

# Teamsters Hazardous Waste Worker Training



## Initial Hazardous Waste Worker Course



Electronic Version is Section 508 Compliant

International Brotherhood of Teamsters — IBT Worker Training Program

**Teamsters Initial Hazardous Waste Worker Course**  
**Electronic version is 508 Compliant**  
**2014 Edition**

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International Brotherhood of Teamsters  
Safety & Health Department  
25 Louisiana Ave. N.W.  
Washington, D.C. 20001  
(202) 624-6963



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## Preface



## About the Teamsters

## Teamster Training

This manual covers the topics that OSHA requires for the initial training of workers involved in the clean up of uncontrolled hazardous waste sites.

[OSHA 29 CFR 1910.120(e)(3)(i) and 29 CFR 1926.65(e)(3)(i).

This manual is used in the:

- 40-Hour Initial Hazardous Waste Worker Course
- 24-Hour Initial Hazardous Waste Worker Course
- 24-Hour “Bridge” Course (for workers upgrading to 40 hours from a prior 24-hour initial course)

This manual was prepared by the Worker Training Program of the International Brotherhood of Teamsters - the Teamsters Union - with grant funds from the National Institute of Environmental Health Sciences.

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Workers founded the International Brotherhood of Teamsters (IBT) in 1903. Today the Teamsters are a diverse union representing 1.4 million workers in transportation, construction, warehousing, and in almost every other type of employment. The IBT Safety and Health Department includes professionals in safety, industrial hygiene and adult education.

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The Teamsters offer safety and health training throughout the United States for:

- Construction Workers
- Hazardous Waste Workers
- Industrial Workers
- Hazardous Materials Transportation Workers
- Emergency Responders
- Radiological Workers

Teamster instructors use effective and participatory adult education methods, real equipment, and realistic hands-on activities.

IBT instructors have experience doing the same types of jobs that trainees perform, including construction, remediation, warehousing and hazmat transportation. Instructors have completed the Department of Energy (DOE) Basic Instructor Training Program and the OSHA 500 Construction Trainer Course. The Teamsters certify each instructor after a period of supervised teaching and evaluation. To maintain certification, each instructor attends an annual Instructor Development Program that includes new regulations and work procedures, and practice teaching. Each Instructor is certified in first aid and CPR as well.

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Teamster Training Centers have classrooms and outdoor areas for realistic hands-on activities. The Training Centers also have mobile units that can transport instructors and equipment to hold courses at hazardous waste sites, remediation projects, construction sites, company locations and union halls ... anywhere.

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For more information, or to schedule a course, contact:

IBT Safety and Health Department  
25 Louisiana Avenue, N.W.  
Washington, DC 20001  
(202) 624-6963  
(202) 624-8125 (fax)  
[www.teamsterworkertrainingprogram.org](http://www.teamsterworkertrainingprogram.org)

**Teamster  
Instructors**

**Teamster  
Training  
Centers**

**For More  
Information**

## Chapter

# 1



# Rights, Responsibilities, and Lessons Learned

## Learning objectives

This chapter discusses the legal standards that apply to worker safety and health at hazardous waste sites, and the rights and responsibilities of workers and employers with regard to occupational safety and health.

After completing this chapter, you will be able to demonstrate your ability to:

1. DEFINE which federal government agency is responsible for regulating:
  - a. Safety and health in the workplace.
  - b. Transportation of hazardous materials.
  - c. Protection of the environment.
2. UNDERSTAND recent changes to pertinent regulations including EPA, OSHA, and DOE Standards.
3. IDENTIFY the training requirements for hazardous waste workers.
4. IDENTIFY the rights and responsibilities of workers and employers with regard to safe and healthy working conditions.
5. DEFINE:
  - a. HAZWOPER.
  - b. Uncontrolled site.
6. IDENTIFY lessons that can be learned from incidents which occurred on the job site over the past year to demonstrate the use of good work practices.

## **Safety and Health at Hazardous Waste Sites**

A Teamster driver pulled their end dump into a hazardous waste site to pick up a load of soil. This was their first trip to this type of project. It looked like a lot of other construction sites the driver had been to before. However, they noticed that other workers in the area where the soil was loaded were wearing respirators and plastic suits.

The driver wondered: Why are these other workers wearing respirators and suits? Is there something unusual about the dirt they're loading? Do I need a respirator and protective clothing too?

It happens that this was the site of a former chemical factory. The soil was heavily contaminated with solvents, some of which are extremely irritating; some of which are known to cause damage to the nervous system, liver and kidneys, and others which are known to cause cancer. It was because of this contamination that the soil was being removed.

This driver should have been trained before they ever entered the site. They should have been told what hazards were present, and what protective equipment to wear.

# Government Agencies You Should Know

**OSHA:** The Occupational Safety and Health Administration is the federal agency that enforces safety and health standards to protect workers on the job. In 26 states there are state safety and health agencies that do this job instead of federal OSHA.

**DOT:** The Department of Transportation is the federal agency that enforces regulations for safe transportation of hazardous materials. Most states have a state agency that also enforces transportation regulations.

**EPA:** The Environmental Protection Agency is the federal agency that enforces regulations to protect the environment. Most states have a state agency that also enforces environmental regulations.

**NIOSH:** The National Institute for Occupational Safety and Health is a federal agency that studies safety and health problems, recommends standards, and distributes information to workers and employers.

**DOE:** The Department of Energy is the federal agency that controls the facilities used to make nuclear weapons. Clean-up of hazardous and radioactive waste is a major project at these sites.

States that have their own Occupational Safety and Health Program		
Alaska	Michigan	South Carolina
Arizona	Minnesota	Tennessee
California	Nevada	Utah
Connecticut*	New Jersey*	Vermont
Hawaii	New Mexico	Virgin Islands*
Indiana	New York*	Virginia
Iowa	North Carolina	Washington
Kentucky	Oregon	Wyoming
Maryland	Puerto Rico	

\* The state programs in CT, NJ, NY, and the Virgin Islands only apply to public sector employees; in these states, private sector employees are covered by federal OSHA.



Congress passed the **Occupational Safety and Health Act** in 1970.

This law created **OSHA, the Occupational Safety and Health Administration**.

The OSHA law says that every employer is required to do two things:

1. Provide to each of its employees: “employment and a place of employment that are free from recognized hazards that are causing or are likely to cause death or serious physical harm.”
2. Comply with all OSHA standards.

The OSHA law tells OSHA to:

1. Write standards to protect workers.
2. Listen to workers’ complaints about unsafe or unhealthy conditions.
3. Conduct inspections and enforce OSHA standards.
4. Protect workers from retaliation if they report safety and health problems.

The safety and health rules that OSHA writes to protect workers are called **OSHA Standards**.

Each OSHA standard has a number, which is called its citation. The citation helps you find the standard in a law book, and it makes it easy to refer to a particular standard.

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For example, the OSHA standard to protect hazardous waste workers is 29 CFR 1910.120.

CFR means Code of Federal Regulations.

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# The OSHA HAZWOPER Standard

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This manual is for  
workers who work at  
uncontrolled sites.

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This is different from a  
treatment, storage and  
disposal site where  
hazardous waste is  
handled in a controlled  
manner.

---

There is an OSHA standard called **Hazardous Waste Operations and Emergency Response**. If you take the first letters of these words you can spell the name **HAZWOPER**, which is what everyone calls this standard.

**HAZWOPER** covers three categories of workers:

1. Workers at hazardous waste clean-up sites, which OSHA calls **uncontrolled sites**.
2. Workers at hazardous waste Treatment, Storage and Disposal (TSD) facilities.
3. Workers engaged in emergency response.

**An uncontrolled site** means that hazardous waste was put on the site without complying with current safety requirements. The hazardous waste creates a threat to the health and safety of people or the environment.

Some **examples of uncontrolled sites** include:

- A construction or demolition site where hazardous waste was left from previous activities.
- A landfill where chemicals were dumped without safeguards to prevent contaminating the water or the air. This may have been legal at the time, but does not comply with current requirements.
- A site where hazardous waste was illegally dumped without any regard for the environment.
- The scene of an emergency release of hazardous materials after the emergency has been resolved but where chemicals still remain to be cleaned up.

The HAZWOPER Standard has 17 sections (“a” through “q”).

## The OSHA HAZWOPER Standard

### The OSHA HAZWOPER Standard

- (a) Scope, application and definitions.
- (b) Safety and health program.
- (c) Site characterization and analysis.
- (d) Site control.
- (e) Training.
- (f) Medical surveillance.
- (g) Engineering controls, work practices, and personal protective equipment.
- (h) Monitoring.
- (i) Informational programs.
- (j) Handling drums and containers.
- (k) Decontamination.
- (l) Emergency response by employees at uncontrolled hazardous waste sites.
- (m) Illumination.
- (n) Sanitation and temporary work places.
- (o) New technology programs.
- (p) Operations conducted under the Resource Conservation and Recovery Act (RCRA).
- (q) Emergency response to hazardous substance releases.

---

**OSHA has a set of standards for the construction industry, and another set of standards for general industry.**

**The same HAZWOPER standard is in both, but it has two different numbers:**

**General Industry:  
29 CFR 1910.120**

**Construction:  
29 CFR 1926.65**

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# HAZWOPER Training Requirements

HAZWOPER has different training requirements for different kinds of workers at uncontrolled sites.

## Training Requirements for Workers at Uncontrolled Sites

General Site Workers	40 hours: Initial training
	24 hours: Supervised on-site experience
	8 hours: Annual refresher

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Occasional Site Workers and Workers with minimal exposure	24 hours: Initial training
	8 hours: Supervised on-site experience
	8 hours: Annual refresher

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## Training Requirements for Supervisors and Managers

Supervisors and managers must have the same training as the workers they supervise, plus eight hours of additional training in the management of hazardous waste sites.

This course provides the initial training for general site workers at uncontrolled sites.

In addition to this course, your employer must provide you with at least three days of supervised on-site experience to orient you to the particular work practices, hazards, and emergency procedures of the site.

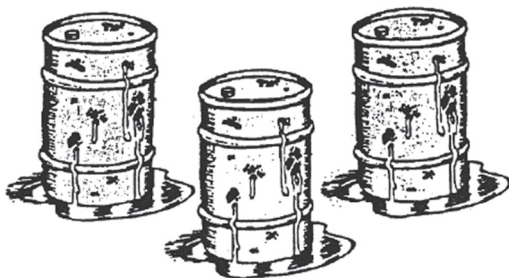
In order to continue doing hazardous waste work, **you must take an 8-hour Refresher Course every year.**

**RCRA** (“Rick Rah”) is the federal law regulating the proper handling of hazardous waste – in order to protect the environment and the community. RCRA requires:

- **Regulations:** The EPA makes regulations for those who generate, store, ship, recycle, treat or dispose of hazardous waste.
- **Cradle to Grave Tracking:** Keeping records of what happens to hazardous waste from when it is created to when it is properly disposed of.
- **Uniform Hazardous Waste Manifest:** A special shipping paper for transporting hazardous waste.
- **Registration** for generators, **licenses** for transporters and **permits** for recyclers and disposal facilities.
- Requirements for **Underground Storage Tanks**.

**Superfund** is a federal program that provides money to clean up the worst hazardous waste sites, called **Superfund Sites**. The Superfund law is called **CERCLA**.

There is another federal law called **SARA**. One part of SARA tells OSHA to write a standard to protect hazardous waste and emergency response workers. This is why OSHA made the HAZWOPER Standard.



## **RCRA, Superfund, and SARA**

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**RCRA: Resource Conservation and Recovery Act of 1976.**

**CERCLA: Comprehensive Environmental Response, Compensation and Liability Act of 1980.**

**SARA: Superfund Amendments and Reauthorization Act of 1986.**

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**Discuss recent changes to pertinent regulations.**

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# Your OSHA Rights

OSHA requires your employer to:

- **Provide a safe and healthy workplace.**
- **Comply with OSHA standards.**

As an employee you have legal rights, and you also have the responsibility to work in a safe manner that is in compliance with OSHA standards.

Your OSHA rights include:

1. **The right to a safe and healthy workplace.**
2. **The right to receive safety and health training.**
  - A. Hazard communication training.
  - B. HAZWOPER emergency response training.
  - C. Respirator training (if applicable).
  - D. Confined space training (if applicable).
3. **The right to information.**
  - A. Safety Data Sheets (SDSs).
  - B. Your employer's Log of Work-Related Injuries and Illnesses (the "OSHA 300 Log").
  - C. Results of workplace monitoring and surveys.
  - D. Your own medical records.
  - E. Your employer's written Site Safety and Health Plan.
  - F. Copies of any OSHA citations.
4. **The right to take part in safety and health activities.**
  - A. Point out hazards and suggest corrections.
  - B. Discuss safety and health concerns with your fellow workers and your union representative.

5. **The right to participate in OSHA inspections.**
  - A. You or your union representative participate in the opening and closing conferences.
  - B. You or your union representative accompany the OSHA inspector during the inspection.
  - C. Respond to questions from the OSHA inspector.
6. **The right to file an OSHA complaint if a hazard exists.**
  - A. Have your name kept confidential by OSHA.
  - B. Be told by OSHA of actions on your complaint.
  - C. Be notified if your employer contests a citation.
  - D. Object to an abatement period proposed by OSHA.
7. **The right to refuse to do work that would expose you to imminent danger of death or serious injury.**
8. **Protection from retaliation or discrimination because of your safety and health activities.**

File a discrimination complaint with OSHA if you have been discriminated against for discussing safety and health, pointing out hazards, filing an OSHA complaint, or refusing dangerous work.

9. **The right to necessary personal protective equipment paid for by your employer.**

If you file a complaint with OSHA, put it in writing, be specific, and cite the exact standard that's being violated. Keep a copy for your records. Be sure to also contact your union representative.

## **Your Responsibilities Under OSHA**

As an employee, you have the responsibility to comply with all OSHA standards which apply to your job.

However, OSHA cannot impose any legal sanctions – such as fines – on workers who violate OSHA standards. OSHA does not issue citations against workers. When Congress wrote the OSHA law, it gave employers the full legal responsibility for safety and health in the workplace.

As an employee, you are expected to comply with the instructions issued by your employer. These can include following safe work practices and wearing personal protective equipment such as a respirator. If you fail to follow your supervisor's instructions, you might be disciplined or terminated.

Later in this chapter, we will discuss the special situation in which a worker believes that it is unsafe to do an assigned task.



## The Right to Refuse Dangerous Work

As an employee, you are expected to do your job the way your supervisor tells you. However, sometimes a situation may arise where you believe it is unsafe to do a task- for example, if the truck that you are assigned has faulty brakes. Usually, you or your union steward will be able to resolve the problem by discussing it with the supervisor.

The union contract and the law give you certain rights if you are ever in the situation where you feel that you must refuse to do dangerous work. In order to preserve your rights make sure that you:

1. **Don't act alone.** Talk with your fellow workers. If you are a union member, contact your shop steward or union representative.
2. **Point out the danger** to the supervisor and to your fellow workers.
3. **Make it clear that you are not insubordinate.** Explain that you are willing to do the job if it can be done safely.
4. **Offer to do other work.**
5. **Don't walk off the job.** Don't leave the site unless ordered to do so by the supervisor.

If you are disciplined, your union representative can help you file a grievance. You should also consider filing a complaint with OSHA and with the National Labor Relations Board.

## The Right to Stop Work at DOE Sites

### For Drivers, Mechanics and Freight Handlers: Section 405

**DOE Order 440.1B** says that workers at DOE facilities can “decline to perform an assigned task because of a reasonable belief that, under the circumstances, the task poses an imminent risk of death or serious bodily harm to that individual, coupled with a reasonable belief that there is insufficient time to seek effective redress through the normal hazard reporting and abatement procedures.”

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**The employee protections, or whistle blower provisions, of the Surface Transportation Assistance Act (STAA), 49 U.S.C. § 31105 (previously referred to as “Section 405”)** protects drivers, mechanics, and freight handlers from discrimination or discharge for:

- Refusing to operate a vehicle if to do so would violate a safety regulation.
- Refusing to operate a vehicle if the employee has a reasonable apprehension of serious injury, or injury to the public, because of the unsafe condition of the equipment.
- Complaining or testifying about violations of vehicle safety requirements.

If you feel that you must refuse to operate the vehicle, make sure that you first ask your supervisor to correct the problem, or give you another, safe vehicle to use.

If you believe that you have been penalized for refusing to drive an unsafe vehicle, you can file a STAA complaint with a regional or local OSHA office. Any complaint must be filed within 180 days.

If you belong to a union, you should talk to your shop steward or union representative.

## **DOT Training Requirements for Transportation Workers**

The Department of Transportation (DOT) has training requirements for workers involved in the transportation of hazardous materials, including hazardous waste. The DOT training requirements apply to workers who:

- Load, unload or handle hazmat.
- Drive a vehicle used to transport hazmat.
- Prepare hazmat for transportation.
- Are responsible for hazmat transportation safety.
- Recondition or test hazmat packaging.

DOT requires five kinds of training for hazmat workers:

1. **General awareness training.**
2. **Function-specific training.** (Specific safe practices that apply to the hazmat activities of your job.)
3. **Safety training.**
4. **Security awareness training.**
5. **In-depth hazmat security training.**

In transportation-related job sites it is often confusing whether OSHA standards or DOT regulations apply. The Teamsters follow the rule of thumb that says most truck driving-related work is under DOT jurisdiction, while loading, unloading, and warehousing are covered by OSHA standards.

DOT will respond to safety complaints, but they may be slow to do so. You do not have the same rights to participate in DOT inspections as you do under OSHA. If you file a complaint with DOT, put it in writing, be specific, and cite the exact DOT regulation that's being violated. Keep a copy for your records. Be sure to also contact your union representative.

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**Workers will critique hazmat or hazwaste incidents that occurred over the last year.**

---

## **Review Questions for Chapter 1**

1. Write the federal government agency responsible for:

\_\_\_\_\_ Worker safety and health:

\_\_\_\_\_ Protecting the environment:

\_\_\_\_\_ Transportation safety:

\_\_\_\_\_ Studying safety and health problems and giving advice:

\_\_\_\_\_ Maintaining nuclear weapons facilities:

2. List the three types of training that you are required to receive as a general hazardous waste site worker.

3. List six types of safety and health information that you have a right to obtain.

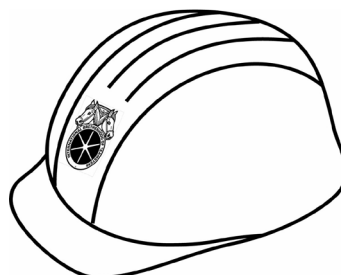
**Review  
Questions for  
Chapter 1**

4. List eight categories of safety and health rights.

5. What should you do if you believe that a task is so unsafe that you need to refuse to do it?

6. What is an uncontrolled site?

**Chapter**  
**2**



# Safety Hazards

## Learning objectives

This chapter discusses how to recognize and control safety hazards at work.

After completing this chapter, you will be able to demonstrate your ability to:

1. IDENTIFY the types of safety hazards found in hazardous waste work.
2. IDENTIFY two ways to prevent accidents.
3. IDENTIFY the four components of the fire pyramid.
4. SELECT the proper definition or example for:
  - a. Combustible.
  - b. Flammable.
  - c. Flash point.
  - d. LEL, UEL and Flammable Range.
5. IDENTIFY four incompatible chemical combinations.
6. EXPLAIN the purpose and procedure for bonding and grounding containers of flammable liquids.
7. EXPLAIN the purpose of grounded power circuits and Ground Fault Circuit Interrupters (GFCIs).

Safety means preventing injuries like cuts, burns, broken bones, or even death caused by sharp objects, fires, falls, collisions or other unwanted events.

Health means preventing diseases and illness such as nerve damage, cancer, respiratory illness, heat stress or hearing loss caused by exposure to things like toxic chemicals, radiation, noise or hot environments.

Many things are both a safety hazard and a health hazard. For example, a solvent like benzene is a fire hazard. Breathing benzene vapors can cause leukemia and blood diseases, so benzene is also a health hazard.

---

**Safety** is the condition of being secure from personal injury and property damage. Safety is when there are no accidents. "Safety is no accident."

Consider this example: You are loading a drum onto a flat-bed. There was no drum grapppler available, so you make a rope sling to lift the drum. The rope slips and the drum falls to the ground. Is this an accident? Yes.

What if no one was hurt? What if the drum isn't damaged? What if nothing leaks? It is still an incident. Someone could have been hurt. Something could have been damaged. They were just lucky. We don't want to depend on luck to avoid accidents.

A near-miss is still an accident and should be investigated.

## **Safety, Health, and Other Hazards on the Site**

29 CFR 1910.120(e)(2)(ii)

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### **"Safety" and "Accident" Defined**

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**INCIDENT-** An incident is an unplanned, undesired event that adversely affects completion of a task.

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**A near-miss is also an incident, even if it doesn't result in an actual injury- and should be investigated.**

---

## What Causes Accidents?

There are two theories about the causes of accidents:

- The theory of unsafe acts.
- The theory of unsafe conditions.

What do you think? Who, or what, is responsible for accidents? We'll look at both the theories.

---

## Unsafe Acts

The theory of unsafe acts says that some people are accident-prone, or simply careless. It blames these workers for most accidents.

We all know people who have made mistakes, or taken a shortcut, or used the wrong tool. When an accident happens, we say, "If only they'd been more careful." But do careless workers really cause most accidents?

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**The theory of unsafe acts blames accidents on careless workers.**

---

Employers developed the theory of unsafe acts one hundred years ago. People worked long hours in unsafe conditions. Many employers felt no responsibility to provide a safe work-place. However, injured workers sometimes sued their bosses – and won.

To avoid costly judgments, employers tried to show that the worker was at fault. This was the root of the theory of unsafe acts: blame the worker in order to avoid responsibility for maintaining a safe workplace.

Unfortunately, many employers, safety specialists, and even workers still have this negative view. Think of all the safety posters that show stupid cartoon figures who leave banana peels on the ground. Is this a fair picture of you and your fellow workers?



## Unsafe Conditions

Many studies have shown that we can't always blame an accident on carelessness or "driver error." If you look behind the events, you often find unsafe conditions that caused the worker to have the accident.

Think about an accident you or someone you know has had. What happened before the accident? Was the equipment properly maintained? Was there enough time to do the job safely? Did they have the right tools? Were they trained to recognize the hazards and avoid them? Were there enough workers to do the job safely?

The theory of unsafe conditions says that most accidents are the result of unsafe working conditions like faulty tools and equipment, poor supervision, inadequate training, or bad planning. As we discussed in Chapter 1, the employer is responsible for providing a workplace that is free of unsafe conditions.

