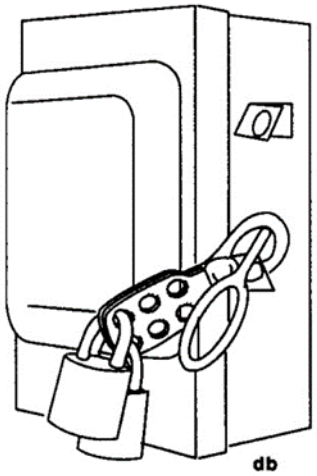
1. Employee name _____
2. Date lock placed _____
3. Time lock placed _____
4. Was starter pushed to determine equipment to be worked on did de-energize? Yes ☐ No ☐
5. Has the undersigned verified that the correct main breaker has been locked out? Yes ☐ No ☐
6. Has the equipment been isolated from other energy systems such as hydraulic or pneumatic which could endanger others? Yes ☐ No ☐

Comments _____

_____

_____

Failure to follow lock-out procedures may result in an emergency immediately hazardous to life and property. Hazards to worker's safety and health when the lock-out policy is not followed include electrocution; chemical or other bums; or being caught in or crushed by mechanical, pneumatic, or other moving parts.



Typical Lock-Out Device with Spaces for Multiple Locks – One lock per person for safety

Fire Prevention

Although it is necessary to monitor for the presence of flammable vapors, constant attention must also be given to preventing fires and explosions. Prevention is the responsibility of both the employer and the employee.

Employer Responsibilities for Fire Prevention

- Maintaining adequate supplies of fire-extinguishing media appropriate for the hazards
- Making certain that fire-extinguishing equipment and supplies are properly positioned
- Ensuring that responsible fire brigade crews are adequately trained to use the specific firefighting equipment and supplies for the hazards which may be present
- Conducting routine evacuation and fire-response drills
- Conducting frequent walk-through inspections for fire safety purposes
- Inspecting fire-suppression equipment routinely
- Posting evacuation routes
- Training personnel in hazard recognition
- Handling and storing compressed gases properly

Worker Responsibilities for Fire Prevention

- Using non-sparking tools
- Observing no-smoking rules
- Using non-sparking radios and other electrical equipment
- Following other reasonable rules to reduce the possibility of fire

Power Tool Use

The use of power tools may pose health and safety hazards. Specific SOPs should be in place for use of specific power equipment at your facilities. The following guidelines are general. Refer to OSHA's General Industry Standards for more information on specific power tools.

General Precautions

- Use pneumatic-powered equipment whenever possible to reduce electric shock hazard potential.
- When electric equipment is used, grounding and/or ground fault interrupter (GFI) circuit breaker must be used, according to OSHA Construction Standard 1926.
- When working with or near flammable and combustible material, use non-sparking, explosion- proof equipment.
- Do not use heat and spark-producing tools (grinders, torches) near flammable or combustible material without adequate testing and other precautions.
- Guards and other safety devices must be kept in place and operational at all times.
- Use appropriate personal protective equipment (PPE), and ensure that it does not become entangled in moving parts or ignited by power tools.

Specific Procedures

- Pneumatic equipment must have safety pins or other restrainer in place during use.
- Tools shall be inspected before each use to assure they are in good operating condition.
- Use the proper tool for the job.
- Tools are to be decontaminated after each use and returned to proper storage.

Specific TSD Work Practices: Unloading/Loading Procedures

In this section we will examine some more specific TSD work practices, including some already required by OSHA's HAZWOPER as well as those required by good safe work practices. These SOPs may vary from employer to employer and will depend on the type of waste being received, handling procedures, and chemical processes. Most of these procedures come from existing RCRA requirements.

A spill containment program must be developed and implemented where major spills could occur. This written program is part of the Safety and Health Plan. Spill control will be addressed in the Emergency Response SOPs chapter later in this manual.

Waste-Receiving Procedures

The following are general requirements for a waste-receiving procedure:

- All facilities are required to maintain a secure site by controlling access to it per EPA regulations (40 CFR 265.14).
- Some facilities require that drivers of waste-hauling vehicles wear PPE while at the facility and/or while their vehicle is connected for unloading or loading.
- In order to protect the facility and the waste generator, verifications as to amount or number of items must take place before the waste is unloaded or as part of the unloading (40 CFR 263.21).

An important part of the procedure is verification. OSHA 1910.120 (j)(1)(iii) requires that when practical, drums and containers be inspected before they are moved. The purpose of this inspection is to ensure their integrity. If this is not possible, the HAZWOPER standard allows them to be moved to a temporary inspection area before they are moved to a more permanent storage or treatment area. In addition, the following steps should be done:

- Bulk loads are scaled or gauged before and after unloading to obtain the net amount of material received.
- Drums or other containers or articles are counted to see that they are as stated on the manifest.
- A difference of more than 10% in volume or any difference in count from the manifest declares the load off-spec.
- In order to protect the facility, the load is sampled, analyzed, and the results compared to the data and paperwork on file at the facility before loading or unloading. Differences in the analysis or physical form of the waste will result in an off-spec load.

When the verification and testing of the waste is complete and the load accepted, the vehicle is directed to the unloading area.

Unloading/Off-Loading Procedure for Drums and Other Containers

Before unloading of drums or containers can begin, the following must be verified and corrected as needed:

- Wheel chocks are in place
- Dock board is secured in place
- Load wrappers, binders, or chains are removed. Be careful when removing these items.

They may puncture the drums or strike you in the face or mouth. When moving drums and other containers:

- 1910.120 (j)(1)(iii) requires that drums and containers be inspected before being moved, where practical. Site operations must be organized so as to minimize the amount of drum or container movement.
- Use proper equipment, such as drum cart, forklift, or similar equipment. OSHA 1910.120(j)(3) requires that material handling equipment has to be used, positioned, and operated to minimize any ignition sources that might ignite vapors released from ruptured drums or containers.
- With a drum cart, be sure drum is securely attached, and tip slowly while watching for leakage.
- Check that all required DOT, EPA, and facility labels are in place and contain proper information. If not, report problems to your supervisor right away. Drums and containers must meet appropriate DOT, OSHA, and EPA requirements for the wastes they contain.
- Place container in proper storage area, segregating containers as directed.
- Report any problems such as leaks, bulging drums, or discolored packaging immediately.
- If slings are to be used for off-loading containers such as transformers, be sure the weight is within the hoist and sling load limits and that the slings are in good condition.
- Make certain that fire-extinguishing equipment is on hand in the event of fires (1910.120 (j)(1)(xii)).