Consider this example: A worker broke his wrist when he tripped on an extension cord strung across the walkway. Was this the result of his carelessness? Look behind the event and you find the real cause:

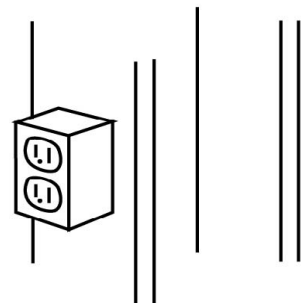
- The cord was across the walkway because it wasn't plugged into its usual outlet.
- It wasn't plugged into the usual outlet because that outlet was broken.
- The regular outlet had been broken when it was struck by a forklift truck.
- It was struck because it was installed on the face of an I-beam, instead of in a protected location.

The improper installation of an outlet created a situation which led to using the only other available outlet, which caused a tripping hazard.

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**The theory of unsafe conditions says most accidents result from unsafe conditions, and are not caused by workers being careless.**

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## Unsafe Conditions

Accidents are usually caused by the interaction of many factors. Some typical unsafe conditions that can lead to accidents include:

- Improper or defective tools.
- Inadequate worker safety training.
- Inadequate safety training for supervisors.
- Defective or improper protective equipment.
- Emphasis on production deadlines, not safety.
- Poor job planning.

## Accident Prevention

The way to prevent accidents is to eliminate the causes.

1. **Eliminate unsafe conditions.**
2. **Prevent unsafe acts.**

---

**Accident Prevention requires a Safety & Health Program that:**

1. **Eliminates unsafe conditions.**
  2. **Prevents unsafe acts by giving supervisors and workers the training, equipment and time they need to do the job safely.**
- 

The contractor is required to have a Safety and Health Program. The Safety and Health Program must include ongoing evaluation and control of hazards, proper equipment and tools, safety training for workers and supervisors, adequate planning and emergency preparedness. The purpose of the Safety and Health Program is to assure that there is a continual effort to find and control hazards so that safety isn't just left to chance. This is another meaning of the slogan, "Safety is no accident". It is useful only when done with the aim of discovering every contributing factor to the accident/incident to "foolproof" the condition and/or activity and prevent future occurrences. In other words, your objective is to identify root causes, not to primarily set blame.

A hazardous waste site is much like a construction site. The job is run by the same contractors who manage construction projects. There are many trades doing different types of work. The site and its hazards change from day to day. These are some of the common safety hazards that you might encounter:

- Unsafe working surfaces.
- Vehicles and heavy equipment.
- Excavation.
- Overhead and underground utilities.
- Electrical hazards from tools.

---

Workers walk, climb and work on many kinds of surfaces at hazardous waste sites, including ladders and scaffolds; gravel, sand and loose dirt; wet, slippery surfaces; areas cluttered with debris; and uneven, sloped or curved surfaces.

To prevent slips, trips and falls:

- Take time to prepare work areas.
- Don't climb on barrels or other unstable objects.
- Use fall protection when at heights.
- Use only ladders and scaffolds that meet OSHA requirements.
- Use only established marked walkways, vehicle routes and controlled work zones.

## **Common Safety Hazards**

## **Unsafe Working Surfaces**

## **Vehicles and Heavy Equipment**

Vehicles and heavy equipment create hazards for drivers and for workers on the ground. The Site Safety and Health Program should include safe driving practices, as well as maintenance and testing of all safety features. There should also be a traffic control plan with marked vehicle routes and controlled work zones.

Here are some basic safety requirements:

- Inspect all equipment before use.
- Follow inspection and maintenance schedules.
- Stay on equipment until it stops.
- Use roll-over protection (roll bars, etc.).
- Use cab shields or protective canopies on equipment loaded by crane, power shovel or loader.
- Use extreme caution on slopes or near excavations.
- Use a safety tire rack to work on tires with split or locking-ring rims.
- Block wheels and set brakes on parked vehicles.
- Beware of rotating equipment – watch for loose clothing.
- Listen for backup alarms.
- Be seen – wear a high-visibility vest.

# Excavation

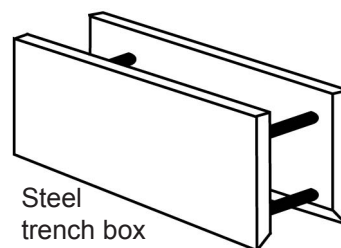
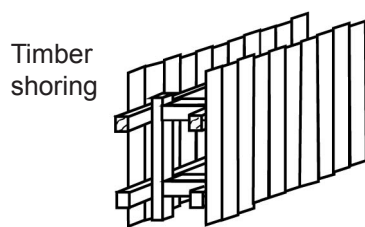
Each year more than 70 workers die in excavations at construction sites. Excavation also takes place at hazardous waste sites to get at buried drums, or to remove contaminated soil.

The most dangerous excavation is the trench. Workers in the trench, or those working near the opening, can be injured or killed if the trench collapses. The collapsing material knocks the person down, and then compresses their chest with enough weight to prevent breathing. Workers have died even in shallow trenches.

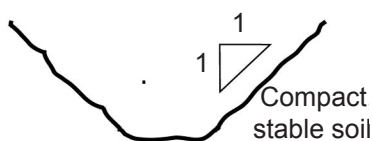
**All trench deaths are preventable.** It simply requires the time and materials to construct the trench properly so that it cannot collapse. Unfortunately, there is often a tendency to ignore the safety requirements.

OSHA requires shoring or sloping for trenches more than five feet deep. [29 CFR 1926.652(a)(1)]

There are many types of **shoring**.



If **sloping** is used, the angle of slope you need depends on how stable the soil is.



Conditions may change. Many things can make the soil less stable: rain, temperature changes, vibration from vehicles and equipment, and the weight of dirt piled near the trench.

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**The trench is the most dangerous excavation.**

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**All trench deaths are preventable if proper procedures are followed.**

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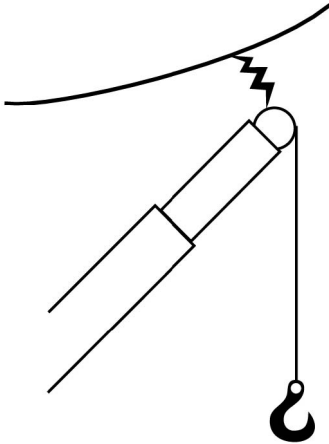
**OSHA requires shoring or sloping for trenches that are five or more feet deep.**

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**Some states have stricter rules and require protection at four feet.**

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## Overhead and Underground Utilities



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The minimum clearance is 10 feet.

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Cranes and other equipment must maintain a sufficient clearance from overhead power lines.

The minimum distance from any power line is 10 feet. A greater distance is required for lines carrying more than 50 kilovolts. [29 CFR 1926.1501(a)(15)(ii)]

A Teamster operating a boom truck is focused on picking and placing the load, and can lose track of how close the boom is getting to a power line. Use a spotter when working near power lines. The spotter can make the difference between a safe job and a potential fatality.

Always assume that any overhead line is energized, unless the owner or the utility has certified that it is not energized – and you can see that it's grounded.

Before any digging or excavation takes place, the contractor must locate all underground power lines, gas lines, communications cables, pipelines and sewers. Contact utility companies for information. All lines should be marked, and if possible, disconnected.

## Electrical Hazards

Most people do not realize how little current it takes to kill – if the current passes through the heart.

**50 milliamperes (1/20 of an amp) can be fatal.**

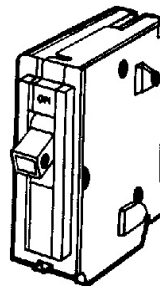
A typical circuit provides 20 amps. That's 400 times what it takes to kill. If only a small part of the available current reaches your heart, you might die.

The heart uses tiny electrical signals to regulate its beat. A small current can disrupt these signals causing rapid, useless beating. This condition is called **ventricular fibrillation**. The heart no longer pumps blood efficiently. Death follows in minutes unless the fibrillation is stopped. (This is why emergency medical personnel use a device called a defibrillator.)

The best way to prevent electrocution and death is to make sure that you never come in contact with wires or equipment that carry electricity.

There are several electrical devices that can help to protect you if you accidentally contact an electric current.

**Circuit breakers and fuses.** A wire can only handle a certain amount of electricity. If too many tools are connected (or too big a tool), then too much electricity will try to flow. The wire will overheat, possibly starting a fire. A circuit breaker (or fuse) disconnects the circuit if more than a specific current tries to pass. This protects equipment and property, but does not necessarily protect you from shock or electrocution.



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**As little as  
50 milliamperes  
(1/20 of an amp)  
can be fatal.**

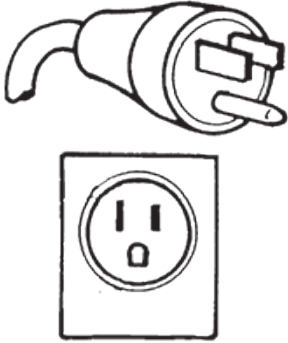
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**Breakers and fuses  
protect equipment and  
property, but do not  
necessarily protect  
you from shock or  
electrocution.**

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## Electrical Hazards



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Most of the current will take the path of least resistance, but a little bit might still pass through your body.

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**Grounded circuits (third wire).** If the wiring inside a tool becomes frayed, and touches the tool's metal case, then electricity can pass into the hand of the person holding the tool. If the person is also in contact with something that conducts electricity (like damp ground), then some electricity will pass through the person's body.

The green ground wire in a tool's cord is attached to the tool's metal case. This wire is supposed to be connected, via the third prong, to a wire that returns to the service box. The idea is for the ground wire to provide such a good path that the electricity will take this route, rather than through the body. This easy path should also allow so much current to flow that the circuit breaker or fuse trips. This only works if the ground wire is in good condition and properly connected all the way back to the service box.

You have heard that "electricity takes the path of least resistance." This isn't exactly correct. Faced with two possible paths, most, but not all, takes the easy path. Most current will return via the ground wire, but a little might still pass through the person's body. If the ground circuit is not in good condition, then even more electricity will pass through the person. It might be enough to kill!

**Double insulation.** Some hand tools don't have a third wire ground, but they do have a plastic case that doesn't conduct electricity. The plastic case is intended to prevent injury, as long as it's not broken.



## Electrical Hazards

**Ground Fault Circuit Interrupter (GFCI).** Electricity moves in a circle, down the black wire, through the tool, and back on the white wire. The tool does not use up the current. The same amount of current leaves the tool as enters it. Under normal conditions, the same current flows through each of the two wires. If there is damage, then some current might return via the green ground wire – or through your body.

A ground fault circuit interrupter senses flow in the black and white wires. If it's not the same, the GFCI shuts off the circuit. If some current is flowing through your body, the GFCI will sense less current in the white wire. The GFCI will trip before your heart does. A GFCI can sense a difference as small as 5 milliamperes, and can shut off in a fraction of a second, before there's enough current to cause ventricular fibrillation.

OSHA requires construction sites to have either an **assured grounding program** or use GFCIs. An "assured grounding program" means that the ground wires are checked at least daily. [29 CFR 1926.404(b)(1)(i)]

However, something could happen between checks. So, GFCIs provide better protection against electrocution.

**The best protection** is a combination of all three:

1. A circuit breaker (or fuse) to protect against fire caused by overheated circuits,
2. A grounded third-wire to provide additional fire protection and some protection against electrocution, and
3. A GFCI for the best protection against current that is enough to kill but too small to blow the breaker.



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We have described what happens if your body acts as a path for some of the current. However, if you contact both regular wires, you are part of the regular circuit. Equal current will still flow through both of the wires. The GFCI won't notice. No device can protect you in this case.

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**The best protection:**  
A combination of

- (1) a circuit breaker (or fuse),
- (2) a grounded third-wire, and
- (3) a GFCI.

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# Fire and Explosion



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Combustion: the chemical reaction between fuel and oxygen which gives off heat and light.

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An explosion of flammable vapor or gas is a super fast fire.

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To put out a fire, remove at least one component of the fire pyramid.

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Many materials are hazardous because they burn. **Combustion** is the technical name for burning and is the chemical reaction between fuel and oxygen which gives off heat and light. Fire is one form of combustion. Some fires produce flames. Others may just smolder.

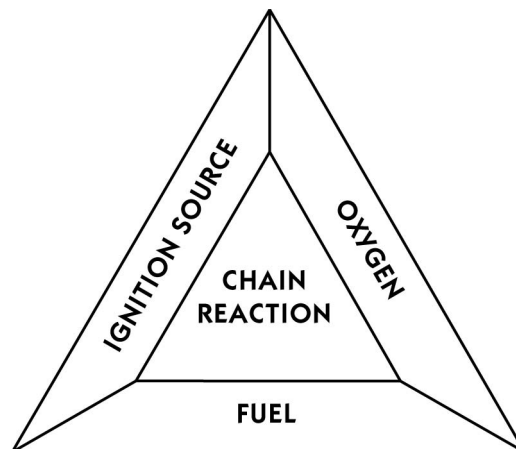
An **explosion** of combustible materials is a form of combustion that happens very quickly, releasing heat and pressure in a fraction of a second. This kind of explosion is a super fast fire.

A material that can act as a fuel (that can burn) is called a **combustible** or a **flammable** material. Later, we will explain the difference between these two terms. A material that doesn't burn is called non-combustible.

Four things are necessary for fire:

1. **Fuel.**
2. **Oxygen.**
3. **Ignition source** (heat) to start the process.
4. **Chain reaction** to keep the fire going.

We call this the **fire pyramid**. If any component is missing, the fire can't happen. If a fire starts, we have to remove at least one component in order to put it out.



# Fire and Explosion

An **ignition source** is anything hot enough to start the fuel burning. It might be a match, a spark of static electricity, an electric current, or a welding torch.

In order for the fire to continue, the heat created by the part of the fuel which starts burning first has to spread to more of the fuel, causing it to burn. This produces more heat, which starts more fuel burning, which creates more heat, and so on. This is the **chain reaction**.

Try to start a “2x4” on fire using a match. You have fuel, oxygen, and an ignition source. You won’t be able to keep a fire going because the heat from the initial reaction (where the match flame touches the wood) is absorbed by the wood and dissipated. There isn’t enough heat to keep a chain reaction going.

Suppose that gasoline has evaporated into a closed room from a leaking tank. The vapor consists of individual molecules of gasoline mixed with oxygen in the air. A tiny spark could start a few molecules burning. This creates a little more heat which burns the surrounding molecules, which makes more heat, which starts more molecules burning, and so on. This chain reaction happens so fast that it seems like all the vapor burned at once. This is an example of an explosion of a flammable substance in the air.

To have an explosion in the air, there has to be the right mixture of fuel and oxygen. Suppose just one teaspoon of gasoline evaporates in the room. The fuel molecules will spread out so far from each other that a chain reaction won’t happen. This mixture of fuel and air is too lean to burn.

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The chain reaction is what keeps the fire going. It’s also what makes an explosion happen.

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# Fire and Explosion

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The LEL is sometimes called the LFL or “lower flammable limit.”

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The UEL is sometimes called the UFL or “upper flammable limit.”

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The flammable range is sometimes called the “explosive range.”

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OSHA requires the concentration of a flammable gas, vapor, or mist to be less than 10% of the lower flammable limit

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It’s also possible to have so many fuel molecules that there isn’t enough oxygen to go around. In this case, the mixture is too rich to burn.

The **Lower Explosive Limit (LEL)** is the smallest concentration of fuel molecules in the air that will sustain a chain reaction and explode in the air. The LEL is different for different chemicals. For gasoline it’s 1.4%. At least 1.4% of the molecules in the air have to be gasoline in order to start a fire or explosion.

The **Upper Explosive Limit (UEL)** is the greatest concentration of fuel molecules that will explode. For gasoline the UEL is 7.6%. With more than this concentration, gasoline can’t burn or explode in the air.

The **Flammable (or Explosive) Range** is all the concentrations between the LEL and the UEL. In this range, any ignition source such as a spark could set off an explosion.

If there’s a release of flammable vapor into the air, we want to be certain that the concentration is far below the LEL. This is because conditions could change. More fuel could evaporate, or the concentration could be greater as we move deeper into a confined space or closer to the source of the fuel. Also, the instrument we use to measure the concentration might not be accurate.

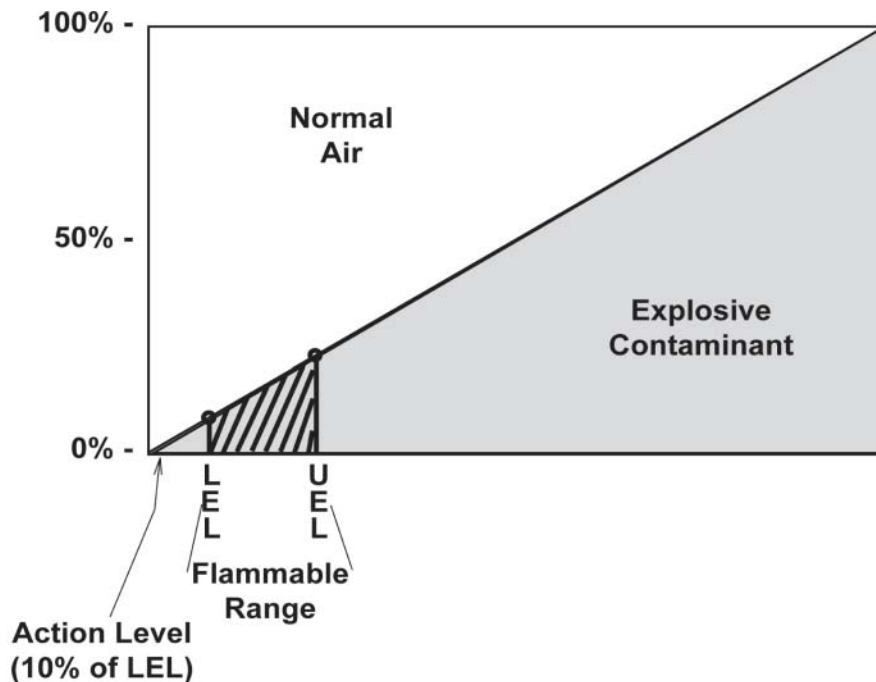
**OSHA requires the concentration of a flammable gas, vapor, or mist to be less than 10% of the LEL.**

[29 CFR 1910.146(b)]

A prudent Site Safety and Health Plan might establish an even lower action level (the point at which you leave). Ventilation is used to lower the concentration below the action level.

# Fire and Explosion

If the concentration is above the UEL, theoretically there can't be an explosion. However, ventilation or air mixing could lower the concentration into the flammable (or explosive) range. **The only safe condition is far below the LEL.**



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The only safe condition is to be far below the LEL.

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Liquids evaporate more easily as they get warmer, and they evaporate less if they are colder. The **flash point** is the lowest temperature of a liquid at which it evaporates enough molecules so that a spark will set off a fire or explosion. Another way of saying this is that the flash point is the lowest temperature of the liquid at which an LEL concentration is created above its surface.

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The FLASH POINT is the lowest temperature of a liquid at which it gives off enough vapor so that a spark will set off a fire or explosion.

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**A low flash point tells you a material is dangerous.** Consider gasoline. Its flash point is minus 45°F. Anytime gasoline is warmer than minus 45°, there will be enough vapor to have a fire or explosion. This means that in any situation (except maybe at the South Pole) liquid gasoline creates enough vapor to burn.

# Fire and Explosion

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**NFPA FLAMMABLE LIQUID** has a flash point under 100°.

**NFPA COMBUSTIBLE LIQUID** has a flash point of 100° to 200°.

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**A DOT FLAMMABLE LIQUID** has a flash point under 141°.

**A DOT COMBUSTIBLE LIQUID** has a flash point of 141° or more.

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**Low flash point means high hazard.**

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Consider diesel fuel. Its flash point is around 130°. Diesel fuel is not as easy to start burning as gasoline.

A **flammable liquid** is one that has a low flash point so that under normal conditions there's enough vapor that a spark will set off a fire or explosion.

A **combustible liquid** is one that has a flash point higher than the temperatures we consider normal. This means that under normal conditions there won't be enough vapor for a spark to set off a fire or explosion.

What's normal temperature? This is confusing because there are two systems in use. One is the NFPA (National Fire Protection Association) classification. According to the NFPA, if the flash point is below 100°F, the material is considered flammable. If the flash point is 100° or above, it's combustible. The idea is that most of the time the temperature doesn't get above 100°, so it isn't hot enough for the liquid to give off enough vapor to burn or explode.

The Department of Transportation (DOT) uses a different cutoff. DOT calls a liquid flammable if it has a flash point of 141° or less. [49 CFR 173.120(a)]

DOT calls a liquid combustible if it has a flash point above 141°. [49 CFR 173.120(b)]

DOT recognizes that it's normal for liquids to get hotter than 100°. This could happen in a tanker on a sunny day, in drums in a sealed trailer in the sun, or on a warm day in Tucson.

The idea behind both the NFPA and DOT systems is that we need to be more careful with flammable liquids because even a little spark could cause a fire.

We have been talking mostly about fires caused by flammable and combustible liquids. Many solids also burn, especially cellulose-based materials such as paper and wood. There are also certain metals which can react rapidly enough with oxygen that they produce a fire.

The first line of defense against fire is often the portable fire extinguisher. There are different types of extinguishers for different types of fires. Using the wrong type might be ineffective, or worse. For example, using water on an oil fire will spread the fire because the burning oil can float on top of the water. The heat could also cause the water to boil with explosive force, blowing burning oil in all directions.

If there is any possibility that you might be expected to use a fire extinguisher, then you should have special training which goes beyond the scope of this course.

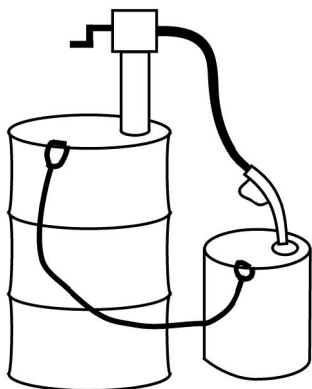
## Fire Extinguishers



### NFPA Classification of Fires and Fire Extinguishers

- |      |          |   |
|------|----------|---|
| Type | <b>A</b> | Fires of cellulose fuels (wood, paper, cotton, etc.). Water is an effective extinguisher; so are dry chemical agents.   |
| Type | <b>B</b> | Fires of flammable or combustible liquids. Water is not a safe extinguisher; it can spread the fire. Use dry chemical agents, carbon dioxide or halon.                                |
| Type | <b>C</b> | Fires in electrical systems. Water conducts electricity, making the situation worse, or creating a shock hazard. Use dry chemical agents, carbon dioxide or halon.                    |
| Type | <b>D</b> | Fires of combustible metals such as magnesium or sodium. Water and common extinguishing agents will make the fire worse. Use only a special fire extinguisher for combustible metals. |

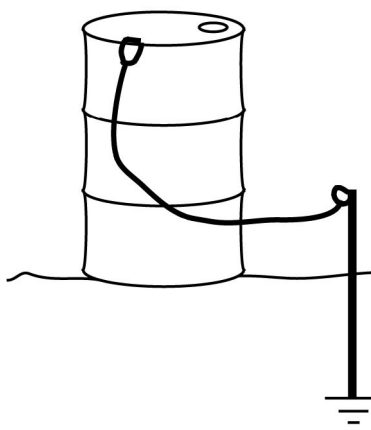
## Bonding and Grounding



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**BONDING:** connecting a good conductor between two containers to prevent a spark.