Bulk Tanker Unloading Procedure

When unloading bulk tankers, you should observe the following general procedures.

Preliminary Procedures

- Review paperwork and placards to be sure tanker is at proper unloading station
- Chock wheels, set brakes, and shut off engine
- Connect tanker to unloading system
- Use PPE as required
- Make sure unloading hose connectors have gaskets in place and that the gaskets and couplings are in good condition to prevent leakage
- Connect a ground lead if unloading flammable or combustible material
- Vent tanker for unloading by opening hatch. Some units unload by pressure or vent by means other than the hatch. Consult driver before opening hatch. Some facilities require driver to open hatch or vent trailer. Failure to vent a tanker may result in vacuum build-up inside and serious damage, including inward collapse and product release.

Opening Procedures (PPE may be required)

- Loosen bolts, but do not lay aside
- Slowly raise hatch, and observe for fluid release if tanker is overfilled. Open the hatch downwind from you if possible. If fluid comes out, re-secure hatch and notify supervisor.

Transferring Procedures

- Open tanker, pump, and receiving container valves
- Start the pump
- Observe for leaks, and correct if necessary
- Monitor operation during transfer

Unloading Problems—Material Will Not Flow From Tanker to Pump

- Valve will not connect. May be incorrect hook-up locations; check with supervisor.
- Check valves—internal and external— to be sure they are open
- Check for proper venting
- Check for accumulation of solids on bottom of tanker that may be blocking or plugging tanker valves

Procedures for Disconnecting Tanker That Was Pumped, Not Pressure, Unloaded

- Check through hatch or inspection panel to see if tanker is empty
- Place drip pan under hose connector
- Close tanker valves
- Loosen hose connection, draining any material into a drip pan
- Place unloading hose in proper location, connecting capping or by other means as required
- Unhook ground lead, if used
- Secure hatch and valve caps on tanker
- Remove chocks, if used
- In the event of equipment failure, overflow, or other emergency, follow emergency shutdown procedures

Bulk Solid Container Unloading Procedure General Procedure

- Position vehicle in proper location
- Release tailgate manual locks (if equipped) from side of container while remote control locks hold
- Position yourself well in front of vehicle and on driver's side as the load is raised to dump
- If load hangs in the bed of the truck, the truck may turn over. Always remain well clear and if load hangs, lower bed and use other means to remove load or correct the problem.
- Rocking or jerking a partially loaded container may cause roll-over. If vehicle rolls, follow emergency procedure.
- When off-loading roll-off boxes, remain clear of box path as boxes are lowered in case of cable failure or run-away box
- If heavy equipment is being used to handle or position waste, beware of equipment around you

Procedures for Vehicles Preparing to Leave After Unloading

After unloading vehicles, prepare them to leave as follows:

- Secure openings by locking tailgates, installing valve caps, securing hatch, or closing doors
- Check for drips and spills. Clean up or contain as described in the SOP.
- Direct the vehicle to wash area if decontamination is required

- Wheel wash may be required for vehicles that entered active landfill areas
- Some facilities may require other containers to be rinsed prior to leaving
- Scale vehicle if empty weight will be required to calculate the volume received
- Process paperwork so that the transport vehicle can take required copy of paperwork along (40 CFR 263.22(A))
- Collect any loaned safety equipment, clean, and return to proper location

Loading Procedures

General Procedures

- Verify integrity of container(s). OSHA 1910.120 (j)(8)(i) requires that drums and containers be identified and classified prior to packaging for shipment.
- Inspect tankers for evidence of damage, leaks, and remaining contents.
- Inspect bulk solid containers for evidence of damage, weak places, and tailgates.
- Inspect drums for evidence of damage, leaks, tight lids and bungs, proper gaskets, and labels.
- Install a liner in container or transport vehicle as required. Plastic sheeting or straw commonly is used with solids to prevent leakage and ease off-loading of solid materials.
- Position vehicle for loading, and set brake.
- Chock wheels if loading drums in trailers or filling tankers.
- Weigh vehicle empty, if required.
- Staging areas must be kept to the minimum number necessary in order to properly identify and classify materials and to prepare them for shipping (1910.120(j)(8)(ii)). Staging areas must have adequate access and exit routes (1910.120(j)(8)(iii)).
- Do not overfill or overload.
- Monitor loading in case of problems.
- Monitor condition of material and containers being loaded for leaks, discoloration, or other unusual conditions.
- Record volume being loaded.
- Operate bulk tank valves, connecting hoses, and transfer pumps.
- Operate loading equipment (e.g., front-end loader, forklift, or similar

equipment).

- Transfer drums to transport vehicle.
- Prepare for transport by completing paperwork (e.g., verify volume, weight, and similar information), and sign and remove copies.
- Conduct final inspection of vehicle for placards, caps in place, traps on, no leakage, cargo braced, and similar procedures.

Drum-Handling Procedures

Both OSHA and the EPA have regulations regarding safe work practices for drum handling. OSHA requirements are listed in 1910.120 (j). RCRA requirements are listed in 40 CFR 264.171–175. Safe work practices for handling drums should be included, as an SOP, in the company's safety and health plan.

Especially dangerous wastes may require shielding materials, remotely operated equipment or robots, or specific PPE to handle, even in drums. In some instances, special PPE may be required such as the use of bomb suits for reactive waste. Especially dangerous wastes should always be handled with extreme care. Workers should strictly adhere to the specific SOPs for handling these materials.

If plans for treatment and storage include bulking/mixing of drummed waste, all material should be tested for compatibility before mixing. Incompatibility may cause violent reactions, including fire and explosion and the release of deadly fumes and gases. Additionally, incompatibility may cause damage to processing equipment through the possible solidification of the material.

Types of Drums

- Closed-top drums are sealed drums which have small openings in the top of the drum through which liquids can be poured. Open-top drums have removable lids and do not have the small openings characteristic of the closed-top drum. Some types of drums and what they contain are listed below.

- Closed-top metal drums normally contain noncorrosive products in liquid form (DOT specification 17C or 17H most common).