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**GROUNDING:** connecting a good conductor between a container and the earth to prevent a spark.

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Because a tiny spark can ignite the vapors, it is essential to **prevent all sparks when handling flammable liquids.**

**Static electricity** is produced when dissimilar materials rub together. Friction transfers electrons from one object to the other. If the extra electrons have no way to leave, they just sit there. That's what "static" means.

A **spark** occurs when the object with the extra electrons gets close to another object that can conduct electricity. The electrons jump through the air to the conductor. When you walk across a nylon carpet wearing rubber soles, electrons transfer from the carpet to your body. When you are about to touch a door knob, the electrons jump to the knob.

When liquid flows through a hose, or pours out of a container, friction causes electrons to transfer from the liquid to the container. When the spout touches another container, there could be a spark which ignites the vapors coming from the liquid.

**Bonding** is connecting a good conductor (such as a copper wire) between two containers so that any extra electrons on one container can flow easily to the other container without causing a spark.

**Grounding** is connecting a good conductor (such as a copper wire) between a container and the earth. This prevents a spark from jumping between the container and a metal object that is in contact with the earth.

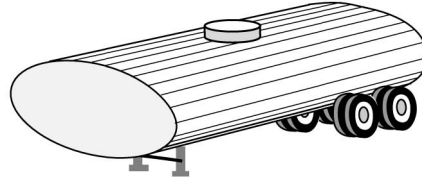
Not just any old wire will do. Use heavy-gauge copper wire with special connectors that are designed for this purpose. These connectors are either clamps with sharp pointed screws, or special heavy duty clips. The connector has to make a good contact with the container, piercing through the rust or paint.



Hazardous waste workers often have to enter and work in **confined spaces**. Some examples are storage tanks, sump pits, manholes and tanker trailers.

These things can make confined spaces dangerous:

- Not designed for continuous worker occupancy.
- Poor natural ventilation.
- Difficult to get in and out.
- Hazardous atmospheres like air contaminants, flammable gases and vapors, or oxygen deficiency.
- Other hazards like moving machinery, electricity, engulfment hazards, liquids or high temperatures.

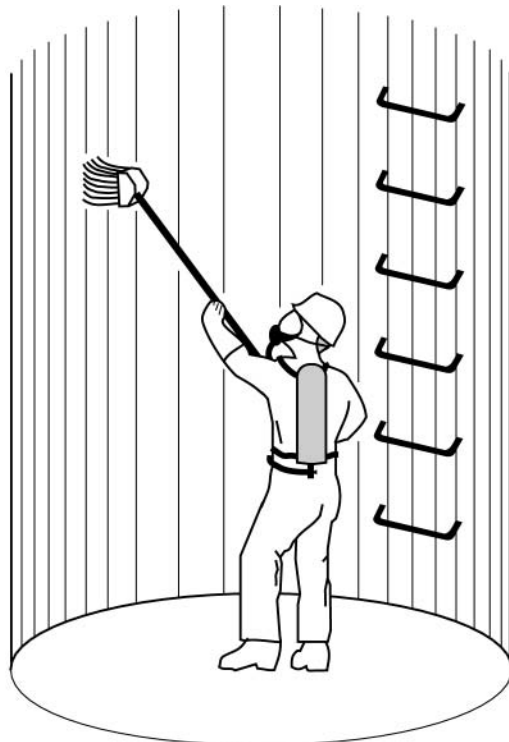


## Confined Spaces

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Any safety or health hazard could be present in a confined space. An accident or chemical exposure is often much worse because it occurred in a confined space.

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Many confined space accidents result in multiple deaths when would-be rescuers die because they don't have the right training and equipment.

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More than half of the workers who perish in confined space accidents are would-be rescuers who lack the necessary training and equipment.

## Chemical Incompatibility

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Incompatible chemicals are combinations of chemicals that undergo dangerous reactions if they mix with each other.

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**Incompatible chemicals** are combinations of chemicals that undergo dangerous reactions if they mix with each other. The effects of these reactions are:

- Production of heat and pressure;
- Fire and explosion;
- Formation of toxic gases and vapors; or
- Formation of flammable gases and vapors.

Some chemicals are dangerous if they simply contact water, air, or common substances like wood and paper.

Because of the extreme danger which incompatible chemicals create, a great deal of effort must be put into analyzing hazardous substances and keeping them separate. This includes the creation of segregated staging areas for chemical storage. It is also why the DOT has special rules about chemical segregation during transportation.

While you are not expected to be a chemist, there are some deadly combinations you can remember:

- Never mix acids and bases. They react violently.
- Never mix cyanide compounds with acids. This creates deadly hydrogen cyanide gas.
- Never let strong oxidizers contact flammables or combustibles. Fire or explosion could follow.
- Never put water on materials that react violently with water, like magnesium or sodium metal.

## Chemical Incompatibility

**Oxidizers** are chemicals that release oxygen when they react with other chemicals. This can cause the other chemical to burn or to explode. Examples are chlorine gas, swimming pool chlorine, ozone, nitrates, concentrated hydrogen peroxide, and sulfuric and nitric acids. Keep oxidizers away from flammables and combustibles, including oils and greases.

**Corrosives** are chemicals that corrode (eat into) other substances. They can cause serious, painful burns to skin, and permanent eye damage. Many corrosives react with metals, so they can't be put in standard drums. A corrosive can eat through the metal of another container, releasing the contents and possibly causing a dangerous chemical reaction.

**Acids** and **bases** are two general kinds of corrosives. While they are similar in that they both corrode many other substances, they react violently together. Never let acids and bases mix.

The pH scale is a way of measuring the strength of an acid or base solution in water. The scale runs from "0" to "14", with "7" in the middle. "7" is neutral, neither acid nor base. "7" is the pH of pure water.

If the pH is less than "7", it's an acid. If the pH is more than "7", it's a base. The further the number gets from "7", the stronger (more corrosive) the solution is.

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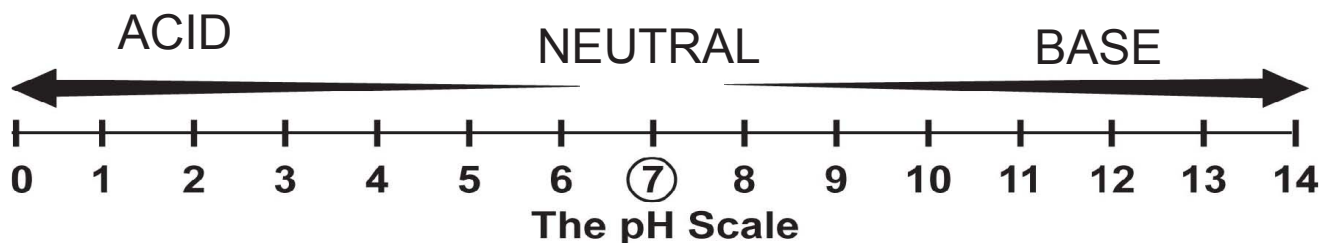
Some chemicals, like sulfuric acid are both corrosives and oxidizers.

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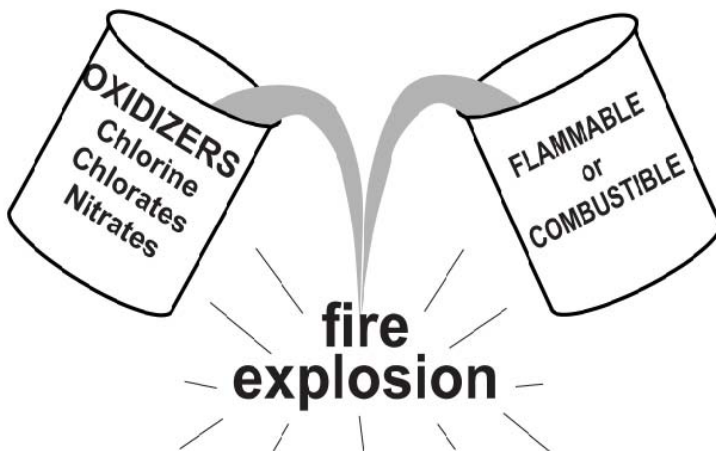
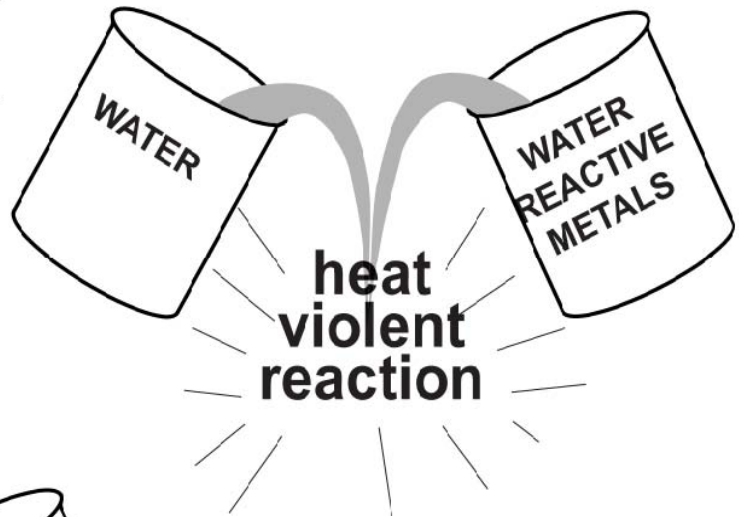
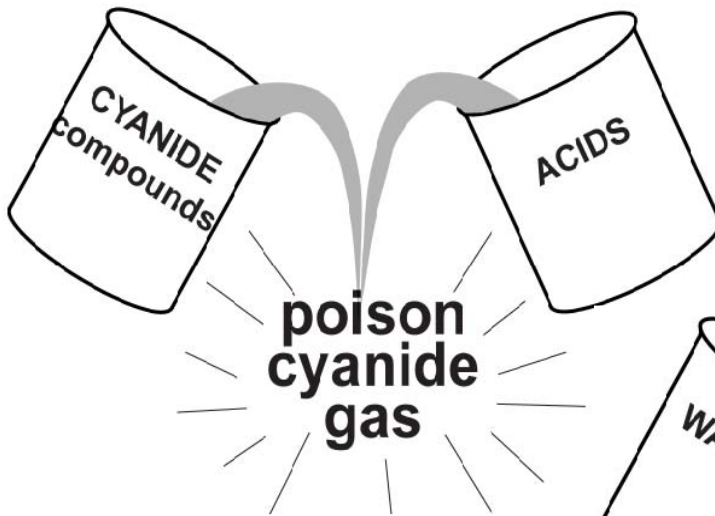
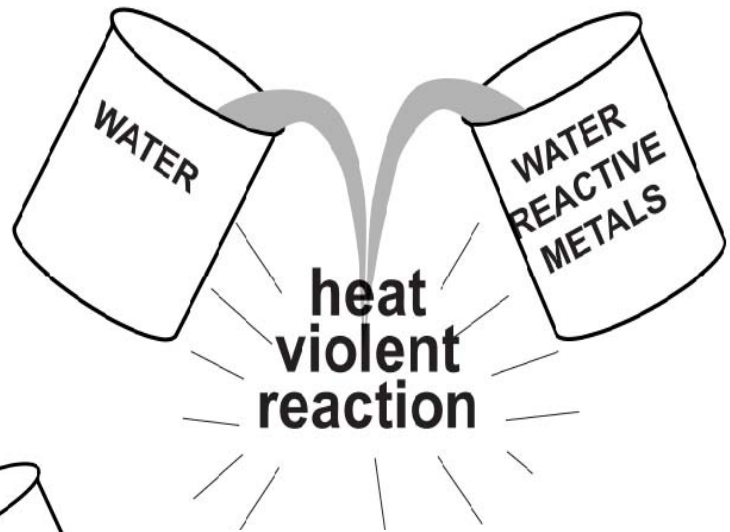
Never let acids and bases mix. Store them separately.

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# Chemical Incompatibility

Some examples of chemical combinations that are incompatible



**Review  
Questions for  
Chapter 2**

1. Define “accident”.
2. Define “safety”.
3. What are two ways to prevent accidents?
4. List the safety hazards you might find at a hazardous waste site.

## **Review Questions for Chapter 2**

5. Define each of the following:

Flash Point:

Combustible:

Flammable:

LEL:

UEL:

Flammable (or explosive) range:

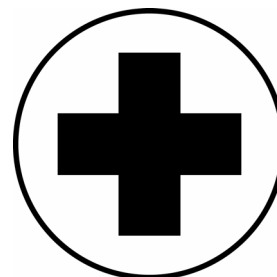
6. Identify four incompatible chemical combinations and state the potential hazardous results of each combination.

## **Review Questions for Chapter 2**

7. List the four components of the fire pyramid.
8. What is the purpose of bonding containers of flammable liquids?
9. What is the purpose of grounding containers of flammable liquids?
10. What is the purpose of grounded power circuits using a third wire?
11. What is the purpose of ground fault circuit interrupters (GFCI's)?

## Chapter

# 3



# Health Hazards

## Learning objectives

This chapter discusses the chemical, physical and biological health hazards that you might encounter at a hazardous waste site.

After completing this chapter, you will be able to demonstrate your ability to:

1. IDENTIFY examples of adverse health effects from occupational exposure to chemicals.
2. IDENTIFY the proper definition of these terms:
  - a. Cancer
  - b. Acute Effect
  - c. Chronic Effect
  - d. Latency Period
  - e. Target Organ
  - f. Local Effect
  - g. Systemic Effect
3. IDENTIFY five routes of entry, into or on the body.
4. IDENTIFY two examples of chronic effects of chemical exposure.
5. IDENTIFY two examples of acute effects of chemical exposure.
6. IDENTIFY six warning signs of possible chemical exposure.



7. IDENTIFY the proper definition of each of these terms:
  - a. OSHA
  - b. NIOSH
  - c. ACGIH
  - d. PPM
  - e. PEL
  - f. TLV
  - g. REL
  - h. STEL
8. IDENTIFY the proper definition of each of these terms:
  - a. Solid
  - b. Liquid
  - c. Gas
  - d. Vapor
  - e. Particulate
  - f. Fume
  - g. Fiber
  - h. Mist
9. IDENTIFY four forms of heat stress.
10. IDENTIFY four measures to prevent heat stress.
11. IDENTIFY the health hazard presented by noise exposure.
12. IDENTIFY four parts of a hearing conservation program.
13. IDENTIFY two health risks of exposure to ionizing radiation.

## Safety, Health, and Other Hazards on the Site

29 CFR 1910.120(e)(2)(ii)

## Chemicals and Your Health

A **health hazard** is a condition that could harm your body by causing irritation, strain, illness, disease, cancer, reproductive effects, or death. We will discuss four kinds of health hazards:

- **Chemical Hazards:** Chemical contaminants in the form of liquids, solids and gases.
  - **Physical Hazards:** Noise, radiation, heat, cold, and vibration.
  - **Biological Hazards:** Plants, animals, insects, bacteria, viruses, molds, etc.
  - **Ergonomic Hazards:** Heavy lifting, awkward positions, repetitive movements, etc.
- 

There are many ways hazardous chemicals can affect you. You might get a rash, feel sick or become dizzy. Your liver, lungs or other organs might be damaged. Your ability to have children might be affected. You might get cancer. The effect depends on the chemical, how much you absorb, and your own state of health.

We divide hazardous chemicals into several categories:

- **Asphyxiants (lack of oxygen).**
- **Corrosives.**
- **Irritants.**
- **Sensitizers.**
- **Toxins (poisons).**

A single chemical might fit into more than one category. For example, an acid might be a corrosive and a poison.

**Asphyxia- Lack of oxygen.** Every living cell in our bodies needs a constant supply of oxygen. Our lungs absorb oxygen from the air. The blood carries the oxygen to all parts of the body. If the body doesn't get enough oxygen, it can die. The technical name for lack of oxygen is "asphyxia."

There are two ways that chemicals can cause a lack of oxygen:

- **Displacing the oxygen in the air.** If a cylinder of argon gas (used in welding) leaks, the argon will take the place of oxygen in the air. Argon is not a poison; but if there is a lot of argon in the air, there won't be enough oxygen to breathe. Any gas or vapor – if enough of it escapes – can decrease the amount of oxygen in the air. Gases and vapors that do this are called **simple asphyxiants**.
- **Interfering with how the body uses oxygen.** Some chemicals, if they get into our system, affect how the body uses oxygen. Carbon monoxide prevents the blood from carrying oxygen so it doesn't reach the cells. Cyanide prevents the cells from using oxygen. Hydrogen sulfide affects the nerves that control the lungs, so that they stop breathing. Chemicals that interfere with how the body uses oxygen are called **chemical asphyxiants**.

The **normal amount of oxygen in the air is 21%**.

OSHA says that you may **not work in an area with less than 19½% oxygen.** [29 CFR 1910.146(b)]

## **Asphyxia Lack of Oxygen**

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Any gas or vapor can be a simple asphyxiant if enough is released to displace oxygen in the air.

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Some chemical asphyxiants are gases that you inhale, others may be solids or liquids that you ingest or absorb through you skin.

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## Corrosives

**Corrosives** cause burning and destruction of any tissue they contact. They can cause permanent eye damage or blindness. They burn the skin, mouth, nose, esophagus, stomach, and lungs.

Examples of corrosives include **acids** like sulfuric acid, nitric acid or hydrofluoric acid; and **bases** like ammonia and lye (lye is also called sodium hydroxide.)

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## Irritants

**Irritants** cause redness, swelling, itching or burning of the eyes and skin. If inhaled, they cause coughing, or difficulty breathing.

Examples of irritants include ammonia, weak concentrations of acids, solvents, turpentine, and diluted solutions of corrosives.

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## Sensitizers

**Sensitizers** cause some people to become “sensitized,” and react to even a very small exposure when they later encounter the material. They can suffer asthma-like symptoms or skin irritation.

Examples of sensitizers include formaldehyde, nickel, and toluene diisocyanide (TDI).

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## Toxins (Poisons)

There are many kinds of **toxins** – they are classified by what organs or parts of the body they damage.

**Liver toxins** (hepatotoxins) can cause hepatitis, cirrhosis, or liver failure.

Examples of liver toxins include ethyl alcohol, PCBs, and chlorinated solvents like chloroform and carbon tetrachloride. Vinyl chloride can cause liver cancer.

## Toxins (Poisons)

**Neurotoxins** affect nerves. Some affect the brain (central nervous system) causing dizziness, nausea, headaches, poor coordination, or behavior changes. Examples include lead, mercury, and solvents like ethyl alcohol.

Other neurotoxins affect the nerves that go to other parts of the body (peripheral nervous system) causing numbness, tingling, weakness or tremors. Examples are lead, arsenic, mercury, and hexane. Many chemicals affect both central and peripheral nervous systems.

**Kidney toxins** (nephrotoxins) damage the kidneys, and may cause kidney failure.

Examples include lead, cadmium, mercury, methyl alcohol, and chlorinated solvents like carbon tetrachloride and chloroform.

**Respiratory toxins** damage the lungs and airways. Corrosives and irritants can cause burning. Ozone and phosgene gas cause fluid to collect in the lungs (edema). Asbestos and silica dust cause cancer and scarring of the lungs. Asbestos and tobacco smoke can cause lung cancer.

**Blood toxins** (hematopoietic toxins) affect the blood, or the organs that make blood cells. Arsine and phosphine gas kill red blood cells. Benzene and lead cause anemia. Benzene can also cause leukemia (blood cancer).

**Reproductive toxins** affect your ability to conceive, or give birth to normal, healthy children. Possible effects include low sperm count, deformed sperm, impotence, menstrual irregularities, infertility, miscarriage, low birth weight and birth defects.

Examples include lead, DBCP (a pesticide that is banned in the United States, but is still manufactured for export), ethyl alcohol, ethylene oxide, Cellosolve, mercury and PCBs.

# Cancer

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**Cancer is the uncontrolled growth of abnormal cells that interfere with the way your body is supposed to work.**

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**Some cancers are caused by exposure to chemicals.**

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**Chemicals that increase your risk of getting cancer are called carcinogens.**

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Your body contains trillions of living **cells**. There are many types, each with special functions to perform in order to maintain a healthy, living body.

**Cancer** is the uncontrolled growth of abnormal cells. Cancer is what happens when some cells begin to “misbehave”, and enough of these “cancer” cells grow so that they cause a problem.

For example, the cells in your lungs form a structure which expands and contracts as you breathe. Some cells form the air passages, others let oxygen pass into your blood. If some cells grow into a mass that interferes with the passage of air or the normal expansion and contraction, then this mass of cells is called lung cancer.

Because there are different kinds of cells, there are different kinds of cancer: liver cancer, lung cancer, leukemia (blood cancer), skin cancer and so forth.

Why do cells “go bad” and become cancer cells? We don’t know all the details. We do know that some cancers are more likely if the person is exposed to certain chemicals. For example, insulation and shipyard workers who were exposed to asbestos fibers are much more likely than other people to get lung cancer, or a rare cancer called mesothelioma. Smokers have a much greater chance of getting lung cancer than nonsmokers.

Workers exposed to benzene have an increased risk of leukemia. Those exposed to benzidine have an increased risk of bladder cancer. Vinyl chloride can cause liver cancer. Workers exposed to chromium have an increased risk of lung cancer.

Chemicals that increase your risk of cancer are called **carcinogens**. Just because you are exposed to a carcinogen doesn’t mean you’ll get cancer.

# Cancer

There are many steps involved prior to the onset of cancer:

- The chemical has to reach cells in the target organ.
- The cells have to be changed by the chemical, but not damaged so badly that they die.
- The damage has to go unrepaired.
- Enough cancer cells have to grow so that they interfere with normal functioning.

Most of the time exposure to a carcinogen doesn't cause cancer. However, the more you are exposed, the more likely it becomes that all the bad steps will occur, and a cancer will grow. It's like lottery tickets. If you just buy one ticket you probably won't win. If you buy many tickets, your chances increase. Not all smokers get lung cancer. But of the people who do smoke, more get cancer than people who don't smoke.

Not all chemicals cause cancer. We need to identify the ones that do, and keep our exposure as low as possible. Very few chemicals have actually been studied to see if they are carcinogens.

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**To decrease your risk, keep your exposure as low as possible. In the cancer lottery we want to buy as few tickets as possible.**

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**There may be cancer causing chemicals we don't know about. This is another reason to keep all exposures as low as possible.**

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## Some Examples of Chemical Carcinogens

<u>Chemical</u>	<u>Type of Cancer</u>	<u>Chemical Uses</u>
Asbestos	Lung cancer, mesothelioma	Insulation, brake linings
Arsenic	Lung cancer	Pesticides, pigments, smelter residue
Benzene	Leukemia	Chemical manufacture, solvents
Benzidine	Bladder cancer	Manufacture of dyes, plastics, chemicals
Chromium	Lung cancer	Welding fumes, plating fumes and residues
Coal tar	Skin and scrotal cancer	Fly ash, roofing and sealing compounds
Naphthalene	Bladder cancer	Manufacture of dyes, rubber, chemicals
Vinyl chloride	Liver cancer	Manufacture of polyvinyl chloride (PVC)

# Chemical Forms

**Chemicals** are made of **molecules**. For example, water is made of water molecules, toluene is made of toluene molecules. Depending on how the molecules are “stuck” together, the chemical may be in the form of a solid, a liquid or a gas.

**Solids** keep their size and shape, unless they’re broken into smaller pieces. That’s because the molecules are tightly stuck together. Solids are things like a stone, a piece of wood, or ice.

**Liquids** flow, like water. That’s because the molecules are loosely stuck together and can attach and detach from each other. Liquids keep the same size (volume), but change shape to fit their container.

**Gases** have no definite size or shape. That’s because the molecules are all separate – free to fly around. A gas expands to fill the space available. If a gas leaks, it disperses in all directions. Gases are individual molecules – flying around.

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Many chemicals can exist in different forms, depending on the conditions.

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Vapors are chemicals that eVAPORate.

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In terms of air monitoring and respirator selection, gases and vapors are the same thing.

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Chemicals can change form, depending on the conditions. For example, if it’s cold enough, water is a solid called ice. With heat, it melts and becomes liquid. Water can evaporate to become a gas (water vapor).

**Vapor** is the word for a gas that evaporates from a liquid or solid. For example, paint thinner is a liquid. We smell it because some of the liquid evaporates to form solvent vapor, which gets into our noses. When a vapor cools, it can condense back into a liquid.

A **gas** is something that’s normally in the form of a vapor. A **vapor** is something that is usually liquid or solid, but has evaporated to form a gas. Vapors behave like the other gases in the air. They diffuse (spread out) into the space available.



## Chemical Forms

**Dust** is a solid material that has been ground into small pieces. You can see dust in the beam of a movie projector, or when you shine a flashlight in a dark room. Because dust floats in the air, it can be inhaled.

**Fibers** are also small solid pieces that float in the air. Fibers are like dusts, except that the individual pieces are much longer than they are wide. For some chemicals, this arrow-like shape makes it easier for them to get deep into the lungs. An example is **asbestos**, which breaks up into thousands of tiny, microscopic fibers that penetrate deep into the lungs.

**Fumes** are extremely small solid particles formed in hot processes like fire, welding, and diesel engines. Fumes are like dusts, except that they are even smaller.

Fume is not vapor, although many people say “fume” when they mean “vapor”. You smell gasoline vapor, not gasoline fumes.

This distinction is important because we use a different kind of filter to trap solid particles like fume than to trap gases and vapors. Respirator labels use these words to mean different things. If you don’t know the difference, you may pick the wrong respirator and not be protected.

**Mists** and **Sprays** are tiny droplets that float in the air, and can settle on clothing or bare skin, or be inhaled.

**Particulate** means any liquid or solid in a form small enough to float in the air. Dust, fiber, fume, mist and spray are all particulates.

**Smoke** from burning is usually a mixture of chemicals including gases, vapors and particulates.

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Fume is a tiny solid particulate. It’s not vapor.

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Particulate is the general term for small solid or liquid things floating in the air. This includes:

Dust  
Fiber  
Fume  
Mist  
Spray

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## **Chemical Forms and Health Effects**

The form of a chemical has a lot to do with how it affects our health, and with how we protect ourselves.

The smaller a particulate is, the more hazardous it is. Very small particulates, like welding fumes, penetrate deep into the lungs when we inhale – and stay there. A larger particulate, like sawdust, might be caught in the nose, and we can blow it out. Fibers, because of their long, thin shape, also penetrate deep into the lungs.

Small particulates are also harder to trap in a respirator filter than larger particulates. For fumes, fibers and very small dusts we need a much better filter than we would need for sawdust.

Vapors and gases, because they are individual molecules, can penetrate deep into the lungs – where they can be absorbed into the blood.

Vapors and gases are difficult to capture in a respirator cartridge. For many gases and vapors, no cartridge works – we have to use a respirator with its own air supply.

## **Air Contaminants**

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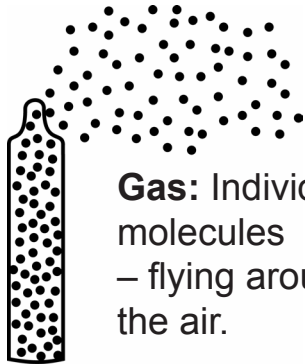
**Air contaminants** are hazardous chemicals in the air.

In order to be small enough to stay in the air and be inhaled, the chemical must be in the form of a gas or a particulate. All air contaminants are either:

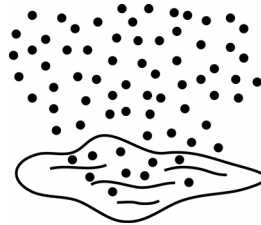
- **Gases and vapors, and/or**
- **Particulates.**

Remember that gases and vapors are the same thing: individual molecules in the air. “Particulates” include dusts, fibers, fumes, mists and sprays.

## Gases and Vapors



**Gas:** Individual molecules – flying around in the air.



**Vapor:** A gas that evaporates from a liquid or solid.

## Air Contaminants

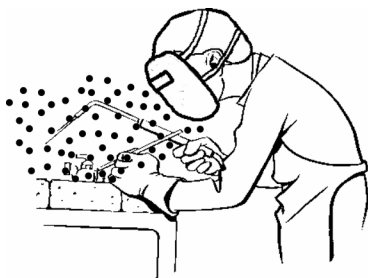
### Particulates



**Dust:** Tiny solid particles – floating in the air.



**Fibers:** Tiny solid particles – much longer than wide – floating in the air.



**Fume:** Very tiny solid particles – from hot processes – floating in the air.



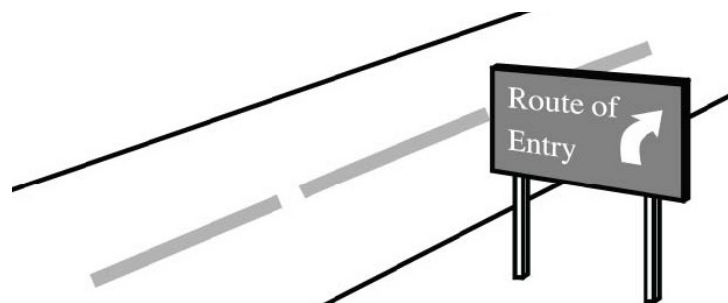
**Mist and Spray:** Tiny liquid pieces – floating in the air.

## Routes of Entry

In order for a hazardous material to affect your health, it has to get into or on your body. The different ways that chemicals do this are called **routes of entry**.

1. **Inhalation** is breathing in a hazardous material. It may damage the lungs, and it may be absorbed in the blood and carried to other parts of your body.
2. **Skin or eye contact** is when a hazardous material gets on your skin or in your eye.
3. **Skin absorption** is when a hazardous material gets on your skin and soaks through the outer layers. It then enters the blood and is carried to other parts of your body.
4. **Ingestion** is when you accidentally swallow a material. This might happen if the material gets on your hands, and then on the sandwich you eat.
5. **Injection** is when a sharp object punctures the skin, allowing a chemical or infectious agent to enter.

Chemicals can use more than one route of entry. For example, if you handle a leaking container of solvent, you may get some on your hands. It can irritate your skin. It can also soak through, into your blood, and reach your liver or other organs. It can also evaporate and you will inhale it. The solvent affects you by skin contact, skin absorption, and inhalation.



## Local and Systemic Effects

If a chemical causes damage where it comes in contact with your body, this is called a **local effect**. For example, if acid spills on your hand, the skin burn is a local effect. When you inhale ammonia, the irritation in your nose, throat and airways is a local effect.

If a chemical is absorbed — by whatever route of entry — and travels through your system to damage another organ, this is called a **systemic effect**. For example, suppose you inhale solvent vapors and start to feel dizzy. The solvent has been absorbed through the lungs, traveled in the bloodstream and caused an effect in your brain. Another example might be a chemical that soaks through your skin and then causes damage to your liver.

Many chemicals produce both local and systemic effects. For example, inhaling a solvent might irritate the nose and lungs. This is a local effect: it happens where the chemical comes in contact with your body. But the solvent will also be absorbed in the lungs and carried by the blood to the liver, kidneys and brain. Damage to these other organs is a systemic effect.

In any case, the organs that a chemical affects are called target organs.

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**Local Effect: Occurs where the chemical contacts your body.**

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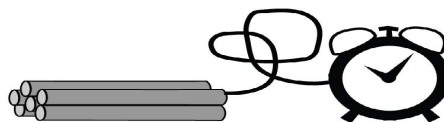
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**Systemic Effect: Occurs in some other organ after the chemical has circulated through your system.**

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Local effect, systemic effect and target organ have to do with **where** the chemical affects you.



Acute effect, chronic effect and latency period have to do with **when** the chemical affects you.

## Short-Term and Long-Term Effects

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Acute = short-term  
Chronic = long-term

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Some chemicals cause effects that occur right away. If acid gets in your eye, it causes a painful burn immediately. If you inhale ammonia vapor, you cough and feel irritation in your nose and airways right away. This is called a **short-term effect** or **acute effect**.

If you breathe small amounts of asbestos fibers, you won't even notice them. There are no acute effects. But if you inhale asbestos month after month, year after year, you greatly increase your chances of getting lung cancer. This is a **long-term effect** or **chronic effect**.

It may take many years between the time you were exposed and when symptoms begin to appear. This is called the **latency period**. For some diseases, like cancer, the latency period can be twenty, thirty or more years.

The same chemical can cause both kinds of effects. For example, toluene is a chemical used in paints and solvents, and in the cement for plastic models. Inhale toluene and you can get dizzy or "high", and feel respiratory irritation. Toluene can also dry and irritate the skin. These are acute effects. However, if you are exposed again and again, toluene will damage your liver and destroy brain cells. These are chronic effects.

We usually notice acute effects. For example, acid burns and we feel it almost immediately. Just one whiff of ammonia vapor can make you cough. These effects can warn us to take precautions.

Unfortunately, you usually won't notice chronic effects until it's too late, because they happen slowly and it takes a long time to develop symptoms. You have to learn the possible chronic effects of the chemicals you work with. Then you will know that you must be careful, and what precautions to take, even if the materials don't cause any immediate effects.

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### Latency Periods: Average Years After Exposure for Cancer to Appear

Asbestos:	33 years
Arsenic:	25 years
Benzene:	10 years
Benzidine:	16 years
Chromates:	21 years
Napthylamine:	22 years
Vinyl chloride:	15 years

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## **Differences Between Acute and Chronic Health Effects**

<b><u>Acute Effect</u></b>	<b><u>Chronic Effect</u></b>
Occurs immediately or soon after exposure.	Develops slowly over a long time (latency period).
Often involves a high exposure in a short time.	Often involves a low exposure over a long period of time.
Often reversible (you recover) after exposure stops.	Many chronic effects are irreversible (permanent).
Often, it's obvious what caused the effect.	Because of the delay, it's difficult to establish what exposure caused the effect

## **Examples of Acute and Chronic Health Effects**

<b><u>Hazard</u></b>	<b><u>Acute Effect</u></b>	<b><u>Chronic Effect</u></b>
Asbestos	None	Asbestosis (scarring of the lung). Lung cancer Mesothelioma (cancer of the lining around the lung)
Acid mist	Irritation of the eyes,	Chronic bronchitis. Emphysema
Trichloro-ethylene	Light-headedness,	Liver damage. Kidney damage. Possibly liver cancer
Carbon-monoxide	Drowsiness. Headache.	Heart attack. Stroke.

## Exposure Limits

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The best policy is to keep any exposure as low as possible.

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Most limits are set for normal work exposures, not emergencies.

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8-hour TWA = The average exposure to a chemical over an 8-hour work day.

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How much exposure is too much? This depends on the chemical. However, the best policy is to keep any exposure as low as possible.

Several organizations and government agencies set limits for common chemicals. The idea is that most people will not be harmed if their exposure is kept below the limit. For example, the OSHA limit for toluene is 100 ppm. OSHA assumes that for most people, this amount in the air at work will not cause health problems.

An exposure limit is based on information from animal experiments and on information about the effects that workers experience in industries that use the chemical. Exposure limits are listed on SDSs (Safety Data Sheets).

We use exposure limits to decide what type of personal protective equipment to use. If you suffer health effects, the limits might be used to decide whether the effects were caused by the chemicals you worked with.

Most limits are for the amount of a chemical in the air. They only deal with the inhalation route of entry.

At work, the amount of a chemical in the air changes during the day, depending on what's going on. For example, if someone is painting, there will be a higher level of solvent vapor than when the paint cans are closed and the products are dry.

Most exposure limits are based on the average exposure. The actual concentration will sometimes be above the average, sometimes less. The average is called the **Time-Weighted-Average** or **TWA**. "Time-weighted" just means that it's the average over a period of time. Usually it's an 8-hour TWA.



## Exposure Limits

A few chemicals have a **Short-Term Exposure Limit**, or **STEL**. These chemicals are so irritating that even if the average concentration were low, the times when the concentration goes above the average would cause problems. An STEL is a limit you should only be exposed to for fifteen minutes or less, and for no more than four fifteen-minute periods a shift, at least one hour apart.

Some chemicals have a **Ceiling Limit** or **C**. This means that the concentration in the air must never go above this limit, even for a few minutes.

Some limits say the word **Skin**. This reminds you that the liquid or solid form of the chemical can be absorbed through the skin. This is not an exposure limit for the skin. It's just a warning to avoid skin exposure by wearing the proper gloves and protective clothing.

Exposure Limits for Air Contaminants	
Time-Weighted Average TWA	Highest average concentration in ppm or mg/ m <sup>3</sup> allowed during an 8-hour day.
Short-Term Exposure Limit STEL	Highest average concentration in ppm or mg <sup>3</sup> allowed during a 15-minute period.
Ceiling Limit C	Highest concentration in ppm or mg <sup>3</sup> allowed. This is an absolute number, not an average.
Skin	This reminds you to use gloves and protective equipment or clothing to prevent skin absorption.

## Parts Per Million ppm

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We can use ppm to describe the concentration of a gas or vapor in the air. We never use ppm for particulates.

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## Percent and ppm

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One percent is equal to ten thousand ppm.  
 $1\% = 10,000 \text{ ppm}$ .

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**Parts per million (ppm)** means how many of one kind of molecule are in a mixture of one million molecules.

Air is a mixture of individual molecules of nitrogen (78%), oxygen (21%) and other gases and vapors (1%). Each breath contains many millions of molecules.

Suppose we could count the molecules as we inhaled them. By the time we got to one million, we would have counted about 210,000 oxygen molecules, about 780,000 nitrogen molecules, and about 10,000 molecules of other gases and vapors. Out of one million molecules we have 210,000 oxygen molecules. One way to say this is that we have 210,000 parts per million (ppm) of oxygen. With big numbers like these, it's easier to just say 21%.

However, for hazardous chemicals, a much smaller concentration can be harmful. Consider benzene. The OSHA Permissible Exposure Limit (PEL) is 1 ppm. This means that OSHA has determined that even if only one out of every million molecules we breathe is a benzene molecule, we may be absorbing enough benzene to damage our health.

We can use ppm to describe the concentration of a gas or vapor in the air. We never use ppm for particulates.

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The exposure limit – to prevent health effects – for benzene vapor in the air is 1 ppm. The Lower Explosive Limit (LEL) – the least concentration required for benzene vapor to burn – is about one percent.

If you do the math, you can show that **one percent (1%) is equal to ten thousand (10,000) ppm**.

Because these levels are so different, we use different instruments to measure benzene concentrations for fire protection and benzene levels for health protection.

**Milligrams per meter cubed (mg/m<sup>3</sup>)** is another way to describe the concentration of a contaminant in the air.

A cubic meter (m<sup>3</sup>) is a measure of volume. Think of a square box with each edge a little longer than a yard. If you haul ready-mixed concrete, then you are familiar with cubic yards. A cubic meter is a little bit more.

A milligram (mg) is a very small weight. For example, a teaspoon of salt contains 6000 mg of salt.

Suppose the air is contaminated with silica dust from dumping crushed rock. Suppose also that we collect a one cubic meter box full of this air. Then we carefully separate out the dust, and weigh it on a sensitive scale.

If the scale reads 6 milligrams, we would describe the air as having 6 milligrams of silica dust in one cubic meter of air: 6 milligrams per meter cubed or 6 mg/m<sup>3</sup>.

For particulates we use mg/m<sup>3</sup> to describe the concentration in the air – never ppm.

Suppose we did the same thing with a cubic meter of air that contained benzene vapor. If we separated out the benzene molecules and weighed them, the scale might read, for example, 3 mg. We would then say that the concentration of benzene vapor was 3 mg/m<sup>3</sup>.

We can use either mg/m<sup>3</sup> or ppm to describe the concentration of a gas or vapor in the air.

## **Milligrams per Meter Cubed mg/m<sup>3</sup>**

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**For particulates we use mg/m<sup>3</sup>. We never use ppm for particulates.**

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**We can use either mg/m<sup>3</sup> or ppm for gases and vapors**

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## Who Sets the Limits?

### Exposure Limits

**ACGIH TLV**  
Recommendation  
of a private  
organization.

**OSHA PEL**  
Legally binding  
standard of a  
government  
agency.

**NIOSH REL**  
Recommendation  
of a government  
agency.

The **American Conference of Governmental Industrial Hygienists (ACGIH)** is an association of industrial hygienists. They prepare a list of recommended limits called **Threshold Limit Values (TLV)**. They are only recommendations, and are not legally binding.

The federal **Occupational Safety and Health Administration (OSHA)**, or in some states, the state safety and health agency, sets legally binding limits called **Permissible Exposure Limits (PEL)**.

[29 CFR 1910.1000]

The **National Institute for Occupational Safety and Health (NIOSH)** makes recommendations called **Recommended Exposure Limits (REL)**.

The TLV, PEL and REL are often the same. For example, xylene has an 8 hour TWA of 100 ppm in all three systems.

Sometimes they are different. For example, for carbon disulfide the TLV is 10 ppm, the PEL is 4 ppm, and the REL is 1 ppm.

For formaldehyde, the OSHA PEL is 1 ppm TWA with a STEL of 2 ppm. NIOSH and ACGIH, have not set a REL or TLV. Formaldehyde is a carcinogen. NIOSH and ACGIH believe that you can't set a limit since any exposure increases your cancer risk somewhat.

## Which Limit to Use?

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Always keep exposures as low as possible.

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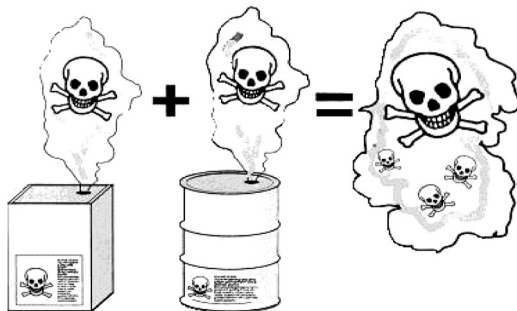
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The PEL is the legally required limit. However, the fact that ACGIH or NIOSH has a lower limit indicates that there are health professionals who believe greater protection is required. You or your union representative should ask for control measures that keep the exposure below the lowest recommended limit. You should argue that there is evidence for the lower limit, and that it is better to err on the side of caution. **The best policy is to always keep exposures as low as possible.**

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The limits are not perfect. Many have been lowered over the years as we discover that even smaller amounts of a chemical are harmful. Here are some reasons why a limit might not be valid (might not be low enough):

- The limit might be based on insufficient information.
- A chemical might cause more than one effect, but have a limit based on only one effect.
- Some of us may be more affected than other people. ACGIH says that its TLVs are believed to protect “nearly all workers” – but not all.
- Limits don’t take into account the effects of other chemicals a worker is exposed to. The combined effect may be more than the individual effects.
- Most limits are based on the amount of chemicals in the air. This ignores other routes of entry. Many chemicals are absorbed through the skin.
- There are over one hundred thousand chemicals used in the United States. There are limits for only about 600. Most chemicals have no exposure limit.



## Can We Trust the Limits?

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For example:

The OSHA PEL for formaldehyde (1 ppm) will protect most workers from respiratory irritation, but these limits don’t necessarily prevent an excess risk of nasal cancer.

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The combined effect of exposure to two or more different chemicals might be greater than the effects of each one separately.

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## Are You Exposed?

How do you know what chemicals you are exposed to? Do you know how much you're exposed to? How do you know if your exposure is below the limit?

There are instruments for monitoring some chemicals in the air. For some chemicals there are tests to see how much is in your body.

There are also clues to indicate exposure even if you don't have special instruments. You may be able to smell a chemical or feel an acute effect like itching skin or watery eyes. There may also be clues in your work environment to indicate exposure.

**Odor.** If you can smell it, you are inhaling it.

However, many chemicals don't have a smell, or the amount needed for smell is higher than the exposure limit. Others have no smell, like carbon monoxide, or they numb your sense of smell, like hydrogen sulfide.

**Taste.** Never taste something that might be a hazardous chemical. However, if you inhale a chemical or accidentally get some in your mouth, it may have a particular taste that warns you're being exposed.

**Particles in your respiratory system.** Your nose and airways have mucus that traps particulates and removes them when you cough or blow your nose. If your mucus is an unusual color or has visible particles in it, then you have inhaled particulates. What you see are particles that were large enough to be trapped. There may be smaller ones that made it deep into your lungs. Particulates this small are too small to see.

**Spills or leaks.** Leaking drums or pools of liquid indicate a hazard. Chemicals may be evaporating into the air. Don't walk through spilled material, or get it on your bare skin.

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This is why for particulate contamination, like asbestos fibers, people say, "It's what you can't see that hurts you".

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**Visible material in the air.** If you see visible clouds of vapor or particulates, there is probably a serious exposure problem. Remember, however, that most gases and vapors are invisible, and that often the most dangerous particulates are too small to see.

**Acute symptoms.** Many chemicals cause irritation. One whiff of ammonia warns you it's there.

**Settled dust.** If there is dust on the ground or on other surfaces, it probably got there by settling out of the air. This means that there are particulates in the air that you could inhale. It is likely that if you walk through the area, or use equipment, you will send more of the settled dust back into the air, increasing the inhalation hazard. If dust settles on the ground, it can also settle on your clothes, on your hair, and on your food.

**Dead vegetation or dead animals.** If they're dead, think about what chemical might have killed them.

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It's important to recognize the warning signs of chemical exposure, like odor, or acute symptoms. But what if there are no signs? Can you forget about exposures? Many chemicals have no smell, taste, or acute symptoms. Some people can't smell certain chemicals. Some chemicals numb your sense of smell. Many air contaminants are invisible. There may be contamination on the things you handle, without there being enough to see or feel.