- Closed-top plastic or composite (plastic inside metal or cardboard) drums usually contain corrosive liquids (DOT specification 37M, 6D, or E8585).

- Open-top metal drums usually contain noncorrosive solids or sludges.

- Open-top plastic drums usually contain corrosive solids or sludges (DOT specification 21C or E711 most common).

- Other types of drums such as stainless steel, nickel, and MONELTM are

used for chemicals that require special containers for safe containment. These containers usually can be recognized by their metallic color.

- Overpack drums (DOT specification E9618 most common) made of metal or plastic may contain any of the above drums.

Drum Inspections

As delineated in OSHA and RCRA regulations, the following points should be part of an SOP for drum handling. Inspect upon receipt for:

- Leaking drums
- Proper and complete EPA, DOT, and facility labels and information
- Proper number of drums for each group listed on the manifest

Inspect daily (or per facility procedure) for:

- Leaking drums
- Swelling or bulging drums
- Other changes—corrosion from outside, crystallization on the outside

Use of Mechanical Devices

The risks of injuries and other safety hazards associated with drum handling can be minimized through the use of the following mechanical devices:

- Drum carts—hand trucks designed especially for drums
- Forklifts or steer loaders with special adapters to grab drums
- Drum up-ender—provides leverage to lift drums from horizontal to standing position

- Drum lifters—allow handling of drums in standing position
- Drum dumpers—allow for easy emptying of drums
- Drum racks/cradles—facilitate horizontal stacking without danger of rolling

Moving Drums

The risks of injuries and other safety hazards can be minimized when proper drum-moving procedures are employed. When moving drums you should:

- Tip slowly and watch bungs or lid seal for leakage
- Tip to edge slowly and steadily when moving by hand. DO NOT JERK, as back injury may result
- When rolling open-top drums, be aware of lid ring bolt so it does not catch hand
- Be sure mechanical device is firmly attached before attempting to tip or move drum
- Use necessary PPE to prevent skin contact
- Use proper respirators if there is danger of airborne contaminants

Drum Storage

Drums should be stored by compatible groups to prevent:

- A reaction if a drum leaks and causes a second drum to release product
- A reaction in case of fire or other upset
- The feeding of the wrong materials to the treatment process.

If drums are stored on pallets, the following procedures should be

followed:

- Store only compatible substances on the same or adjacent pallets
- Drums must sit squarely on pallets; do not hang off edges
- Use only intact pallets without broken or damaged boards
- Band drums together, if possible
- Place labels on drums facing outward so they can be read, if necessary

Drum-Opening Procedures

The following procedures and precautions should be followed when your job calls for opening drums:

- Wear appropriate respiratory protection and chemical-protective clothing (CPC) for the chemicals/wastes that are contained in the drums.
- Use remote-controlled devices if possible. Use pneumatically operated impact wrench or non-sparking bung wrench to remove drum bungs. Use hydraulic or pneumatic drum piercers for puncturing drums. Use hydraulic, pneumatic, or electric cutters to cut out tops.
- Always use bonding and grounding where appropriate.
- Do not use chisels, picks, or other hand-held tools to puncture drums.
- Relieve excess pressure from bulging drums slowly, using remote devices. When relieving pressure manually, personnel must be protected by a shield.
- Open exotic metal and PVC-lined drums through the bung by removal or drilling. Use extreme caution when handling these containers.
- Re-seal open bungs and lids after emptying to avoid vapor generation and prevent leakage of residue.
- Check overpacks frequently for leaks, especially if corrosives are overpacked in steel overpacks. Use caution when handling overpacks, as the drum shifting inside makes the overpack hard to handle. Standard drum-handling equipment may not fit overpacks, which could create handling problems.

Drum Sampling

The following list of procedures should be used for drum sampling:

- Review appropriate documents
- Prepare sampling equipment
- Wear appropriate PPE
- Implement a sampling plan that indicates how to mark drums
- Mark the drums and sample bottles so that they can be related
- Determine the number, volume, and locations of samples
- Inspect the area and the drum for the presence of hazardous conditions
- Open drum, following recommended drum-opening procedures
- Use appropriate sampling device for material (Coliwasa, thief, etc.)

- Close drum
- Dispose of sampling equipment or decontaminate according to the SOP

There are situations where sampling may not be done due to hazardous drum conditions; therefore, remote puncturing of the drum will be required. Report the presence of any of the following conditions to your supervisor:

- The drum has a bulging top. This condition warns of an excessive build-up of pressure within the drum.
- The drum appears damaged in some way, such as a large dent. This condition could also cause a build-up of pressure.
- There is an appearance of vapor or mist coming from the top of the drum, usually near the bung hole.
- There is an obvious leak.

Work practices to protect your health and safety are included in a number of federal regulations, including OSHA's HAZWOPER and Hazard Communication Standard and the EPA's RCRA regulations.

Standard Operating Procedures (SOPs) are carefully planned and detailed written work instructions intended to provide workers with necessary guidelines to carry out work tasks safely. Some SOPs are used in general routine plant operations; others provide guidelines for what should be done at specific types of TSD facilities. SOPs should exist for routine operations that are commonly found in industrial settings. SOPs for confined- space entry, lock-out/tag-out, fire prevention, and power tool use delineate the necessary work practices required to protect a worker's health and safety.

Specific SOPs should exist that relate to operations at specific TSD facilities. The specific SOPs available would depend on what types of work practices were routinely engaged in at the site. Specific SOPs should exist for waste-receiving which should include how to maintain a secure site, the necessity of PPE, and verification procedures. SOPs should exist for procedures dealing with unloading and loading of vehicles, including how movement of materials should occur.

If workers at the facility engage in drum handling, specific SOPs should include information on drum inspections, the use of mechanical devices during handling, and how drums should be moved.

If the facility stores drums, SOPs should exist for how drums are to be stored. Segregation of incompatibles should be addressed.

If drums will be sampled, SOPs should exist for drum-opening and sampling procedures.

Small Group Activity

Background: You are walking to the loading dock when you hear the brakes being set on a semi. You go over to help the driver get the truck ready to unload. As you reach the cab, you notice the driver has already left. You also notice some liquid dripping from the trailer's rear doors.

Instructions: Without getting any closer to the scene, how would you answer the following questions?

What information would you want to gather?

What should you do at this point?