Use the common sense clues we've discussed as warning signs. But never assume you're not exposed just because you don't see or feel any warning signs.

## Are You Exposed?

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Acute symptoms like dizziness, nausea or headache may also warn you of exposure. But it's easy to ignore these, or assume that you're just getting a cold or the flu.

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## What If There Are No Signs or Symptoms of Exposure?

# Biological Hazards

**Biological Hazards**, also known as **biohazards**, are organisms, and plant and animal agents that may produce both **toxic** and **allergic reactions**. These organisms are found in water, soil, plants, and animals. They include:

- Bacteria
- Fungi
- Insects
- Rodents
- Viruses
- Pollens
- Snakes

Biological hazards may be found at any hazardous waste site. These hazards may result from infectious agents that were disposed of, such as medical waste, or they may be natural inhabitants of the area.

**Infectious waste.** The most common forms of waste that might contain biological hazards are infectious medical and laboratory waste. This can include syringes and other “sharps”, as well as bandages and materials contaminated with infected body fluids.



Bio-Hazard  
Warning Symbol

Infectious waste is required to be packed in red plastic bags. Needles, syringes, scalpels and other sharps are required to be packed in hard red plastic containers. These red bags and plastic containers must be printed with the biohazard warning symbol.

Infectious waste may only be legally disposed of at sites specifically authorized to accept infectious waste. However, it has frequently been disposed of improperly, so you might encounter infectious waste at any waste site.



## Biological Hazards

**Hantavirus** is transmitted to humans from the dried droppings, urine, or saliva of mice and rats.

**Molds and fungi** release millions of spores into the air. Some cause allergic or asthma-like reactions as well as other respiratory symptoms.

**Bloodborne pathogens** include human immunodeficiency virus (HIV), hepatitis B, and hepatitis C.

These pathogens might be found in waste from hospitals and clinics, especially if the waste contains used needles. Used needles abandoned by drug users are also a potential hazard.

You might also be exposed to bloodborne pathogens from a worker who is injured.

If you are stuck by a needle or other sharp or get blood in your eyes, nose, mouth, or on broken skin:

- Immediately flood the exposed area with water and clean any wound with soap and water or a skin disinfectant if available.
- Report this immediately to your supervisor.
- Seek immediate medical attention.

# Heat Stress

**Heat stress can be a serious, life-threatening hazard**, especially for workers wearing impermeable protective clothing, which do not allow the passage of fluid. Heat stress means that your body is having trouble keeping its temperature at the normal level – about 99°F. It means that your body is overheating.

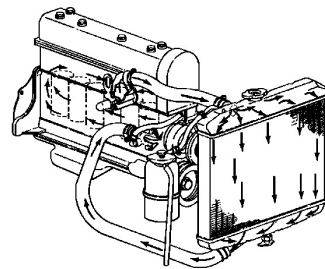
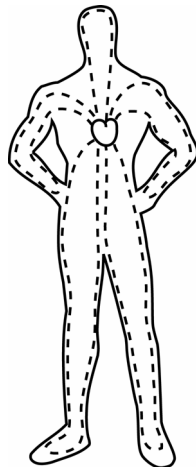
Heat in your body comes from two sources:

- Heat your muscles make as they work.
- Heat from the environment around you.

If your body gets too hot it means that:

- You are working too hard, and/or
- The environment is too hot, and/or
- Something is keeping your body's cooling system from working effectively.

Your body has a cooling system. As the body gets hotter, it sends more blood to the skin where heat in the blood dissipates into the air. This is like the way hot water from an engine goes to the radiator where it gives off heat. Your body also sweats. As the sweat evaporates, it takes even more heat with it.



Heat stress is possible if you are working in a hot environment.

Heat stress is also possible if you are wearing protective clothing— even when it isn't very hot.

Protective clothing can keep chemicals out. But these garments also trap sweat inside, and keep it from evaporating. Sweating only cools if the sweat evaporates. **If sweat can't evaporate, it can't cool.**

If you wear heavier or more protective clothing than you need, you may create a new hazard: heat stress.

Even in moderate weather, it's possible to suffer heat stress if you're in protective clothing that interferes with your body's cooling.

It's important to recognize the signs and symptoms of heat stress so you can take preventive action before heat stress causes serious problems. Preventive action means taking adequate rest breaks, drinking plenty of water, and not working harder than your fitness allows.

## Heat Stress



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**Protective clothing can cause heat stress even if it's not very hot out.**

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# Reactions to Heat Stress

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## Heat Stress Can Kill

Heat stress is one of the most serious hazards you might encounter in hazardous waste work. There are many possible effects of heat stress. The most dangerous effect is called heat stroke. Heat stroke is a serious medical condition. Almost one-half of all people who experience heat stroke die as a result.

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There are four types of adverse health effects caused by heat stress:

**Heat Rash.** Itchy rash that occurs when the skin becomes swollen and plugs the sweat glands. This is not a life-threatening condition, but indicates that heat stress conditions may be present.

**Heat Cramps.** These are painful muscle cramps caused when sweating diminishes water and electrolytes so that not enough are available for your working muscles. This is not life-threatening, but it indicates you are working under heat stress conditions. Stop work; rest in a cool, shaded area; and drink fluids.

**Heat Exhaustion.** You feel worn-out, nauseous, dizzy or faint. You experience heavy sweating. You may have rapid, shallow breathing. Stop work: rest in a cool place. Drink fluids. Get medical assistance: heat exhaustion can develop into deadly heat stroke.

**Heat Stroke.** This is a serious medical emergency. **Call emergency medical help now!** Symptoms include:

- Hot, red, dry skin with little or no sweating.
- Very rapid pulse.
- Core body temperature above 105°F.
- Dizziness, nausea, delirium or possible coma.

One-half of all heat stroke victims die. Get help immediately!

You should monitor yourself for heat stress whenever you work in a hot environment. You should also monitor yourself whenever you wear impermeable protective clothing, even if it's not hot out. Here's how:

- **Check your pulse.** Take your pulse when you begin a break. If your heart rate is more than 110 beats per minute, then you should shorten your next work period, or work less vigorously. Touch your arm lightly just above the wrist. Count the beats for 15 seconds. Multiply by 4 to get beats per minute.
- **Take Your Temperature.** Take your temperature at the beginning of a break, before drinking. Keep the thermometer under your tongue for at least two minutes. Normal body temperature is about 99 °F. If your temperature is above 100 °F, shorten your next work period, or work less vigorously.
- **Weigh Yourself.** Weigh yourself at the beginning and end of the day. If you've lost more than a pound in one day, this is probably water loss. You need to drink more.

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If you are healthy and are not wearing protective clothing that interferes with sweat evaporation, then you may become used to the heat. This takes several days, so take it easy at first. If you are wearing protective clothing, your sweat may not be able to evaporate. It's possible to suffer heat stress no matter how fit you are, no matter how "used to it" you are.

## Monitoring for Heat Stress

## Becoming Acclimated

# Preventing Heat Stress

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You don't feel thirsty until you've started to dehydrate. Drink water or other fluids regularly throughout the day, before you get thirsty.

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There are several ways to help prevent heat stress:

- **Recognize the signs of heat stress in yourself and in your fellow workers.** Often we don't notice what's happening to ourselves. If your buddy looks like they're having a hard time, getting too red, sweating too much, or acting dizzy and uncoordinated, don't be afraid to say something. You might be saving their life.
- **Adjust schedules.** Take breaks. Heavy work in protective clothing or in a hot environment may require more time resting than working. Schedule heavy work in the coolest part of the day, or at night.
- **Provide rest shelters.** Have shaded rest shelters with chairs or benches. Air conditioning is even better.
- **Drink fluids.** Sweating cools the body, but it also robs the body of fluid. Drink enough to replace what you lose. You may not feel thirsty until you've become dehydrated. Drink regularly throughout the day. Don't wait until you're thirsty. Your employer is required to provide clean running water, or sanitary, insulated water jugs.
- **Keep fit.** The healthier you are, the more resistant your body is to conditions that cause heat stress. Your muscles work more efficiently and your body is better able to transfer heat to your skin surface where sweating can dissipate this heat.

## Noise Exposure

Long-term (chronic) exposure to loud noise levels at work can harm your hearing by damaging or destroying nerve cells in your inner ear. This kind of hearing damage is called **industrial hearing loss**.

**This is a permanent condition.** Because it develops slowly, over several years of noise exposure, you won't notice it until it's too late. You may be surprised one day when you realize that you can't understand your grandchildren, or that music just doesn't sound right anymore.

You need to protect yourself now in order to prevent hearing loss later.

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Industrial hearing loss is a permanent condition. There is no cure. That's why prevention is so important.

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OSHA has two different standards for noise exposures. One is for workers in general industry. [29 CFR 1910.95]

The other standard is for workers in the construction industry. [29 CFR 1926.52]

Both standards require the employer to control noise exposure with engineering controls (which includes good maintenance) and administrative controls (like limiting the amount of time a worker is exposed).

If, despite using engineering and administrative controls, your average daily exposure is 90 dBA or above, OSHA requires hearing protection (plugs or muffs) to be worn.



## Controlling Noise Exposure

## Hearing Conservation Programs

The general industry standard also requires a **hearing conservation program** if average sound levels are 85 dBA or above. The program must include:

- Training and information about risks and how to control them;
- Measuring noise levels at work;
- Annual hearing exams;
- Engineering and administrative controls, where feasible;
- Protective equipment; and
- Keeping records.

Even if your work-site is “construction industry,” it’s still a good idea to have a hearing conservation program, including training and annual exams.

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## Measuring Noise

Noise is measured with a **sound level meter** which reads in **decibels**. We use the abbreviation “dBA” for decibels. The “A” means that OSHA requires a certain type of sound level meter, an “A scale” meter. A conversation in a quiet room makes about 60 dBA. A jet engine can create 150 dBA.

Decibels are different than ordinary numbers. According to OSHA, every time the sound level goes up 5 dBA, it’s twice as loud! So, 95 dBA is twice as loud as 90 dBA. 100 dBA is four times as loud as 90 dBA.

If your average daily exposure is 90 dBA or above, OSHA requires hearing protection (plugs or muffs).

[29 CFR 1910.95(b)(1) and 29 CFR 1926.52(b)]



The sound level you experience from a piece of equipment depends on what it is, how well it is maintained, whether it has sound insulation, how close you are, and whether you wear hearing protection.

How the sound level affects you depends on how loud it is and on how long you are exposed. OSHA says that an average of 90 dBA for eight hours is the most you are supposed to receive. This is the same as just four hours at 95 dBA, 2 hours at 100 dBA, 1 hour at 105 dBA, ½ hour at 110 dbA or ¼ hour at 115 dBA.

## Noise Limits

### OSHA PEL for Noise

90 dBA	8 hours
95 dBA	4 hours
100 dBA	2 hours
105 dBA	1 hour
110 dBA	30 minutes
115 dBA	15 minutes
Above 115 dBA	Not allowed

### Typical Sound Levels

170 dBA	Space shuttle takeoff
160 dBA	
150 dBA	Jet engine
140 dBA	Threshold of pain
130 dBA	
120 dBA	Pneumatic chipper
110 dBA	Bulldozer
100 dBA	Diesel truck passing by
90 dBA	Plugs or muffs required
80 dBA	Noisy office
70 dBA	Vacuum cleaner
60 dBA	Conversation
50 dBA	Quiet office
40 dBA	Quiet home
30 dBA	Recording studio
20 dBA	Whisper
10 dBA	Quietest sound a healthy ear can hear

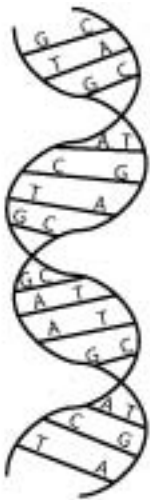
### What's the difference between noise and sound?

It's like the difference between a weed and a flower. Noise is sound that's not wanted. Whether you call it sound or noise depends on your point of view. Whether it can harm your hearing depends on how loud it is and how long you are exposed. Many an aging rock star knows the hearing damage caused by exposure to loud sound.

# Ionizing Radiation



# Health Effects of Ionizing Radiation



**Ionizing radiation** is a form of energy given off by radioactive materials and by certain electronic devices such as X-ray equipment. Exposure to ionizing radiation increases your risk of cancer and reproductive effects.

There are four types of ionizing radiation that radioactive materials might give off, depending on the type of material. The four types of ionizing radiation are called **alpha, beta, gamma and neutron**.

**Gamma radiation** can pass right through many substances, including wood, paper, plastic, glass and sheet metal. It can also pass right into our bodies, like an X-ray. This is the reason there are special packaging, loading and shielding requirements for radioactive materials that give off gamma radiation. Even if you have no contact with the material, the radiation it gives off may be harmful.

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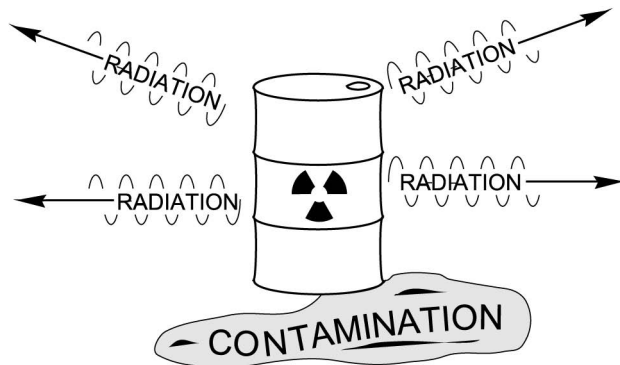
Ionizing radiation has enough energy to directly damage molecules in your cells, to change their structure by “ionizing” them. One of the most important molecules in each cell is called DNA. DNA is responsible for telling the cell how to be the kind of cell it’s supposed to be. If the DNA is damaged, then the cell might not function properly, or might become a cancer cell. This is why ionizing radiation can cause cancer and birth defects.

Just because you’re exposed to ionizing radiation doesn’t mean you’ll get cancer. But your risk of cancer will be increased.

Likewise, if the developing fetus in a mother’s womb is exposed to ionizing radiation, it will not necessarily be injured, but the chance of birth defects is increased, especially in the early weeks of pregnancy.

It is important to understand the difference between radiation, and radioactive contamination.

- **Radiation is a type of energy.**
- **Radioactive contamination is material in an unwanted place.** It gives off radiation.



## Radiation and Contamination

When working around radiation sources, the best practice is to continually try to keep exposures to ionizing radiation “As Low As Reasonably Achievable” (ALARA). This sounds like what we’ve said repeatedly for chemical exposures: keep them as low as possible. The difference is that for ionizing radiation this isn’t just a good idea that you should demand of your employer. In the nuclear industry it’s the accepted practice, and at DOE facilities it’s required by regulation. Under the ALARA principle, the employer must maintain an active program with both management and worker involvement. The program sets goals to minimize exposure, revises operating procedures, conducts training and continually reviews records of actual exposure.

## ALARA

## Non-Ionizing Radiation

**Non-ionizing radiation** is a form of energy including visible light, ultraviolet (UV) radiation, infrared (IR) radiation, microwaves, radar waves, and radio waves. Non-ionizing radiation does not have enough energy to ionize molecules in living cells, but some forms of non-ionizing radiation can still cause health effects.

**Sunlight** has ultra violet (UV) radiation which can cause sunburn and dried skin, and can also cause skin cancer. The best protection from sunlight is to limit direct exposure as much as possible, to wear clothing that covers the skin, and to use sun-blocking cream.

**Arc welding** gives off intense UV radiation. Even a momentary exposure can damage the eyes, causing a painful condition known as welder's flash.

Use appropriate eye protection (safety glasses, goggles, welding helmets, or welding face shields) of the correct strength, and avoid striking the arc with the shield up. Portable UV screens are available to protect bystanders who also should not look at the arc. The UV radiation from the welding arc can burn the skin and cause skin cancer. Welders should keep their hands, arms and neck covered.

**Lasers** produce a very intense, highly focused beam of IR, UV or visible light. Low-power visible light lasers are very common at construction and hazardous waste sites. The narrow, straight beam is used to guide tunneling and trenching equipment, and to check that surfaces are level.

More powerful IR and UV lasers are used in testing operations and in laser cutting.

Avoid looking directly into a laser beam, even after it has reflected off a surface. Unfortunately, you cannot see an IR or UV beam, but they can still severely damage your eyes.

## Vibration

**Vibration** from power tools and vehicles can damage nerves, joints and organs. Vibration can affect the whole body, as when you're seated in a vibrating vehicle cab. It can also affect specific parts of the body like the hands or wrists, as when you use vibrating tools.

Repeated exposure to whole body vibration can cause digestive disturbances, fatigue, loss of appetite, blurred vision, hearing loss, and damage to the kidneys.

Repeated vibration of the hands, especially when cold, can lead to an injury called "Raynaud's phenomenon", or "white finger syndrome". The symptoms include loss of color, numbness and insensitivity to pain or temperature, poor coordination, and sores on the fingertips. Chronic exposure can cause permanent disability.

Use vibrating tools only when there is no other practical method. Use tools that are designed to minimize vibration. Make sure that tools are properly maintained and adjusted. Wear warm gloves when using vibrating equipment in a cold environment. Properly maintain vehicles and cab suspension systems.

## Cold Stress

In a cold environment, the body tries to keep its internal organs warm by restricting the flow of blood to the skin and the extremities (fingers, toes, nose and earlobes) in order to slow down cooling. This is the opposite of the body's reaction to a hot environment.

Less blood flow makes hands and feet numb, causing poor coordination and difficulty using tools or driving.

If the body cannot maintain its internal warmth, then you shiver. This is an attempt to generate heat.

If changes in blood flow and shivering are not sufficient to maintain warmth, your temperature will drop. This is **hypothermia**.

**Hypothermia can be life-threatening.** The environment does not have to be really cold for this to occur. Dampness from sweat or from wet clothing can cool the body rapidly. In fact, most cases of hypothermia occur at temperatures above freezing.

**Frostbite** is the freezing of body tissues. There may be a prickling sensation, but because cold causes numbness, you might experience frostbite without noticing that it's happening. Effects include pain, blisters, nerve damage, or gangrene requiring amputation.

Wind chill and direct contact with frozen objects make frostbite more likely to occur.

## Preventing Cold Stress

**Wear several layers of clothing** that can be adjusted to match outside conditions and the heat generated by your work. Don't dress too warmly. If sweat cannot evaporate, your clothes will become wet and chill your body. A windbreaker as the top layer of clothing can reduce the effects of wind chill.

**Keep your extremities warm.** Wear insulated gloves and boots. Fingers can freeze in a few minutes or less if temperatures are below freezing and there is a strong wind.

**Change out of wet clothing.** If your clothes become sweaty or damp, or get soaked with water, or if you experience numbness or pain, seek warm shelter where you can change your clothes, dry off and warm up.

**Alcohol does not warm the body**, although some people may think it does. Alcohol interferes with the body's ability to regulate its temperature and it causes increased urine production which cools the body more.

## Ergonomic Hazards

**Ergonomic hazards** can cause injuries to muscles, tendons, ligaments, joints, cartilage, and nerves. These injuries most often involve the back, shoulders, neck, legs, arms, wrists and hands.

There are many different names and conditions relating to ergonomic injuries:

- Musculoskeletal disorder (MSD).
- Repetitive strain injury (RSI).
- Cumulative trauma disorder.
- Carpal tunnel syndrome.
- Lower back pain.
- Disc injury.
- Tendinitis.
- Sciatica.

These are painful and often disabling conditions that often develop over a long period of time. **They are very difficult to cure, so prevention is always important.**

MSDs can cause pain, numbness, tingling, stiff joints, difficulty moving, muscle loss, and paralysis. This can result in lost time or even the inability to work at all.

You might have a musculoskeletal disorder if you have any of these symptoms:

- Numbness in your fingers.
- Numbness in your thighs.
- Stiff joints.
- Back pain.



**Lifting** is one of the most common ergonomic hazards. Improper lifting can cause serious back injury.

Construction workers and hazardous waste workers move materials. They put drums in overpacks, move materials and equipment, load and unload trucks. These activities often require lifting heavy objects by hand. If not done correctly, lifting can injure your back.

**Proper Lifting Technique.** To prevent painful, possibly permanent injury, use the proper technique.

- Don't overestimate your strength: if it's too bulky or too heavy, get assistance.
- Keep the back straight and lift with the legs.
- Lift slowly and carefully.
- Keep the load as close to your body as possible.
- Don't turn or twist while you are lifting.
- Be just as careful putting the load down.

Lifting puts a tremendous strain on the muscles and discs in the lower back. Even a worker using proper technique has a force of several hundred pounds on the lower back.

If the load is too heavy, or if the worker reaches out too far, or twists while lifting, the force can be many times greater, even if the weight of the object is not very great.

The job should be planned to minimize the amount of manual lifting. There should be enough workers to lift safely. Use drum grapplers, forklifts and boom trucks, whenever possible.

## Ergonomic Hazards



**Correct**



**Wrong!**



## Ergonomic Hazards

**Ergonomics** means designing jobs to fit the worker, rather than forcing the worker's body to fit the job.

Ergonomics means adapting job tasks, work stations, tools, vehicles and equipment to fit the worker in order to reduce physical stress on the worker's body and to eliminate potentially serious, disabling injuries like musculoskeletal disorders (MSD).

Examples of ergonomic solutions include fully adjustable driver's seats, preventive maintenance to reduce vibration, and good job planning to minimize manual lifting.

**Back belts.** Do back supports work? NIOSH studied workers who do lifting. They found that workers wearing supports are just as likely to be injured as those who don't use them.

Makers of back supports, and also some scientists and workers, disagree with NIOSH. Many people believe supports help because they remind you to use proper technique. One thing is certain: a back support won't make you stronger. Don't assume that you can lift more just because you have one.

## **Review Questions for Chapter 3**

1. Give four examples of health effects or diseases caused by occupational exposure to chemicals.

2. Define each of the following:

Cancer:

Acute effect:

Chronic effect:

Latency period:

Target organ:

Local effect:

Systemic effect:

**Review  
Questions for  
Chapter 3**

3. List five ways chemicals get into or on your body.

4. Give two examples of chronic health effects.

5. Give two examples of acute health effects.

6. Define each of these terms:

OSHA:

NIOSH:

ACGIH:

**Review  
Questions for  
Chapter 3**

7. Define each of these terms:

PPM:

PEL:

TLV:

REL:

STEL:

Solid:

Liquid:

Gas:

Vapor:

Particulate:

Fume:

Mist:

## **Review Questions for Chapter 3**

8. List four circumstances that might make an exposure limit invalid.
9. Give six warning signs that indicate possible chemical exposure.
10. Identify four types of adverse health effects caused by heat stress.



## Chapter

# 4



# Medical Surveillance

## Learning objectives

This chapter discusses the medical examinations that you are required to have if you work at a hazardous waste site.

After completing this chapter, you will be able to demonstrate your ability to:

1. EXPLAIN the purpose of medical surveillance.
2. IDENTIFY the four types of workers covered by the HAZWOPER medical surveillance requirements.
3. IDENTIFY when medical exams are required.
4. DESCRIBE the four main parts of an occupational medical exam.



**Medical surveillance** means keeping track of workers' health by providing occupational medical exams and maintaining medical records.

The OSHA HAZWOPER Standard requires the employer or contractor at a hazardous waste site to establish a medical surveillance program for workers who may be exposed to hazardous substances, or who wear respirators for thirty days or more during a year.

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The following four types of workers must be included in a medical surveillance program:

- Workers who might be exposed to hazardous substances at or above the PEL for thirty (30) or more days a year.
- Workers who wear a respirator on thirty (30) or more days a year.
- Workers who are members of a HAZMAT emergency response team.
- Workers who are injured due to overexposure from an emergency incident involving hazardous substances or other health hazards.

OSHA assumes that these four categories of workers are the most likely to be affected by hazardous substances, and that they are the ones whose health should be kept track of. [29 CFR 1910.120(f)(2) and 1926.65(f)(2)]

## Medical Surveillance

29 CFR 1910.120(e) 2)(vi)

### Who is Covered?

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The first three categories are workers who are exposed to hazardous substances as an expected part of their job.

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The fourth category is workers who are exposed because something happened which was not supposed to be part of their job.

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## When Do You Need a Medical Exam?

If you are a member of one of the first three categories listed on the previous page – that is, if the possibility of exposure to hazardous substances is an expected part of your job – then you must receive occupational medical exams as follows:

[29 CFR 1910.120(f)(3)(i) and 1926.65(f)(3)(i)]

- Prior to employment.
- Once a year after you start working.
- When you cease employment as one of the first three categories of worker covered by medical surveillance.
- As soon as possible after you develop signs or symptoms of overexposure to hazardous substances, or after you have been injured or exposed to a hazardous substance above the PEL in an emergency situation.

If you are a member of the fourth category listed on the previous page – that is, if you are injured by overexposure to hazardous substances in an emergency situation which is not an expected part of your job – then you must receive occupational medical exams as follows:

[29 CFR 1910.120(f)(3)(ii) and 1926.65(f)(3)(ii)]

- As soon as possible after the incident where you were overexposed.
- At additional times if the examining physician determines that follow-up exams are necessary.

There are two main reasons for medical surveillance:

- To assess your health and fitness for work, including whether you can wear a respirator.
- To detect early warning signs and symptoms of occupational disease and overexposure.

Medical surveillance also provides information for:

- Studies of the effects of workplace exposures.
- Evaluation of the effectiveness of control measures to prevent or limit exposures.
- Insurance claims and litigation.

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Medical exams must be performed by a licensed physician. The HAZWOPER Standard says, “preferably one knowledgeable in occupational medicine.”

Ideally, it should be a physician who is Board Certified in Occupational Medicine. This is a doctor who has special training and experience in occupational medicine, and has passed a rigorous examination to verify his or her qualifications in occupational medicine. Unfortunately, most physicians receive very limited training in occupational medicine.

You want a doctor who knows how exposure to chemicals or to physical agents at work can affect your health; who knows what signs and symptoms are work-related; who knows what questions to ask and what tests to perform; and who knows how to treat occupational diseases and injuries.

## **The Purpose of Medical Surveillance**

## **What Doctor Do You See?**

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**Most doctors have little or no specialized training in occupational medicine.**

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**You want to see a doctor who is Board-Certified in Occupational Medicine.**

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## Who Pays for the Exam?

Your employer pays for medical exams required by HAZWOPER. They must be at a reasonable time and place without loss of pay. [29 CFR 1910.120(f)(5) and 1926.65(f)(5)]

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## Who Sees the Results of the Exam?

Your employer receives a written opinion limited to medical conditions related to your work:

- Whether or not you have a medical condition that would place you at risk of health problems if you work with hazardous substances.
- Whether or not you are able to wear a respirator without incurring a risk to your health.
- Whether or not the physician recommends any limitations on your work or respirator use.

The written opinion also includes a statement that you have been informed of the results and told of conditions that may require further examination or treatment.

Both the opinion given to the employer, and the result given to you, must be provided in a timely manner.

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**You must get the results in a timely manner.**

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Your exam results are confidential. The employer only gets an opinion as to the three items listed above. The physician may not provide the specific results, nor any findings unrelated to occupational exposure unless you give permission. [29 CFR 1910.120(f)(6) and 1926.65(f)(6)]

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**You have a right to confidentiality.**

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A recommendation that prevents or restricts your eligibility to work must be based on the clearly stated written criteria in the Medical Surveillance Program.

Keep a copy of the exam results. You may need it to show to another doctor, or for a compensation case.

The medical exams required by HAZWOPER have to do with figuring out whether you can work with hazardous substances, whether or not you can wear a respirator, and whether or not you have been injured or made ill by your work. This is why we refer to the exam as an occupational medical exam.

An occupational medical exam includes four parts:

- **Work history.**
- **Medical history.**
- **Physical examination.**
- **Laboratory tests.**

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An occupational physician knows what kinds of questions to ask in order to understand how your work in the past, your current job, and your possible future job assignments might affect your health. The physician asks you questions to determine your work history:

- Previous employers and job duties.
- Work locations.
- Types of workplace exposures, including both chemicals and physical agents.
- Military service.
- Work-related injuries and illnesses.
- Use of personal protective equipment.
- Exposures from hobbies or work around the house.
- Exposures of other family members that might affect you.

## **Occupational Medical Exam**

### **Work History**

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**Remember that this specific information does not go to your employer without your permission. Your employer only gets the doctor's opinion as to whether you are fit to work.**

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## Medical History

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**Remember that this specific information does not go to your employer without your permission. Your employer only gets the doctor's opinion as to whether you are fit to work.**

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The occupational physician also asks you questions to determine your medical history:

- All medical problems, diseases and injuries you have had. Special attention should be given to asthma, lung disease, heart disease, liver and kidney problems, stress, allergies and skin conditions.
- Medical treatment, operations, physical therapy and prescribed drugs you have taken or are currently taking.
- Family medical history, including diseases which your parents, brothers and sisters or other close relatives have had.
- Personal habits (smoking, drinking, exercise, etc.).

## Physical Exam

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**Remember that this specific information does not go to your employer without your permission. Your employer only gets the doctor's opinion as to whether you are fit to work.**

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This is where the doctor examines your body. The physical exam is similar to others that you have probably received. It should be thorough and include your:

- General appearance and fitness.
- Vital signs (heart rate, weight, temperature, etc.).
- All parts of your body, including skin conditions.
- Muscle and skeletal condition.
- Eyes.
- Ears. Audiometric testing may be required if you work in a noisy environment, or have had hearing problems or noise exposure in the past.

Laboratory tests are part of the medical exam. The tests:

- Establish base-line information to compare to the results of tests conducted in the future. This will help the physician determine whether a condition is getting better or worse.
- Find medical conditions that cannot be diagnosed from the physical exam alone.
- Measure the levels of work-related chemicals or their metabolites in your body.

Some of the most common laboratory tests include:

- Lung function test.
- EKG.
- Chest X-ray.
- Urinalysis and blood tests.

---

Medical surveillance is not perfect. You should be aware of its limitations so that you do not have a false sense of security:

- Routine, medical examinations do not guarantee that you will not become ill in the future.
- Many diseases do not have tests for early diagnosis.
- Tests sometimes give false results.
- The doctor must know what possible exposures the worker faced. This means that the employer must provide good exposure assessment, chemical inventories, and record keeping.

## Laboratory Tests

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**Remember that the specific results don't go to your employer without your permission. Your employer only gets the doctor's opinion as to whether you are fit to work.**

---

## Limitations of Medical Monitoring

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**Even the best medical surveillance will not make up for an unsafe or unhealthy workplace. Prevention of unsafe and unhealthy conditions is still the primary way to assure workers' safety and health.**

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## **Make it work for you**

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**For help in  
understanding medical  
surveillance, contact the  
Teamsters Safety and  
Health Department**

---

You and your union representatives can take steps to make sure that the medical surveillance program works for you.

- Read the specifics of the medical surveillance program in the Site Safety and Health Plan. See if it complies with the HAZWOPER requirements.
- Learn the meaning of the medical words that are used to describe the program.
- Use the Site Safety and Health Plan to find out what exposures are possible at the site.
- Obtain all the information you can about exposures using your rights under OSHA.
- Ask about the qualifications of the physician who administers the occupational medical exams. What is the doctor's training? Is the doctor Board-Certified in Occupational Medicine?
- Keep a personal written log of all exposures at work. What chemicals do you handle? What physical agents are present? What symptoms do you experience?



## **Review Questions for Chapter 4**

1. What are the four types of workers for whom a medical surveillance program is required?
2. What are the four main parts of an occupational medical exam?
3. What are two main reasons for medical surveillance?
4. When are you required to have a medical exam?

## Chapter

# 5

SDS	
Acme Special Solvent	
Section I Manufacturer Information	
ABC Chemical Products, Inc. 2 Canary St., Anywhere, MA 12345 Emergency Phone: 1 800 555-1234 Date Prepared: April 10, 2005	
Section II Hazardous Ingredients	
Acetone	20% PEL 750 ppm
Ethylene Glycol	2% PEL 50ppm C
Methyl Ethyl Ketone	3% PEL 200ppm
Xylene	6% PEL 100ppm
Section III Physical Characteristics	
Bolling Point:	125 °F
Flash Point:	5 °F
Vapor Pressure	135 mmHg

# Hazard Communication

## Learning objectives

This chapter discusses the OSHA Hazard Communication Standard, which provides workers with information about hazardous chemicals.

After completing this chapter, you will be able to demonstrate your ability to:

1. IDENTIFY the five major requirements of the OSHA HAZCOM Standard.
2. IDENTIFY the kinds of information about a chemical that you can find on its SDS.
3. LIST six types of information which must be on a chemical label.
4. IDENTIFY the sections of the Emergency Response Guidebook
5. IDENTIFY the four types of information provided by a National Fire Protection Association (NFPA) label.

The **OSHA Hazard Communication Standard (HAZCOM)** requires employers to have:

1. **Written HAZCOM program** to inform workers of chemical hazards.
2. **Safety Data Sheet (SDS)** for each hazardous chemical in the workplace, and make these SDSs available to workers on all shifts.
3. **Labels** on all containers of hazardous chemicals.
4. **List of hazardous chemicals** in the workplace, and make this list available to workers.
5. **Training** for workers about:
  - The Hazard Communication Standard.
  - The employer's HAZCOM program.
  - The operations or locations in the workplace where hazardous chemicals are present.
  - What hazardous chemicals are present.
  - How to use SDSs.
  - How to interpret chemical labels.
  - How to detect the presence of chemicals.
  - The physical, health, simple asphyxiation, combustible dust and pyrophoric gas hazards as well as hazards not otherwise classified of the chemicals in the work area.
  - Safe work practices, protective equipment and emergency procedures for the chemicals.

**The OSHA  
HAZCOM  
Standard**

[29 CFR 1910.1200 and 1926.59]

---

The chemical inventory list should reference chemicals by using the name found on the container label and the name listed on the SDS

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Training on HAZCOM must be provided at the beginning of each new assignment involving hazardous chemicals or whenever a new physical or health hazard is introduced.

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# Chemical Labels

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See the next page for the OSHA Pictograms

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A Chemical Abstract Service (CAS) Number is a unique number assigned to every chemical, regardless of its name. This is helpful because many chemicals have more than one name.

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There is an exception: If the secondary container is only used by one worker for only one shift, then it doesn't have to be labeled.

---

Labels on chemical containers must include:

1. Product identifier
2. Signal word
3. Hazard statement
4. Pictograms
5. Precautionary statement
6. Name, address and telephone number of the chemical manufacturer, importer, distributor, or other responsible party.

The label may include a CAS number, which is a unique "social security" number for each chemical. This is helpful because most chemicals have more than one name. If you look in another information source you can be sure that you are getting information about the right chemical if you verify the CAS number.

The label might also include a UN/NA identification number, which is the DOT number for the chemical, or for the group of chemicals it belongs to.

If you transfer a chemical to a secondary container, HAZCOM requires the secondary container to be labeled also. For example, if you fill a one-quart can and take it to the repair shop, this secondary container also needs a label.

# HAZCOM Pictograms

Health Hazard



- Carcinogen
- Respiratory Sensitizer
- Reproductive Toxicity
- Target Organ Toxicity
- Mutagenicity
- Aspiration Toxicity

Flame



- Flammables
- Self-Reactives
- Pyrophorics
- Self-Heating
- Emits Flammable Gas
- Organic Peroxides

Exclamation Mark



- Irritant
- Dermal Sensitizer
- Acute Toxicity (harmful)
- Narcotic Effects
- Respiratory Tract Irritation
- Hazardous to Ozone Layer (Non-Mandatory)

Gas Cylinder



- Gases Under Pressure

Corrosion



- Skin Corrosion/Burns
- Eye Damage
- Corrosive to Metals

Exploding Bomb



- Explosives
- Self-Reactives
- Organic Peroxides

Flame Over Circle



- Oxidizers

Environment  
(Non-Mandatory)



- Aquatic Toxicity

Skull and Crossbones



- Acute Toxicity (Fatal or Toxic)

# Safety Data Sheet (SDS)

---

**SDSs must be:**

- available to all workers
  - available on all shifts
  - available in each work area
  - printed in English
- 

Your employer is required to have a **Safety Data Sheet (SDS)** for every hazardous chemical used in the workplace.

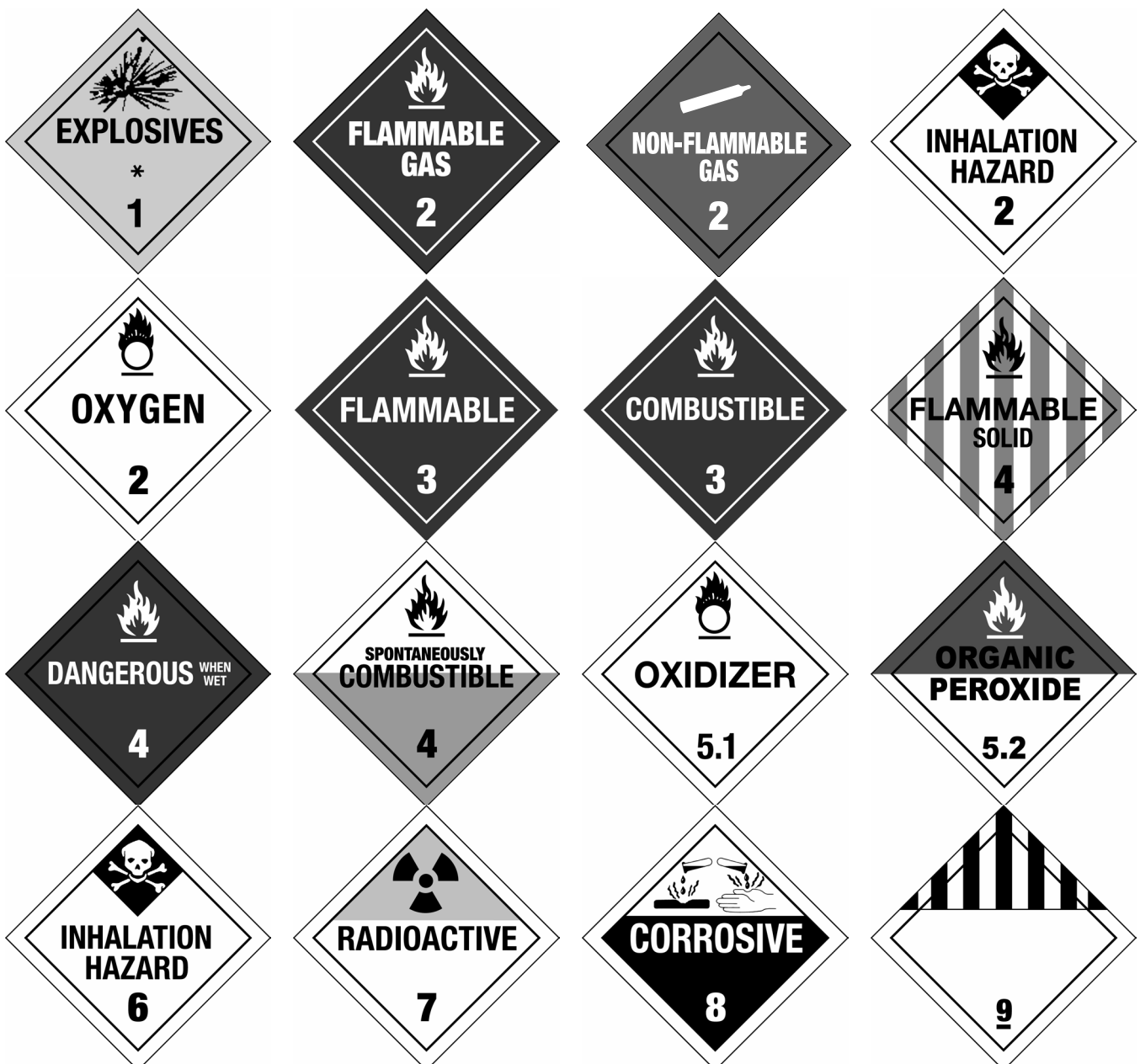
The SDS must provide the following information in the order listed below:

1. Identification;
2. Hazard identification;
3. Composition/information on ingredients;
4. First-aid measures;
5. Fire-fighting measures;
6. Accidental release measures;
7. Handling and storage;
8. Exposure controls/personal protection;
9. Physical and chemical properties;
10. Stability and reactivity;
11. Toxicological information;
12. Ecological information;
13. Disposal considerations;
14. Transport information;
15. Regulatory information; and
16. Other information including date and preparation or last revision.

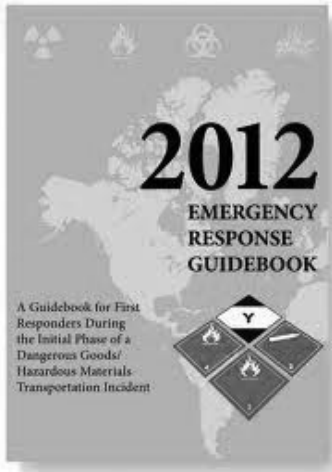
The US Department of Transportation (DOT) has requirements for placards, labels and markings on hazardous materials in transportation. These can help you identify the chemical hazards in your workplace.

Placards are attached to the outside of a vehicle, bulk container, or rail car. They are diamond-shaped, and include the class/division number, name and symbol.

## DOT Placards, Labels and Markings



# Emergency Response Guidebook



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The ERG is intended to assist emergency responders during the first half-hour of their response. After that, it is assumed that more complete information, such as expert consultation and computer databases will be available.

---

The DOT Emergency Response Guidebook (ERG) provides information to **identify hazardous materials (hazmat) and make decisions about response and evacuation during the initial response to a hazmat incident.**

The ERG contains **guides**, which are two-page descriptions of how to respond. Each guide is for a different set of circumstances. The guides are the “guts” of the book.

The ERG has six color-coded sections:

**White: (front)** The white section at the front of the book has pictures of all the different placards, and pictures of different kinds of vehicles.

The purpose of the white section is to help you find the right guide if you only know the placard or the type of vehicle.

**Yellow:** The yellow section is a list of all of the UN/NA identification numbers. For each number it tells the name of the hazmat and also tells which guide to use.

The purpose of the yellow section is to help you identify the hazmat and find the right guide to use – if you know the UN/NA identification number.

**Blue:** The blue section is a list of the names of different hazmats. For each name it tells the UN/NA identification number and also tells which guide to use.

The purpose of the blue section is to help you identify the hazmat and find the right guide to use – if you know the name.



## Emergency Response Guidebook

**Orange:** The orange section contains the guides. Each guide gives information about:

- Health hazards.
- Fire hazards.
- Protective clothing.
- Evacuation.
- Fire response.
- Spill response.
- First aid.

**Green:** The green section contains more detailed information about isolation and protective distances for certain hazmat.

The green section also has a list of hazmat that produce toxic gases if they react with water. This is important information that firefighters need before they use water to suppress a fire or to dilute a spill.

**White:  
(back)** The white section at the back of the book contains a glossary of words used to describe hazmat and emergency response.

This white section also has information about protective clothing, fire and spill control, and indications of a chemical, biological, or radiological incident.

You should be familiar with the ERG – and practice using it – so that you can quickly get information if you are involved in a hazmat incident.

Keep the ERG with you when you transport hazmat.

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If the name and UN/NA number of the hazmat was highlighted in the yellow and blue sections, then there is more information about that hazmat in the green section.

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Both the front and back white sections contain a list of emergency phone numbers

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# NFPA Hazard Identification System

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The NFPA Hazard Identification System is intended to provide information to fire fighters during an emergency.

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The higher the number, the greater the hazard. "4" is the most extreme hazard.

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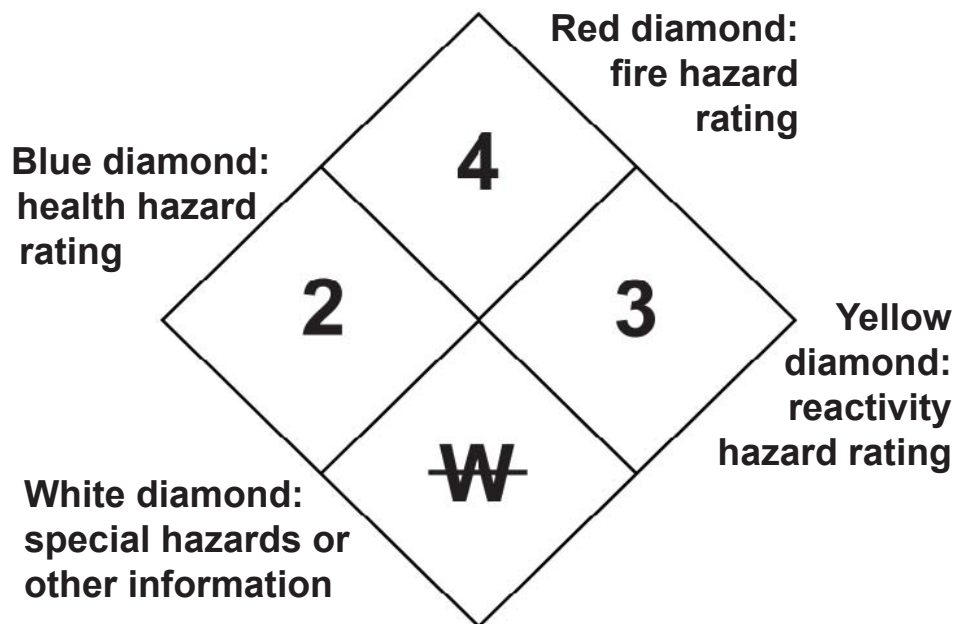
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The NFPA label does not identify the chemical, the specific health effects, or the manufacturer.