Review Questions

1.What is the Hierarchy of Controls?

2. Why are SOPs necessary?

3. Describe a confined space situation. Why is a permit necessary?

4. What are the basics of a lock-out procedure?

5. List three elements of a fire prevention program.

EMERGENCY RESPONSE SOPs

The Emergency Response Plan (ERP) contains vital information about procedures to be followed during an emergency situation. This section outlines information which should be found in an ERP.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Describe OSHA and EPA regulations dealing with emergency response
- Describe the relationship between HAZWOPER and RCRA regulations for emergency response
- Describe what is required in a Contingency Plan and an Emergency Response Plan
- Evaluate an Emergency Response Plan
- Understand emergency response actions which require additional training

Introduction

Both the OSHA HAZWOPER and EPA RCRA regulations have requirements concerned with emergency response, and there is some degree of overlap between the two. OSHA requires a written **Emergency Response Plan** (ERP). The EPA requires a written **Contingency Plan** (CP). This section will cover emergency response as delineated in both EPA and OSHA regulations.

Relationship of RCRA and HAZWOPER

OSHA's emergency response standard for TSD facilities (1910.120(p)(8)) states that the required Emergency Response Plan must include the RCRA required Contingency Plan. The written Emergency Response Plan should not duplicate areas already covered by the Contingency Plan, according to OSHA.

The combination of the Contingency Plan and the Emergency Plan must be included in the TSDF's written safety and health plan.

RCRA Requirements for a Contingency Plan

All TSD facilities with EPA permits must meet RCRA requirements (40 CFR 264 or 265) that deal with contingency plans. What follows is a summary of these requirements.

Preparedness and Prevention

Facilities must be maintained and operated to minimize the possibility of a fire, explosion, or any unplanned release of hazardous waste to air, soil, or surface water which could threaten human health or the environment. All facilities must be equipped with the following:

- An internal communications or alarm system capable of providing immediate emergency instruction (voice or signal) to facility personnel.
- A system of visual signals which must be practiced and known to all employees.
- A device, such as a telephone (immediately available at the scene of operations) or a hand-held, two-way radio, to communicate with outside personnel to get emergency assistance from local police departments, fire departments, or state or local emergency response teams.
- Fire-control equipment (including portable fire extinguishers; special extinguishing equipment, such as that using foam, gas, or dry chemicals); spill control equipment; and decontamination equipment.
- Stationary fire control methods, which must include water at adequate volume and pressure to supply water hose streams, or foam-producing equipment, or automatic sprinklers or waterspray systems.

Testing and Maintenance

As part of general preparedness and prevention, there must be routine testing and maintenance of equipment. All facility communications or alarm systems, fire-protection equipment, spill control equipment, and decontamination equipment must be tested and maintained to assure proper operation. Written procedures should exist for these activities and be conducted at specified times during the year. RCRA regulations also require regular inspections of the facility.

Access to Communications and Alarm Systems

Whenever hazardous waste is being handled (poured, mixed, spread), all personnel involved in the operation must have immediate access to an internal alarm or emergency communication device, either directly or through visual or voice contact with another employee.

Required Aisle Space

The owner or operator must ensure that aisle space is great enough to allow the unobstructed movement of personnel, fire-protection equipment, spill-control equipment, and decontamination equipment to any area of facility operation in an emergency.

Contingency Plan Development and Implementation

Each owner or operator must have a plan for the facility. The contingency plan describes actions to minimize hazards to human health or the environment from fires, explosions, or any release of hazardous waste. To comply with RCRA regulations for the contingency plan, the following must be done:

- The provisions of the plan must be put into effect immediately.
- The plan must describe in plain language the actions to be taken in response to fires, explosions, or any unplanned release of hazardous waste.
- The plan must describe arrangements with local police departments, fire departments, hospitals, contractors, and state and local emergency response teams to coordinate emergency services.
- The plan must list names, addresses, and phone numbers (office and home) of all persons qualified to act as the emergency coordinator. This list must be current.
- The plan must include a list of all emergency equipment at the facility (such as fire-extinguishing systems, spill-control equipment, communications and alarm systems, and decontamination equipment), its location, a description of each item, and a brief outline of its capabilities. This list must be current.
- If site specific evacuations might be necessary, plans must be included. This plan must describe signal(s) to be used to begin evacuation, evacuation routes, and alternate evacuation routes (in cases where the primary routes could be blocked by release of hazardous wastes or fires).
- Copies of the plan must be available at the facility to workers.
- At all times, there must be at least one employee either on the facility premises or on call with the responsibility for coordinating all emergency response measures. This emergency coordinator must be thoroughly familiar with all aspects of the facility's emergency plan, all operations and
- activities at the facility, the location and characteristics of waste handled, the location of all records within the facility, and the facility layout. In addition, this person must have the authority to carry out the plan.
- You or your supervisor must know who this person is at the beginning of each shift.

OSHA Requirements for an Emergency Response Plan

Employers who meet all the following conditions are not required by OSHA to have an ERP:

- They evacuate their employees from the workplace when an emergency occurs.
- They do not permit any of their employees to assist in handling the emergency.
- They have already in existence an emergency action plan in accordance with OSHA.

Standard 1910.38 (Employee Emergency Plans and Fire Prevention Plans).

OSHA's General Industry Standard 1910.38, which applies to those employers who plan to evacuate their work site in the event of an emergency, at a minimum requires:

- Emergency escape procedures and escape route assignments.
- Procedures for those employees who remain to perform critical operations, such as machine shut-downs.
- Methods to account for all employees after evacuation has occurred.
- Rescue and medical duty assignment for employees.
- Procedures for reporting fires and emergencies to other responders.

Employers who plan to have some of their employees assist in emergency response, either as first responders or HAZMAT teams, **must provide additional training beyond what is received in this course.**

Additionally, those employers who plan to have employees assist in emergency response must also develop an Emergency Response Plan as required by OSHA.

An Emergency Response Plan (ERP) is required at all plants where a hazardous materials emergency response may occur. The ERP must be in writing. It must be developed and practiced before work begins with materials which may be hazardous. The specific topics that must be covered in the ERP are:

- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, training, 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 procedures
- Emergency alerting and response procedures. This includes compliance with 29 CFR 1910.165, the alarm system(s) for employee notifications.
- Critique of response and follow-up
- Personal protective and emergency response equipment

Site topography, layout, and prevailing weather conditions must also be included.