---

The NFPA Hazard Identification System is intended to provide information to firefighters in an emergency. You will find the diamond-shaped NFPA labels on containers, storage tanks, doors and walls.

Numbers from 0 to 4 in the three top diamonds indicate how dangerous the material is in terms of fire hazard, health hazard and chemical reactivity. "0" means no hazard. "4" means the most severe hazard. The bottom diamond is for special information, such as "radioactive", or "water reactive".



In the example, the health hazard rating of "2" indicates an extreme acute health hazard. The fire rating of "4" means extremely flammable. The reactivity rating of "3" means that the material may explode. The "W" with a line through it indicates that the material reacts dangerously with water, so don't use water to fight a fire here. The complete definitions of the hazard ratings are found on the next page.

The NFPA label does not identify the chemical. It does not give specific health effects. It also does not identify the manufacturer. These are all things which OSHA requires on product labels.

## NFPA Hazard Identification System

Health Hazard Color Code: Blue	Flammability Color Code: Red	Reactivity (Stability) Color Code: Yellow
<p><b>4</b> Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment was given.</p>	<p><b>4</b> Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.</p>	<p><b>4</b> Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.</p>
<p><b>3</b> Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment was given.</p>	<p><b>3</b> Liquids and solids that can be ignited under almost all ambient temperature conditions.</p>	<p><b>3</b> Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation, or which react explosively with water.</p>
<p><b>2</b> Materials which on exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.</p>	<p><b>2</b> Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.</p>	<p><b>2</b> Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form explosive mixtures with water.</p>
<p><b>1</b> Materials which on exposure would cause irritation but only minor injury if no treatment is given.</p>	<p><b>1</b> Materials that must be pre-heated before ignition can occur.</p>	<p><b>1</b> Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.</p>
<p><b>0</b> Materials which on exposure would offer no hazard beyond that of ordinary combustible material.</p>	<p><b>0</b> Materials that will not burn.</p>	<p><b>0</b> Materials which in themselves are normally stable, even under fire exposure conditions and which are not reactive with water.</p>

# NIOSH Pocket Guide

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“Carcinogen” means something that causes cancer.

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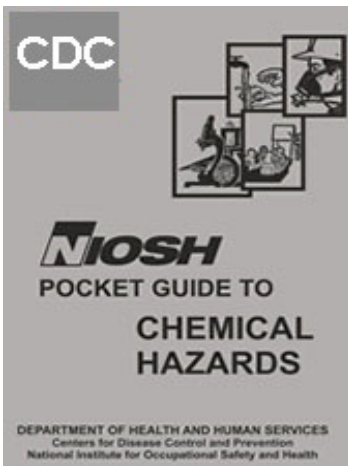
The **NIOSH Pocket Guide to Chemical Hazards** describes more than 600 chemicals. These are all the chemicals for which OSHA has a Permissible Exposure Limit (PEL), plus some others for which NIOSH has recommended a standard.

In order to pack a lot of information into one book, the NIOSH Pocket Guide uses many abbreviations. These are all explained in the front part of the book.

The Guide gives an **Immediately Dangerous to Life or Health (IDLH)** level for many chemicals. This is the **airborne concentration that “is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such environment.”**

If the chemical is a **carcinogen**, you will find “**Ca**” written in the IDLH column. NIOSH believes that any exposure to a carcinogen increases your risk of cancer, which is a permanent adverse effect. Therefore, no other IDLH value is listed for carcinogens.

If you can’t find the chemical you’re looking for, look in the “Synonym and Trade Name Index”, the “CAS Number Index”, or the “DOT ID Number Index” at the back of the book. These indexes give the page on which the chemical is listed.



The **IBT Safety and Health Department** has many Fact Sheets about hazardous materials and other safety and health hazards. To obtain copies, go to the Teamsters internet site [www.teamster.org](http://www.teamster.org) and click on "Members" and then "Safety and Health." You can also call the IBT Safety and Health Department between the hours of 9:00 AM and 5:00 PM (EST) at **(202) 624-6960**.

There are hundreds of internet sites with health and safety information. Here are just a few sites to help you get started. All have links to other useful sites.

- **U.S. Occupational Safety and Health Administration (OSHA):**  
[www.osha.gov](http://www.osha.gov)
- **U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration:**  
[www.phmsa.dot.gov/hazmat](http://www.phmsa.dot.gov/hazmat)
- **National Institute for Occupational Safety and Health (NIOSH):**  
[www.cdc.gov/niosh](http://www.cdc.gov/niosh)
- **New Jersey Department of Health:**  
[www.state.nj.us/health/eoh/rtkweb](http://www.state.nj.us/health/eoh/rtkweb)

**For More  
Information  
about Health  
and Safety  
Hazards**

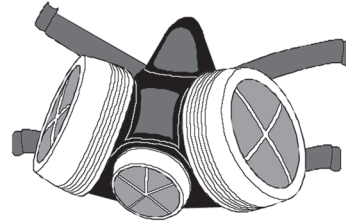
## **Review Questions for Chapter 5**

1. List the five requirements of the OSHA Hazard Communication Standard (HAZCOM).
2. List the information that must be included on a Safety Data Sheet (SDS).

## **Review Questions for Chapter 5**

3. List six types of information that must be on the label of a chemical container.
  
  
  
  
  
  
  
  
  
  
4. True or false:
  - a. An NFPA label has four parts.
  - b. An NFPA label identifies the chemical.
  - c. An SDS must say if the chemical is a carcinogen.
  - d. Only supervisors are required by law to be able to look at an SDS during working hours.
  - e. SDS's usually don't tell the routes of entry.
  - f. Each CAS number is unique (each chemical has a different CAS number).
  - g. It is possible for more than one chemical to have the same UN/NA number.
  
5. What are the four types of information provided by a National Fire Protection Association (NFPA) label.

# Chapter 6



## Air-Purifying Respirators

### Learning objectives

This chapter discusses the respirators that workers use at hazardous waste sites, and focuses on one type: Air-Purifying Respirators (APRs).

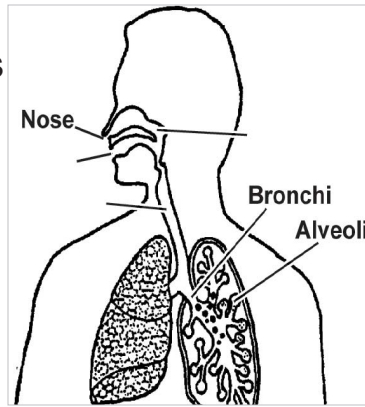
After completing this chapter, you will be able to demonstrate your ability to:

1. DESCRIBE three categories of airborne hazards.
2. DESCRIBE two basic types of respirators.
3. SELECT the proper definition or example for:
  - a. APR
  - b. PAPR
  - c. HEPA
4. DESCRIBE the difference between a qualitative and a quantitative fit test.
5. DESCRIBE the factors to consider in choosing the correct respirator.
6. IDENTIFY six situations in which it is unsafe to wear an Air-Purifying Respirator.



## Protecting Your Respiratory System

The respiratory system includes the **lungs**, and also the passages through which air gets to the lungs. This means the **nose, mouth, pharynx, windpipe, bronchi**, and the millions of **tiny air sacks (alveoli)**. The alveoli are where the lungs absorb oxygen and give off carbon dioxide.



Workers wear respirators for these reasons:

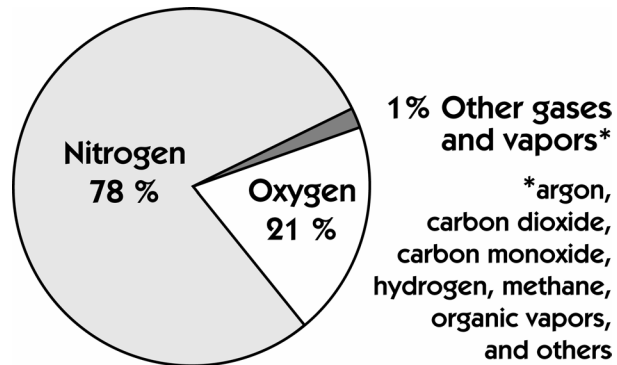
1. **For protection from air contaminants.**
  - **To prevent injury to the respiratory system (local effects).**
  - **To prevent the entry of chemicals that affect other parts of the body after being absorbed in the lungs (systemic effects).**
2. **To provide breathing air in oxygen-deficient atmospheres.**

An example of a local effect caused by inhaling an air contaminant is the irritation and burning sensation when you inhale acid mist.

An example of a systemic effect caused by inhaling an air contaminant is the dizziness or unconsciousness caused by inhaling solvent vapors. The chemical is absorbed in the lungs, but it travels through the system and affects the brain and nerves.

# The Air We Breathe

The air we breathe is a mixture of gases. It contains 21% oxygen and 78% nitrogen. The other 1% includes several other gases and vapors.



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The normal amount of oxygen in the air is 21%.

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We need about 21% oxygen to function normally. Our bodies pretty much ignore all the nitrogen.

Some of the other gases and vapors in the air, for example carbon monoxide, are harmful to our health.

There are also lots of particulates (very small solid or liquid particles) floating in the air. These include dusts, powders, mists, pollen, etc. Many are harmful to our health.

The harmful gases, vapors and particulates in the air are called air contaminants.

## Air Contaminants

For something to be an air contaminant, it must be **small enough to stay in the air** and **small enough to be inhaled**. There are two ways that this can happen: It can be in the form of a gas or vapor, or it can be a particulate.

If you toss a piece of chalk up in the air, it will fall down. It's too big to float, and too big to inhale. A piece of chalk is not an air contaminant. But if you shake chalk dust into the air, it will float for a while, and you can breathe it in. The chalk dust is an air contaminant. It's a particulate, floating in the air.

When a gas escapes from a cylinder, or when a liquid evaporates and forms a vapor, individual molecules of the chemical become part of the air. If they are in the air, you will inhale them.

All air contaminants fit in one of these two categories:

1. **Gases and Vapors.** These are individual molecules that become part of the air itself.
2. **Particulates.** These are tiny pieces that float in the air. Solid particulates: dust, fibers and fumes. Liquid particulates: mist and spray.

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**Gases and vapors** behave the same way in the air.

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**"Fume"** means a tiny particulate from a hot process, like welding. **"Fume"** is **NOT** another word for vapor.

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# Oxygen Deficiency

After a fire, or in a confined space, the amount of oxygen in the air may be too little for your body to function safely. This is called **oxygen deficiency**.

Our bodies expect to breathe air that contains about 21% oxygen. Less than 19½% is dangerous.

Too much oxygen is also dangerous – because things burn much more easily when there is extra oxygen.

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19½ % oxygen is the lowest level OSHA allows.

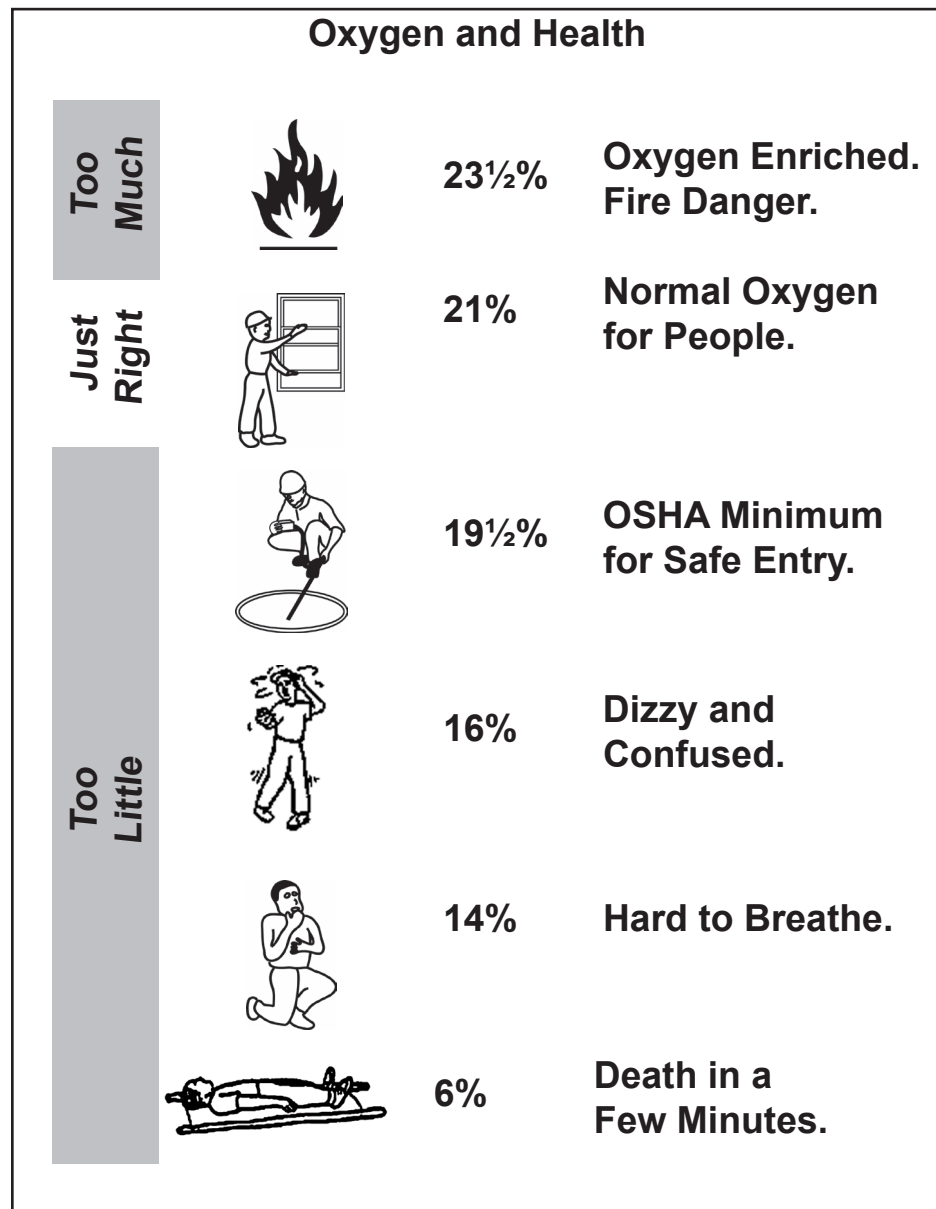
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Below 19½ % you must have a respirator that supplies breathing air.

---



There are three hazardous conditions in the air that require workers to use respirators:

1. **Gas and vapor contaminants.** These are individual molecules that become part of the air itself.
2. **Particulate contaminants.** These are tiny pieces that float in the air. Solid particulates: dust, fiber and fume. Liquid particulates: mist and spray.
3. **Oxygen deficiency.** Too little oxygen can cause serious adverse effects, including death. The lowest level you are allowed to breathe is 19½%.

You will often encounter a combination of all three conditions.

---

It is important that you understand that:

- Respirators are serious equipment. It is dangerous to wear a respirator without proper training.
- There are different kinds of respirators.
- Each kind of respirator is only good for certain conditions.
- **If you use the wrong respirator, the results could be fatal.**

## **When Do You Need a Respirator?**

## **Respirators For Hazardous Waste Workers**

## Types of Respirators

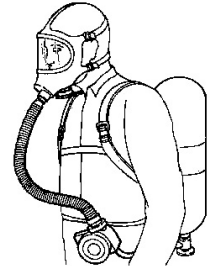
There are two basic types of respirators:

1. **Air-Purifying Respirators (APRs).**

You breathe the dirty air around you. The respirator has filters or cartridges that try to clean the air before you inhale it. APRs do not supply oxygen.



2. **Atmosphere-supplying respirators.** These have a separate, clean air supply from a cylinder on your back (SCBA), or an air-line.



In an oxygen-deficient atmosphere you must have an atmosphere-supplying respirator.

## Air-Purifying Respirators (APRs)

With an **air-purifying respirator** or **APR**, the air you breathe is the air around you. It starts out contaminated, and you depend on the filters or cartridges to catch the contaminants before you inhale them.

As you inhale, the air pressure inside the APR goes down. We call this **negative pressure** because it's lower than the air pressure around you. Air always moves from higher to lower pressure. When you inhale, the atmosphere around you pushes air into the respirator.

If the respirator doesn't fit your face almost perfectly, some dirty air will get in around the edge of the respirator, skipping the filters or cartridges.

**There are many chemicals for which there is no filter or cartridge that works.**

**Air-purifying respirators do not supply oxygen.**

Here are the kinds of APRs that hazardous waste workers use:

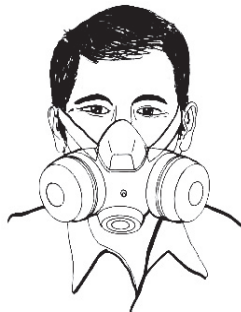
- **Full-face APR.**

The facepiece covers the chin, mouth, nose and eyes. There are dual filters or cartridges.



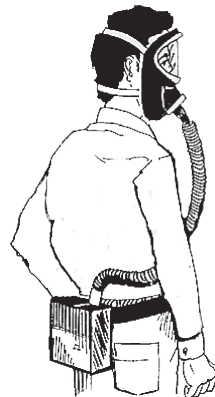
- **Half-face APR.**

The facepiece covers the chin, mouth and nose, but not the eyes. These use the same dual filters and cartridges as the full-face APR



- **Powered Air-Purifying Respirator (PAPR).**

This has a fan that blows air through the filters or cartridges. The PAPR has a full facepiece (chin, mouth, nose and eyes.) There are conflicting claims about whether a PAPR provides more protection than a regular full-face APR.



## Air-Purifying Respirators for Hazardous Waste Workers

# NIOSH Approval

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TC means:  
Tested & Certified.

---

## Some APRs Are Not For Hazardous Waste Work

NIOSH has standards for approving respirators.

- Never use a respirator or cartridge unless it, or its package, has the NIOSH Tested and Certified (TC) number and the NIOSH symbol.
- Never try to use filters, valves or parts from one make of respirator on another make.

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There are other APRs that might be used in normal industrial or hospital settings where concentrations of air contaminants are known and controlled. These APRs are not appropriate for hazardous waste work.

- **Dust mask or surgical-style mask.**

The material the mask is made of acts as the filter. Some have an exhalation valve to help prevent the mask from soaking up moisture from your breath. **Do not use any dust or surgical-style mask for hazardous waste clean-up work.**



If you use a dust mask for other work, make sure that it is the kind that has two straps. Never use the kind that has only one rubber band; it won't seal very well against your face.

- **Quarter-face APR.**

The facepiece only covers the mouth and nose. This type often leaks around the edge. **Never use a quarter-face APR for hazardous waste clean-up work.**





## Filters and Cartridges for APRs

Air-purifying respirators use either filters, or chemical cartridges, or both:

- **Filters for particulates.**

Particulates are small solid or liquid pieces floating in the air. A filter traps these particulates.

Gases and vapors are individual molecules. They are so small that they easily pass through even the finest filter. **Filters do not trap gases and vapors.**

- **Chemical Cartridges for gases and vapors.**

A chemical cartridge is filled with grains of **activated charcoal**. As the individual molecules of a gas or vapor pass through the cartridge, they bump into the charcoal and stick to the surface. This is called **adsorption**.

However, particulates easily go through chemical cartridges – they don't stick to charcoal.

**Chemical cartridges do not protect against particulates.**

One of the most common mistakes that people make with respirators is to not understand the difference between a filter and a chemical cartridge. If you are exposed to particulates, use a filter. If you are exposed to gases or vapors, use a chemical cartridge.

If you are exposed to particulates and gases/vapors at the same time, then you need to use a **combination filter-chemical cartridge**.

## Filter for APRs

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Use a filter if there are particulates in the air.

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Filters do not work for gases and vapors.

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“P 100” is the best filter you can get. It is also called “HEPA.”

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The “100” filter is actually only 99.97% efficient.

---

**Filters are for particulates.** There are filters that are supposed to catch 95%, 99% and 99.97% of the particulates. That last number is almost 100%, but not quite. These filters are called “95”, “99” and “100.”

If there is oil mist in the air (like the spray from lubricants in a machine shop), this can damage the filter and make it not work. The best filters are oil-proof – they work even if there is oil in the air.

<b>Particulate Filters for APRs</b>			
	<b>95% Effective</b>	<b>99% Effective</b>	<b>99.97% Effective</b>
<b>Not resistant to oil</b>	<b>N 95</b>	<b>N 99</b>	<b>N 100</b>
<b>Resistant to oil</b>	<b>R 95</b>	<b>R 99</b>	<b>R 100</b>
<b>Oil proof</b>	<b>P 95</b>	<b>P 99</b>	<b>P 100</b>

The smaller the particulates are, the more difficult it is to trap them, so the filter has to be very fine. The best available filter is called a **HEPA filter**. This stands for **High Efficiency Particulate Air** filter. The “100” filters are HEPA filters.



How well a filter traps particulates depends on how small the particulates are, and how fine the filter is. It does not depend on what the particulates are made of. A HEPA filter, for example, will trap silica dust, asbestos fibers, welding fume, and any other particulate.

## Chemical cartridges are for gases and vapors.

These cartridges contain a granulated material called **activated charcoal**. Some gases and vapor stick to activated charcoal, some do not.

**There are many gases and vapors for which there is no chemical cartridge**, which means that an APR won't protect you against these materials.

To know whether there is a chemical cartridge for the gas or vapor to which you are exposed, look in the respirator column of the **NIOSH Pocket Guide**.

If it says "chemical cartridge respirator with organic vapor cartridges" or has an abbreviation that includes CC (for chemical cartridge) and OV (for organic vapor), then there is a chemical cartridge available.



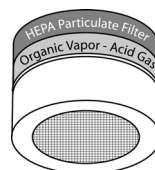
Now look at the cartridge selection chart from the manufacturer of your respirator and select the appropriate cartridge or combination.

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There are APR cartridges for protection against low concentrations of acid mists in the air. These cartridges have a chemical inside that neutralizes acid.

---

A common APR cartridge for hazardous waste work is the one that handles the most contaminants. This is a combined organic vapor/acid gas cartridge with HEPA filter.



## Chemical Cartridges for APRs

## Acid Cartridges for APRs

## Combination Filter-Chemical Cartridges

## How Long Do the Filters or Cartridges Last?

There is a limit to how much contaminant a filter or cartridge can hold. The greater the concentration of contaminants in the air, the sooner the filter or cartridge will get full. Also, the harder you work, the more you breathe, which means that more contaminants will enter the filter or cartridge and it will get full sooner.

**Filters.** OSHA says that for filters, you can use them until you sense increased breathing resistance, which means that the filters are getting clogged.

**Chemical cartridges.** Breathing resistance does not increase when a chemical cartridge gets used up.

The only way that you might tell that the cartridge has stopped working is if you can smell the contaminant coming through. However, OSHA says **never rely on your sense of smell**. Some chemicals have no smell. Some chemicals only smell if the concentration is way above a safe level. Some chemicals dull your sense of smell so you don't notice them.

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Humidity above 85% will reduce the service life by 50%.