The ERP must be available for inspection and copying by OSHA personnel and by employees or their representatives. OSHA personnel do not require that new written programs be developed for the ERP if existing programs can be incorporated or referenced. For example, the respirator SOP could be included in the section on personal protective equipment. Duplication of information in compliance documents for regulatory agencies may lead to confusion in an emergency because of slight, or

major, discrepancies in SOPs. A comprehensive site ERP which consolidates requirements and includes appendices for specific requirements is encouraged.

Who Will Carry out the ERP?

Only people who are trained in Industrial Emergency Response will perform the activities called for in an Emergency Response Plan.

What Is an Emergency?

A hazardous materials emergency is a spill or release that cannot be controlled without outside help. OSHA defines “outside help” to mean anyone other than employees working in the immediate area of maintenance personnel. The most common type of emergency is either a spill or a release. There may not be a simple way to make a distinction between when you should and when you should not try to clean up or try to stop the spill or release. The following are some questions that should be considered:

- Do you know the extent of the spill or release?
- Do you know the nature and type of release as well as the material involved?
- Have you been given explicit instruction by a qualified person on how to stop or clean up the spill or release?
- Are you absolutely positive that you should try to clean up or stop the spill or release?
- Do you know your PPE is appropriate?

If you answered no to any of these questions, get your supervisor, if available, and sound the emergency alarm.

If you answered yes to ALL of these questions, then the following procedures might be appropriate, if provided for in your safety and health plan.

Non-Emergency Spill Control

This section outlines basic methods of control, containment, and confinement that may be used to deal with spills. If an emergency situation exists, those who are trained to do emergency response must be alerted. This course does not provide adequate training to do emergency response.

Before undertaking any activities, the personnel involved must be warned of the potential hazards of the contents. U.S. DOT-specified salvage drums or containers and suitable quantities of the proper (compatible) absorbent must be kept in the area where spills, leaks, or ruptures may occur. Employees must use the spill control supplies whenever the need arises. A Spill Containment Program must be developed and implemented where spills could occur.

This written program is part of the safety and health plan. Containment and remediation of minor spills or leaks may be accounted for in your safety and health plan. Methods may include:

- Moving the container so that the leaking area is at the top
- Overpacking the container in a larger container
- Collecting material in a container or diked area
- Using absorbent material

Consult your company's health and safety plan for details on approved methods for containment and remediation of small leaks.

Control, Containment, and Confinement

Basic control to prevent further release is the first step. This may include shutting off a valve. Containment includes those procedures undertaken to keep a material in its container. Containment activities include plugging and patching leaks and overpacking.

- **Plugging**: A plug is placed in the leaking drum to prevent or limit further release. Common plugging materials include wood, epoxy putty, clay putty, and screw with a washer and gasket. All plug materials must be compatible with the chemical which is leaking.
- **Patching**: A patch is applied over the leaking area. Patching materials include rubber, patching mud, and tape. Patching materials must be compatible with the chemical which is leaking.
- **Overpacking**: Placing a leaking drum into a larger drum will contain the spread of the contents.

Confinement includes procedures to keep a material in a defined area. These activities include confining a spill or release by diking, blocking, absorption, and/or collection.

- **Diking**: Dikes may be built around the perimeter of the leak with sand, earth, straw, sorbent, or similar materials. The type of diking material must be compatible with the spill material. Plastic sheeting can be used as an additional barrier to slow leakage, if appropriate.
- **Blocking**: Drains, ditches, or storm sewers should be covered and blocked to prevent run-off of spill materials. This blocking can be done with a sorbent pad, a piece of plastic, or a rubber pad. If flammable or toxic materials enter these systems, the potential for damage to property or people is increased.
- **Absorption**: Run-off can sometimes be absorbed with dirt, sand, saw dust, wood chips, peat moss, vermiculite, or other material. The sorbent material should be positioned so that spill material runs into it. Care must be taken to be certain that the sorbent is compatible with the spill.

Specific methods for routine control, containment, and confinement at your facility should be outlined in an SOP.

Your Responsibility in an Emergency

- If you observe a potentially life-threatening event, activate the alarm system
- Notify the emergency coordinator
- Carry out designated activities for which you have been trained

Make sure you know where to go and what to do before an emergency occurs.

When it happens, it's too late to read the plan.

It is not the intent of this manual to address specific SOPs for emergency response, as they can vary significantly from facility to facility and with the types of waste handled/processed. Within the confines of the TSDF, or TSD designated area of a facility, there are no specific training levels for hazardous materials emergency response.

Individuals/teams that respond to chemical emergencies outside of the TSDF or areas of a facility not designated as TSD are required to comply with paragraph (q) of the HAZWOPER standard. There may be confusion in these situations as to whose regulation is in effect – DOT, EPA, OSHA, or state/local. Typically, a HAZMAT team trained per (q) may respond to almost any chemical emergency within their level of training, assuming they have the skills and equipment/resources to do it safely and be in compliance legally. Customized emergency response training may be incorporated into this program at the request of the TSDF or delivered to you at a later date.

Exercise: Using an Emergency Response Plan

Use your plant's ERP or the example ERP provided later in this guide. In small groups, answer all of the following questions that are assigned to your group. Your instructor will lead a discussion of each group's answers when you have finished.

Pre-emergency Planning

What is the importance of pre-emergency planning?

What pre-emergency planning is included in the plan?

What other pre-planning items might be included to improve the plan?

Communication

What are the purposes of communication during an emergency?

What can happen to interfere with communications?

Training

What training is required for personnel?

Are the training requirements consistent with the Final Rule?

Why is training important?

Emergency Recognition and Prevention

What are the procedures for fire alarms?

What is required for fire prevention?

What types of chemical accidents are possible? What are the procedures for notifying personnel?

What are the evacuation procedures? Who can authorize an evacuation?

Decontamination

What are the decon procedures?

Are the decontamination procedures adequate? If not, what additional information is needed?

Emergency Medical Treatment

Who will provide First Aid?

Example of an Emergency Response Plan - for Training Only

1.0 Description of the Facility

The ABC Company manufactures small electronic components from aluminum metal plates delivered to the facility by tractor-trailer. The parts are formed by a punch press, loaded into baskets and degreased in a vapor-phase unit containing trichloroethylene (TCE). The de-greaser unit is 6' x 3' x 5'.

The 700 employees are organized by department depending on the component produced. Each of the 20 departments has a degreaser. TCE is delivered by railcar and transferred to outside storage tanks.

Identified emergency situations at the facility include:

- TCE Spill
- Fire
- Confined Space Entry

2.0 Purpose

In accordance with 29 CFR 1910.120 (p) (8), the following plan is designed to minimize or prevent damage to human health and the environment in the event of an unplanned sudden or non-sudden release of hazardous material within the plant perimeter. It is understood that provisions of this plan must be carried out immediately when such an event occasion would necessitate an immediate response.

3.0 Pre-Emergency Planning and Coordination

The following procedures describe the actions facility personnel must take in order to ensure compliance with 29 CFR 1910.120(p) in response to an emergency. Arrangements have been made to coordinate the emergency plan and emergency services with the local police department, fire department, hospitals, and Local Emergency Preparedness Committee (LEPC), which developed the Local Emergency Response Plan (LERP).

Community telephone contacts include:

Police …….. 911

Fire Department ……663-9101

Hospital .....…….663-5107

LEPC Coordinator…….....550-3156

A meeting was held with the following representatives of these organizations on January 3, 2022:

- Police: Officer Sam Sonite
- Fire: Chief Red Trucker
- Hospital: Ms. Ann Other
- LEPC: Coordinator Lou Planner

Meetings will be held annually with personnel from these groups. Minutes will be kept by the Plant Supervisor, whose responsibility it is to call the meeting.

A copy of the emergency plan and all revisions will be maintained at the Facility in the main office area and will be submitted to the local district police department, fire department, and hospital.

The emergency plan will be reviewed and immediately amended whenever:

- Applicable regulations are revised
- The plan fails in the event of an emergency
- The Facility changes in design, construction, operation, maintenance, or other circumstances that may increase the potential for fires, explosions, or releases of hazardous materials, or changes in the response necessary in an emergency
- The list of emergency coordinators changes
- The list of emergency equipment changes

4.0 Personnel Roles, Lines of Authority, Training, and Communication

4.1 Personnel

The facility has personnel on-site 24 hours/day, 7 days/week the entire year. The head person in the guard shack will be aware of the primary and alternate emergency coordinators in the emergency plan, as well as all emergency procedures. The primary and alternate emergency coordinators are thoroughly familiar with all aspects of the Facility emergency plan, all operations and activities at the Facility, the location and characteristics of hazardous material, the location of all records with the facility, and the Facility layout. The Emergency Response Team for the Facility consists of:

- ER Coordinator (1), Alternates (2)
- ER Technician level (12)
- ER Operations level (24)

The Emergency Coordinator and Alternates shall have been trained at the On-Scene Incident Commander level. Responsibilities of the Emergency Coordinator include:

- Identifying the material involved in the emergency
- Activating the internal facility alarms or communication systems to notify all personnel
- Notifying, if needed, police/fire departments, and state and national organizations
- Assuming overall authority for managing the Emergency (unless higher command arrives), performing termination procedures, and conducting critique and follow-up

The ER Technician level personnel shall perform all duties assigned by the Coordinator, consistent with his or her training at the Technician level. These may include:

- Implement the ER plan
- Use monitoring equipment
- Function within the Incident Command System
- Select and use specialized PPE
- Perform advanced control, containment, and/or confinement operations
- Implement the decon procedures
- Participate in hazard and risk assessment and termination procedures

The ER Operations level personnel (Operations-Level First Responder) shall perform all duties assigned by the Coordinator consistent with training at the Operations level. These may include:

- Use provided PPE
- Basic control, containment, and/or confinement measures
- Implement basic decon procedures
- Participate in the ER procedures, termination process, and basic hazard and risk assessment techniques

The owner or operator must note in the operating record the time, date, and details of any incident that require implementing the emergency plan. The report must include:

- Name, address, and telephone number of the owner or operator
- Name, address, and telephone number of the facility
- Date, time, and type of incident

- Name and quantity of material(s) involved
- Extent of injuries
- Assessment of actual or potential hazards to human health or the environment
- Estimated quantity and disposition of recovered material(s)

4.2 Lines of Authority

If the incident response is limited to plant personnel, the Emergency Coordinator has overall responsibility for all actions. Personnel should check with the Emergency Coordinator before undertaking any actions not directly ordered by him or her.

If additional personnel are involved, the Emergency Coordinator will defer to the Incident Commander, who gives all instructions.

4.3 Training

Individual members of the ER team will receive training as specified in 1920.120 (q). In addition, all plant employees will receive four hours of training annually to update Hazard Communication Training (1910.1200).

Personnel who may be expected to wear SCBAs receive monthly training drills in donning, doffing, and maneuverability as described in the written respirator program required under 1910.134

4.4 Communication

The Emergency Coordinator is in charge of all communication while the incident is under the sole control of plant personnel. When outside help is sought the Emergency Coordinator assumes a role of direct responsibili8ty to the Incident Commander of the outside group.

Internal Communication

The specifics of the internal communication systems (radios, who has them, frequency band, consequences of jamming the system) are included in the appended SOP.

Following are the primary and alternate emergency coordinators for this Facility, their names, title, business phone numbers, and home phone numbers:

- Fred Friendly X-313, Supervisor of Emergency Response (555) 777-3333
- Susan Smith x556, Laboratory Director (662) 551-3177
- Johnny Spot x753, Quality Control Supervisor, (555) 832-1176

External Communication

The Emergency Coordinator is in charge of all communication until additional personnel are called. Communication with outside personnel is the sole responsibility of the Coordinator (or his or her designee). The following may be called:

- Police……911
- Fire Department…… . 663-9101
- Hospital……663-5107

When making a call, include the following information:

- Identify yourself
- State the exact location
- Describe the emergency
- Give the names of persons involved
- Identify the areas potentially affected

5.0 Emergency Recognition and Prevention

5.1 Fire

Whenever the fire alarm sounds (continuous ringing), all no supervisory personnel must evacuate the facility immediately. After exiting the building, proceed quickly to the consolidation are (flagpole). Do not re-enter the building until the “all clear” condition has been established and the Emergency Coordinator has verified conditions are suitable for re-entry. Supervisory personnel will shut down the line and immediately evacuate.

In the event that alarms sound on the weekends, at nights, or on holidays, it is important that the gate operator be notified, so that the front gate is open when the fire equipment arrives. The phone number for contacting the gate operator is x111.

False Alarms

False alarms do occur, fortunately far more frequently than legitimate occurrences. Very often, they are the result of power failures. However, should the alarm be triggered accidentally, the person responsible should present himself/herself to the Fire Department upon their arrival and explain. No charges will be filed unless the act was malicious or intentional. In fact, the Fire Department will be relieved to learn that no emergency exists.

Fire Prevention

In order to minimize the potential for fire, the following SOPs have been developed:

- Maintenance degreasers
- Fire-suppression system maintenance and testing

These SOPs are appended. In addition, a no-smoking policy has been adopted in the manufacturing areas. All employees are trained at employment and yearly in the no-smoking policy and the fire alarm system. Degreaser maintenance and testing are required monthly and the results reported to the Plant Safety Officer.

5.2 Chemical Accidents

Chemical accidents at this plant may result from a release of TCE or due to entry into the degreaser.

Recognition of a release of TCE will generally be the result of a visual observation of a leak or unusual behavior of a pressure gauge. All degreaser employees have been told to report any suspected leak to the supervisor immediately. Reminders of this policy are posted at each degreaser.

Degreaser maintenance is conducted only after the heating element has been disengaged and lock-out assured by the foreperson. All maintenance activities are conducted according to the SOP, which includes sections on the buddy system and confined space entry procedures. (SEE SOP, appended).

All maintenance personnel receive annual training in the safety practices pertinent to the degreasers.

6.0 Safe Distances & Places of Refuge

6.1 Evacuation

If the evacuation horn is sounded, all non-supervisory personnel must report immediately to the flagpole area. Supervisors should secure their area per previous training and then report to the flagpole.

6.2 Non-Evacuation

All personnel will follow the direction of the Emergency Coordinator. Unless you have a direct role or are requested to assist, leave the area.

7.0 Site Security & Control

The Emergency Coordinator manages site security and control. The SOP will be followed (appended).

8.0 Evacuation Routes & Procedures

Whenever a need arises to evacuate any area of the Facility, all employees in that area shall proceed to the nearest exit after hearing the fire alarm. It shall be each employee's responsibility to be completely aware of the exit plan for those areas in the Facility in which they work. The Emergency Coordinator or a designee shall then count all employees present once they are assembled at the flagpole. Only when the "all-clear" signal is given and verified by the Emergency Coordinator will employees be allowed to re-enter the Facility.

The following alarms are used:

- Fire notice - continuous blast
- "All clear" - short 1-second blasts

An exit plan is posted at each supervisor's station, at each stairwell, and near each time clock. In case of fire do not use the freight elevators; use only stairwells or emergency escape ladders located at each window above the second floor.

The consolidation area is the flagpole in front of the Administration Building, southwest of the facility. Upon regrouping, check to see that everyone known to have been in the facility is outside. This "head count" will be reported to the fire department, so it is imperative that all personnel go directly to the consolidation area. Stay in the consolidation area until instructed otherwise. Be prepared to move cars if necessary. Also, attempt to determine the reason for the alarm, nature of the fire, and identities of missing persons so that this information can be provided to the fire department upon its arrival.

9.0 Decontamination

All emergency apparatus (brooms, shovels, temporary dikes, etc.) will be rinsed on-site and washed in a tub (20- to 30-gallon) several times with detergent water and/or any of several varieties of commercial decon solutions with brushes and sponges, then placed on a bench or rack for drying. Fire extinguishers will be sent off-site for refilling, and SCBA/air purifying respirators will be cleaned in accordance to manufacturer's specifications. All personnel gloves (inner and outer), hats, boots, coveralls, and coats will be placed in sealed plastic bags to be sent out for proper disposal.

10.0 Emergency Medical Treatment & First Aid

10.1 First Aid

One person on each shift is trained in First Aid. A nurse is on duty during the first shift. The nurse and/or supervisor are authorized to decide whether First Aid is insufficient.

10.2 Medical Care

The Facility is located 0.25 miles from Friend-of-the-Plant Hospital. Hospital/ER personnel can respond within three minutes. Annual meetings to review hazards at the plant include hospital representatives.11.0 Emergency Alerting and Response

11.0 Emergency alerting and response procedures

Emergency situations may arise at any time and in any location within the Facility. In an emergency or disaster, all employees present must handle the situation as calmly and promptly as possible. Emergencies will generally be in the nature of spills, files, or explosions, which could result in the spread of hazardous material. Since it is not possible to devise a set of rules or procedures to govern all possible emergencies, the following considerations are presented only as a guide to aid the user in establishing more specific emergency procedures applicable to his or her working conditions.

The Supervisor and the Emergency Coordinators should be notified immediately. If neither can be reached of the emergency is of such a nature to require outside help immediately call one of the following numbers.

11.1 Emergency Alerting

Emergency Contact for Telephone

Injury or severe, sudden illness	Life Squad/Hospital	911
Fire or explosion	Fire Department	911
Accidental release of hazardous waste	Main Office/Guard	x-222
Loss of essential building services or utilities	Police 555-2222	

Then:

- **Identify yourself** to the person who answers
- **State the exact location** of the emergency, either in the Facility itself or on the grounds
- **Describe** the nature of the emergency briefly and calmly
- **Give the name(s)** of the person(s) involved

During an emergency, alertness and prompt action by the employees present at the facility will help prevent further injury or property damage.

11.1.1 Fire Emergency

The fire alarm system is an automatic/manual network consisting of automatic sprinkler/hose flow sensors, manual pull boxes, alarm bells, a notifier connected to the Fire Department, and a system control box.

Activation

The alarm system may be triggered in any of the following ways:

- Any flow in the sprinkler/hose system automatically trips the alarm. Hence, fire hoses should not be used for anything other than firefighting.
- The alarm may be activated manually by use of any pull box.
- Through the notifier box, located on the loading dock, the Fire Department is alerted any time the alarm system is activated. They are required to respond and will do so shortly after the alarm sounds.

Deactivation

The alarm may be silenced after the arrival of the Fire Department by use of the “SILENCE” button on the alarm control panel located on the right hand wall just inside the door of the fire pump room. Do not silence the alarm prematurely. The notifer box must be manually reset by the Fire Department before the alarm system can be used again.

Action

Any time the alarm sounds, all personnel are required to evacuate the facility.

11.2 Response Procedures

11.2.1 Small Spills

For small spills, a mobile spill cart has been assembled which will contain two 55-gallon drums with accompanying shovel, tools, and adsorbents. Persons using the spill cart will be properly attired with neoprene boots, chemical-resistant pants, jacket, goggles, and air-purifying respirators. Four SCBAs are conveniently located on each floor for use by persons performing plugging, patching, or other aggressive control actions.

Personnel using this equipment will have been trained in the Safety Equipment SOP (appended).

After proper protective attire has been donned, adsorbent will be placed on the spill. The contaminated adsorbent will then be shoveled into a receiving drum. The drum, containing the absorbed substance, will be secured into the drum storage area. The

drum storage area, which is diked, can contain the rupture of the largest container (55-gallon drum) plus 20% of the total capacity.

Following the absorbing procedure, the area where the spill has occurred will be washed with detergent and rinsed three times with potable water. The run-off will be collected, analyzed and, if nonhazardous, discharged into the floor drains in the facility.

In the event that toxic vapors, mists, or fumes are released into the air as a secondary hazard, the vapors will be settled by spraying a fine water mist into the air with a hose. The collected fluid will be analyzed and, if nonhazardous, discharged through the floor drains.

All equipment used to clean up a spill will be washed thoroughly with water. The water from this rinsing will also be collected and analyzed. If it is nonhazardous, it can be discharged into the sewer or shipped to an appropriate disposal facility. Clothing will be bagged and considered hazardous waste.

11.2.2 Large Spills

For large spills such as the rupturing of one of the holding tanks, an outside emergency response team will be contacted. Both the emergency response team from the Fire Department and the National Response Center may be called. This immediate notice must be given by phone to the National Response Center (NRC) (toll free: 800-424-8802 or toll call: 202-426-2675). This notice must include:

- Name and phone number of reporter
- Name and address of carrier
- Date, time, and location of incident
- Extent of injuries
- Hazard class, name, and quantity of hazardous material involved
- Type of incident and nature of materials involved

Two companies with the capabilities of initiating remedial action within 15 hours are:

- In-A-Flash 1-800-555-5656
- R. Mead Action 1-800-555-8899

The above company telephones are operated 24 hours a day. The Emergency Coordinator will call the company and describe the incident. The company will immediately send an advance team to assess the problem and decide what equipment is needed.

The following persons have the authority to commit funds to initiate remedial action:

- Susan B. Incident (Primary)
- Johnny 0. Spot (Alternate)
- Karl Fast (Alternate)
- Sam King (Alternate)

Also, the Chemical Manufacturer's Association (CMA) maintains a public service center in Washington, D.C. under the title of the Chemical Transportation Emergency Center (Chemtrec). The toll-free number is 800-424-9300, and it is available on a 24-hour-per-day basis.

Should a major spill or tank rupture occur, the containment of the drainage is of primary concern. Mechanical plugs are available for the drain system that is near the tankage. In the event that a spill becomes a major catastrophe with ensuing fire/explosion and release of toxic fumes and vapor, it may become necessary for the Emergency Coordinator to have the building evacuated (in accordance with standard evacuation procedures) and the facility shut down. The main power supply will be turned off at the direction of the Emergency Coordinator.

11.2.3 Fire

See Section 5.1. It has been determined to rely on the Fire Department for response.

11.2.4 Confined Space Entry

The Plant Manager is responsible for compliance with the Confined Space Entry SOP (appended). Should injury occur in the course of an entry, emergency provisions of the SOP will be immediately implemented.

12.0 Critique of Response and Follow-Up

A thorough investigation is required to ensure the adequacy of procedures and identify needed changes in the response plan. Immediately upon completion of the termination procedures, a debriefing will be conducted with all department personnel and any outside agencies. A meeting will be called by the Emergency Coordinator, who will make a full report to the plant manager. Sections of the report will include:

- Description of the emergency
- Diagram
- Personnel responding and roles
- Material released – Identity and quantity
- Environmental measurements
- Zones
- Site security operations

- Reported health effects
- Actions or events contributing to the emergency
- Needed follow-up action

13.0 Personal Protective Equipment and Emergency Equipment

13.1 Personal Protective Equipment

Personnel protective equipment is maintained by the staff of the Safety Director. A full inventory is available on the internal computer system. Response procedures have been established at the Facility for response to emergency situations.

13.2 Emergency Equipment

Both the fixed and portable safety apparatus to be used for most emergency conditions are found in the appendix. Descriptions and specifications are provided. A general listing of the emergency equipment available at the Facility includes:

- Safety showers
- Eye wash
- Self-contained breathing apparatus SCBA (4 per floor)
- Spill-control cart (Protective gear, adsorbents, etc.)
- Respirators
- Gloves
- Safety glasses
- First Aid supplies (kits and cabinet)
- Fire hoses
- Fire extinguisher

Summary - Emergency Response SOPs

Requirements of a Contingency Plan include:

- Describing the emergency actions to be taken.
- Describing how coordination of emergency services will occur.
- Listing persons qualified to act as the emergency coordinator.
- Including a list of all emergency equipment at the facility.
- Including plans if an evacuation might be necessary.
- Making copies of the plan available at the facility to workers. Requirements of an Emergency Response Plan include:
- Pre-emergency planning and coordination with outside parties.
- Personnel roles, lines of authority, training, 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 procedures.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- PPE and emergency response equipment.

Review Questions

1) What are some required parts of pre-planning and prevention as stated in the RCRA regulations?

2) What are some requirements of an ERP?

3) What is an emergency?

4) What is your role in your company's ERP?

CLOSING AND PROGRAM EVALUATION

Thank you for participating in this program.

This is an opportunity to ask any questions you may have, or to discuss how the knowledge and skills learned can be used at work. Were all of your initial questions answered?

Please take the next 10 minutes to complete the program evaluation forms. These are important for improving the program. The Midwest Consortium does take your comments seriously and has made changes in content and the skill exercises based on feedback. Your comments are anonymous.

We hope to see you at another Midwest Consortium program in the future