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For chemical cartridges, OSHA requires the employer to use a **change-out schedule** that is based on the concentration of contaminants in the air and on how hard you are working. This has to be determined by a person with technical expertise.

OSHA also allows you to use a chemical cartridge that has an **End-of-Service-Life Indicator (ESLI)**. This is something that changes color when the cartridge is full. However, there are very few of this kind of cartridge available.

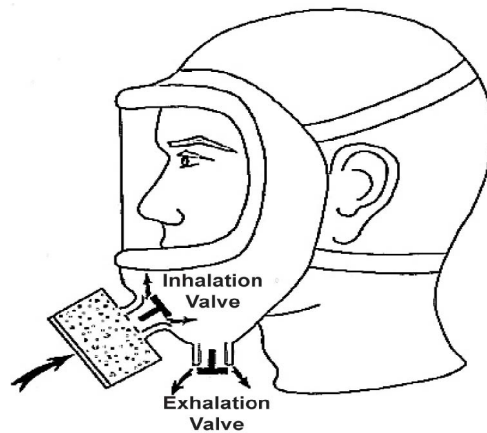
## How an APR Works

With an air-purifying respirator you breathe the air around you. You trust that the filters or cartridges will remove the contaminants from the air you inhale.

The air enters through the filters or cartridges. It passes through **inhalation valves**. These are one-way flap-valves that let air enter, but don't let it go out.

The air that you exhale leaves the respirator through an **exhalation valve**. This is a one-way flap-valve that lets air out but doesn't let it in.

The purpose of the inhalation valve is to make sure that your exhaled breath – which has a lot of moisture in it – doesn't pass back through the filters or cartridges. Excess moisture can damage filters and cartridges.



The purpose of the exhalation valve is to give your exhaled breath an easy way to leave the respirator, without creating resistance.

You should inspect the inhalation and exhalation valves each time before you use the respirator. If the exhalation valve is missing, or broken, or dirty, it won't close completely when you inhale. This would allow dirty air to enter through the exhalation valve. The result would be like not wearing a respirator at all.

Most APRs have a cover that you can easily remove to inspect the exhalation valve.

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**Check the valves each time before you use the respirator.- especially the exhalation valve.**

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# Finding a Respirator That Fits Your Face

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Fit is the single most important factor that determines how much protection a respirator provides.

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**Qualitative = Quality.**  
Does the respirator seem to fit your face adequately?

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**Quantitative = Quantity.**  
Measures exactly how well the respirator fits.  
Provides a **FIT FACTOR** for the respirator.

---

If an APR doesn't fit your face very closely, dirty air will be sucked in at the edge of the face piece.

Everyone's face is different. You may have to try several different sizes, models and manufacturers, to find one that fits your face.

Full-face respirators provide a better fit than half-face ones because the full-face seals around the outside of your face. The half-face goes over the bridge of the nose, the hardest place to seal.

If you have the correct filters or cartridges installed, then **fit is the single most important factor that determines how much protection a respirator provides.**

You have to take a fit test to make sure that the respirator seals against your face to keep contaminated air out. There are two kinds of fit tests:

1. **Qualitative fit test.** In this test you are exposed to a smelly substance while you wear the respirator. If it fits adequately, you won't smell it. This is called a "qualitative" test because it gives you an idea of the quality of the fit. It either seems to fit, or it doesn't. The test doesn't measure exactly how well it fits.
2. **Quantitative fit test.** This test measures exactly how well the respirator fits. A special instrument measures the amount of a test chemical in the air around you, and also measures how much of the chemical has gotten inside the respirator.

If the test chemical in the air has a concentration of 1,000 ppm, but only 10 ppm inside the mask, then the air in the mask is 100 times cleaner than the air outside. This is called a **fit factor** of 100.

The **Protection Factor (PF)** means how much cleaner the air in the respirator is assumed to be if you pass a qualitative fit test. In the qualitative test, we don't actually measure the air – that's why we use the assigned protection factor to assume how much cleaner it is inside the mask.

For example, a PF of 10 means the air in the respirator is supposed to be ten times cleaner than the outside air. If the contaminated air has 1000 ppm, then the air in the respirator – what you breathe – ought to be 100 ppm.

If you pass a qualitative fit test, you assume that the respirator has at least the protection indicated by the PF.

Most employers must now use PFs assigned by OSHA.

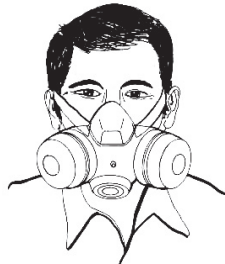
## OSHA Assigned Protection Factors

The protection factor means how much cleaner the air is supposed to be in the respirator, compared to the contaminated air outside the respirator.

### OSHA Assigned Protection Factors (PF) [29 CFR 1910.134(d)(3)(i)(A)]



**Quarter-face  
APR: 5**



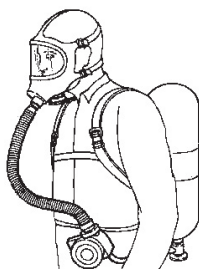
**Half-face APR:  
10**



**Full-face APR:  
50**



**Full-face  
PAPR: 1,000**



**SCBA: 10,000**



**Air-line with  
escape cylinder:  
1,000**



**Air-line without  
escape cylinder:  
1,000**

## NIOSH and ANSI Protection Factors

Most employers had been using the NIOSH assigned protection factors. However, in November 2006, OSHA added a list of PFs to its respiratory protection standard. These are now the protection factors that all employers covered by OSHA must use.

The American National Standards Institute (ANSI) is a private organization that recommends standards for occupational safety and health.

Some employers, including **contractors at DOE facilities**, may use ANSI assigned protection factors, some of which are different than the NIOSH or OSHA PFs.

Comparing NIOSH, ANSI and OSHA Assigned Protection Factors			
	NIOSH	ANSI	OSHA (new)
Quarter-Face APR	5	10	5
Half-Face APR	10	10	10
Full-Face APR	50	100	50
Full-Face PAPR	50	1,000	1,000
Full-Face SCBA	10,000	> 1,000	10,000
Full-Face Air-Line with escape cylinder	10,000	> 1,000	1,000
Full-Face Air-Line without escape cylinder	2,000	1,000	1,000



**IDLH** means **Immediately Dangerous to Life and Health**. NIOSH has determined an IDLH concentration for many of the chemicals listed in the NIOSH Pocket Guide. If you are exposed to an IDLH concentration (or greater) for thirty minutes or more, you will likely:

- Become unconscious or otherwise unable to leave the area (after which you might die, or suffer permanent damage to your health);
- Suffer permanent damage to your health; or
- Die.

**You must never use an APR in an IDLH situation.**

If the APR stops working, for example if the filter or cartridge gets used up, then you will risk death or permanent damage to your health.

NIOSH does not list IDLH concentrations for chemicals that cause cancer (carcinogens). This is because NIOSH believes that any exposure to a carcinogen increases your risk of cancer. NIOSH recommends that you do not use APRs for protection against carcinogens.

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**Never use an APR in IDLH conditions.**

**The only type of respirator allowed in IDLH conditions is an atmosphere-supplying respirator.**

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## If You Wear Glasses

### **Never wear regular glasses with a full-face APR.**

This is because the arms of the glasses would pass under the respirator and break the seal against your skin. If you have to wear glasses, then you need a “spectacle kit”. This is a special set of frames that clips inside the face piece. Respirator makers sell spectacle kits. Your optometrist puts in the prescription lenses.

OSHA does not prohibit wearing contact lenses with a respirator. However, it is generally not a good idea to do so. Many air contaminants can irritate your eyes if they get behind the contacts.

If you do wear your contacts, and you need to remove them or adjust them, leave the area, remove your respirator and clean your hands and face before touching your contact lenses.

## A Clean Shave

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**You have to shave to wear a respirator.**

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Because the respirator has to seal against your face to keep out contaminated air, OSHA requires that you be clean shaven.

It is not possible to get a proper fit if there is a beard or stubble where the respirator touches your face. Facial hair prevents the respirator from sealing against your skin. It will leak, and you will be exposed to contaminants.

It is important that you understand when you can – and cannot – use an air-purifying respirator.

APRs can only be used when:

- There is at least 19½% oxygen.
- There will be no confined space entry (unless it is established by air monitoring before and during entry that contaminant levels cannot rise above the range of the available APR filters or cartridges).
- You know the identity of the contaminants. Otherwise you can't pick the right cartridge or filter.
- You know the concentration of the contaminants. Otherwise you don't know if the respirator is rated for this concentration.
- There are no IDLH concentrations.
- There is a correct APR filter or cartridge available.

If there's a possibility that the situation might change for the worse – a leak might occur or a fire might start – then you won't know what the contaminants or concentrations are. Don't rely on an APR.

Look at the NIOSH Pocket Guide and at the manufacturer's selection chart to see what type of respirator you need to use.

## Choosing the Right Respirator

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**Unless you can say "yes" to all of these conditions, then it's unsafe to enter the area with an APR. You need greater protection than an APR can provide.**

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**Under certain conditions it is unsafe to use an air-purifying respirator. Then you have to use one of the atmosphere supplying respirators that we discuss in Chapter 7.**

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# Color Code for APR Cartridges

Filter and Cartridge Colors
HEPA or P-100: Magenta
Organic vapors: Black
Acid gases: White
Organic vapor/ acid gas combo: Yellow
HEPA/organic vapor/acid gas com- bo: Yellow & Magenta
Ammonia gas: Green

Filters and cartridges for APRs have a label which tells what they can be used for.

Respirator manufacturers also color the labels to identify different types of filters and cartridges.

NIOSH requires that the P100 (HEPA) filters be magenta. This filter is used for welding fumes, asbestos, radioactive dusts and other fine particulates.

A combination filter/cartridge has more than one color if it can handle two or more different kinds of contaminants.

A very common APR cartridge used at hazardous waste sites is the combination HEPA/organic vapor/acid gas cartridge. This combination cartridge has a magenta stripe and a yellow stripe.

There are problems with relying on the color code:

- The shade may vary from one manufacturer to another. In other words, one manufacturer's "magenta" may look very different from another manufacturer's.
- Some people are color blind and cannot distinguish between the colors used.

NIOSH recommends:

Users should not rely on memorizing the color code, but should always READ THE LABEL! This is the only foolproof way of ensuring use of the correct cartridge or canister.

(NIOSH Guide to Industrial Respiratory Protection, 1987, page 31)

You must be medically fit for the type of respirator you wear. OSHA requires a medical evaluation by a Physician or other Licensed Health Care Professional (PLHCP) who understands the strain that respirator use involves.

If you have heart, circulation or lung problems, the extra effort it takes to breathe through a respirator, or the extra work to carry an SCBA cylinder or drag a hose may be dangerous or even deadly. The following physical and psychological problems may be associated with respirator use:

- More effort to breathe, especially with APRs.
- Extra weight to carry, especially with SCBAs.
- Impaired visibility with full-face respirators.
- Difficulty communicating.
- Heat stress.
- Claustrophobia.
- Discomfort.
- Scars or missing dentures may affect respirator face piece seal.

## **Medical Fitness to Wear a Respirator**

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**Employers are required to pay for the medical evaluation and any related expenses, including travel cost, as a result of the evaluation.**

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**The PLHCP must keep strictly confidential any information revealed during the medical evaluation.**

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## **Respiratory Protection Programs**

If workers need to wear respirators, then OSHA requires the employer to have a written respiratory protection program. At a hazardous waste site, this will be part of the Site Safety and Health Plan.

The respiratory protection program must include:

- Procedures for selecting the correct respirators.
- Medical evaluation of workers who use respirators.
- Fit testing.
- Procedures for the proper use of respirators.
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and maintaining respirators.
- Procedures to assure air quality for atmosphere-supplying respirators.
- Training employees to use respirators correctly.
- Procedures for regularly evaluating the effectiveness of the program.

You should inspect your respirator every time before you use it. When you put it on you should perform a couple of quick seal checks.

### **User inspection.**

- Make sure that you have the correct respirator and the correct filters or cartridges.
- Inspect the face piece, straps and visor.
- Inspect the inhalation and exhalation valves.

### **Negative pressure check.**

- With your hands, cover the inlets to the filters or cartridges.
- Inhale. If the respirator is working properly, then you should be able to feel the face piece being sucked toward your face.
- Hold your breath for 10 seconds. The face piece should remain sucked in.



### **Positive pressure check.**

- Cover the exhalation valve with your hand.
- Exhale. You should be able to feel the respirator expanding away from your face.
- Again, hold it for 10 seconds.



## **Inspecting and Checking Your Respirator**

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**User seal checks are NOT a substitution for quantitative or qualitative fit tests.**

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## Review Questions for Chapter 6

1. List the three hazardous conditions of the air that might require the use of a respirator.
  
  
  
  
  
  
  
  
  
  
2. With an air-purifying respirator (APR), the air you breathe comes from:
  
  
  
  
  
  
  
  
  
  
3. a. Normal air contains \_\_\_\_\_ percent oxygen.  
b. The danger of excess oxygen is that it increases the risk of \_\_\_\_\_.  
c. The lowest oxygen level allowed by OSHA is \_\_\_\_\_ percent.
  
  
  
  
  
  
  
  
  
  
4. Why is it important to be clean-shaven if you wear a respirator?



**Review  
Questions for  
Chapter 6**

5. What is the difference between a qualitative and a quantitative respirator fit test?

6. List six conditions that must all be true in order to wear an air-purifying respirator.

7. Define each of these terms:

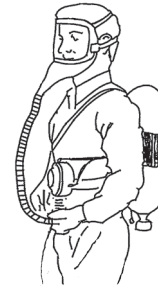
a. APR:

b. PAPR:

c. HEPA:

## Chapter

# 7



# Atmosphere-Supplying Respirators

## Learning objectives

This chapter discusses respirators that have their own clean air supply so that you don't have to rely on trying to filter the air around you.

After completing this chapter, you will be able to demonstrate your ability to:

1. DESCRIBE the two basic types of atmosphere-supplying respirators.
2. SELECT the proper definition or example for:
  - a. SCBA.
  - b. Escape bottle.
  - c. SAR.
  - d. Grade D air.
3. IDENTIFY the limitations of:
  - a. Self-contained breathing apparatus.
  - b. Supplied-air respirators.
4. LIST the conditions under which it is required that you wear an atmosphere-supplying respirator.

There are many situations in which it is unsafe to wear an APR. They don't provide oxygen, and they can't protect you from highly toxic substances, or from high concentrations of contaminants.

If any of the following conditions is present, then you must wear an atmosphere-supplying respirator.

- There is less than 19½% oxygen in the air. APRs don't supply oxygen – atmosphere-supplying respirators do!
- The identity of the contaminants is unknown. If you don't know what's there, you can't pick the right cartridge or filter for an APR.
- The concentration of the contaminant is unknown. If you don't know how much is in the air, you don't know whether an APR can handle it.
- The concentration is above the IDLH level (Immediately Dangerous to Life or Health). No APR is rated for IDLH conditions.
- There are no APR filters or cartridges approved for those contaminants at those concentrations.

The atmosphere-supplying respirator you wear will be either a Self-contained Breathing Apparatus (SCBA) or a Supplied-air Respirator (SAR).

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Atmosphere-supplying respirators are tested and certified according to NIOSH regulations. Respirators are certified as a unit. Never try to connect the parts from different models or makes of respirator. This is illegal – and it could prove deadly.

## **When Do You Need an Atmosphere-Supplying Respirator?**

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**If any of these conditions is present, then you must wear an atmosphere supplying respirator.**

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## **NIOSH Approval**

## Two Types of Atmosphere-Supplying Respirators

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SCBA, and the air-line respirator with escape cylinder, provide the greatest amount of respiratory protection available.

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## Maximum Respiratory Protection

Atmosphere-supplying respirators provide you with a clean source of air. You're not breathing the dirty air around you. There are two styles:

1. **Self-Contained Breathing Apparatus (SCBA).** The air comes from a high-pressure cylinder on your back. There are half-hour and one-hour cylinders. These usually last less than the stated time. Don't worry, there's an air gauge and a low-level alarm. The SCBA has a full face-piece.



2. **Air-Line Respirator (Supplied-Air Respirator or SAR).** This respirator supplies clean air through a high pressure hose from a storage cylinder or air compressor. You can keep working without having to leave the hot zone (contaminated area) to change cylinders.



There's a danger, however, that the air hose could be cut or kinked, stopping the air. For this reason, you must have a 5-minute SCBA escape cylinder that you can turn on if the hose fails.

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No respirator provides absolute protection. However, an SCBA, or an air-line respirator with an escape cylinder, provide the maximum respiratory protection available.

Because atmosphere-supplying respirators have their own air supply, they are the only respirators that you can use when there is **oxygen deficiency**.

## How Atmosphere- Supplying Respirators Work

Atmosphere-supplying respirators have regulators that control the flow of air into the face-piece. They must be operated in either the full-flow mode or in the pressure-demand mode.

Full-flow means that enough air for breathing is always flowing in, even though you actually take one breath at a time.

**Pressure-demand** means that a small amount of air is always flowing in, but when you start to inhale (demand), the regulator lets more air in so there's enough to breathe.

Both the full-flow and the pressure-demand mode maintain **positive pressure in the face-piece**. This means that if there is a leak around the face-piece, most likely clean air will leak out, rather than dirty air leaking in. This is the reason that these respirators provide so much greater protection than APRs. It is the reason that atmosphere-supplying respirators are generally preferred for response activities.

The air for atmosphere-supplying respirators has to be clean. It should be tested periodically to assure that it meets the specifications for **Grade D breathing air**.

If you use a compressor to fill air cylinders or to supply air to an air-line respirator, the compressor must be located outside of the hazardous area so that it can supply clean air. Make sure that the compressor is not sucking in contaminated air such as vehicle exhaust.

The face piece of an atmosphere-supplying respirator has to seal tightly against your skin. These face pieces require the same kinds of fit testing that was described in the last chapter for APRs.

---

### Grade D Breathing Air

Oxygen: 19½ – 23½%

Hydrocarbons:  
less than 5 mg/m<sup>3</sup>

Carbon monoxide:  
less than 10 ppm

Carbon dioxide:  
less than 1000 ppm

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No noticeable odor

## Using an Atmosphere-Supplying Respirator

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SCBAs and most SARs have a face piece with a tight-fitting seal.

OSHA requires fit-testing and a clean shave for all tight-fitting seal respirators.

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## Limitations of Atmosphere-Supplying Respirators

To safely use an atmosphere-supplying respirator all of the following must be true:

- You are trained to use the atmosphere-supplying respirator.
- You are medically approved to wear the atmosphere-supplying respirator.
- You are fit tested to wear that specific model and size respirator face piece.
- You use only a Grade D or better air supply.

And, if you use an air-line respirator:

- You have no more than 300 feet of air hose.
  - You have an escape cylinder.
- 

Atmosphere-supplying respirators provide much greater protection than APRs do. However, atmosphere-supplying respirators do have limitations:

- SCBAs are heavy. Cylinders can weigh 25-35 pounds. This is a lot of extra weight to carry while you're working.
- Air-line respirator hoses may limit your movement. The hose may be awkward to handle, and may get caught or damaged.

The protection factors for atmosphere-supplying respirators are much higher than the protection factors for APRs. This is because atmosphere-supplying respirators have their own clean air supply.

Air-line respirators (SARs) use the same face pieces and the same quality of air as Self-Contained Breathing Apparatus respirators (SCBAs). However, there is an important difference: the hose.

You may be dragging as much as three hundred feet of hose connected to your SAR. It is possible for that hose to get cut, or to be squashed by a vehicle tire. If that happens, you have no air. You have to take off the face piece and hope that the air around you won't harm you while you escape from the area.

In order to avoid this problem, you should wear an **escape cylinder** whenever you use an SAR. If there's a problem with the SAR, you can switch on the escape cylinder and breathe clean air while you leave the area.

Because the protection factor with an SAR might drop to nothing in the situation we've just described, NIOSH gives SARs without an escape cylinder a lower protection factor than SCBAs.

The OSHA assigned protection factor for the SAR is 1,000 - whether or not you have an escape cylinder. This doesn't change the fact that if your hose is damaged or blocked, an escape cylinder could save your life.



## Protection Factors

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### OSHA Assigned Protection Factors

Quarter-face APR: 5

Half-face APR: 10

Full-face APR: 50

PAPR: 1,000

SCBA: 10,000

Air-line :1,000

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### NIOSH Assigned Protection Factors

SCBA: 10,000

Air-line with escape cylinder: 10,000

Air-line without escape cylinder: 2,000

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## **Medical Fitness to Use an Atmosphere- Supplying Respirator**

You must be medically fit to wear a SAR or SCBA. You need to be evaluated by a physician or other licensed health care professional who understands the physical and mental strain that this type of respirator can create. If you have heart, circulation or lung problems, the extra effort it takes to carry an SCBA cylinder or drag a SAR hose may be dangerous or even deadly.

The following are physical and psychological problems that may be associated with using an atmosphere-supplying respirator:

- It may be more difficult to exhale because of the positive pressure in the face piece.
- There is extra weight to carry, especially with an SCBA. An SCBA tank and harness can weigh as much as thirty-five pounds.
- There's the danger of heat stress caused by doing extra work carrying the cylinder or hose.
- There is impaired visibility with full face pieces.
- It's difficult to communicate.
- You may feel claustrophobic knowing that you are depending upon a limited air supply.



You must use an atmosphere-supplying respirator – either an SCBA or an air-line respirator with an escape bottle – in any of these conditions:

- Confined space entry (unless you have proven that no respiratory hazard can occur).
- Oxygen level less than 19½%.
- Unknown contaminants.
- IDLH concentrations of contaminants.
- Unknown concentrations of contaminants.
- Contaminants or concentrations for which no APR filter or cartridge is available.

## **When to Use an Atmosphere- Supplying Respirator**

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**Use an SCBA or an air-line respirator with an escape cylinder when any of these conditions is present.**

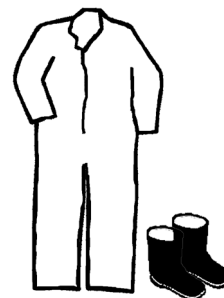
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## Chapter

# 8



# Personal Protective Clothing and Equipment

## Learning objectives

This chapter discusses clothing that protects against chemicals, and how protective clothing and respirators are used together.

After completing this chapter, you will be able to demonstrate your ability to:

1. DEFINE the following:
  - a. Permeation.
  - b. Penetration.
  - c. Degradation.
  - d. Liquid-protective.
  - e. Vapor-protective.
2. IDENTIFY the type of protective clothing and respiratory protection used in Level C.
3. IDENTIFY the type of protective clothing and respiratory protection used in Level B.
4. IDENTIFY the type of protective clothing and respiratory protection used in Level A.

There are many types of protective clothing. These include hard hats to protect the head from bumps and from falling objects; safety glasses to protect the eyes from flying particles; goggles and face shields to protect the eyes from chemical splashes; safety shoes and boots to protect the feet from cuts, punctures, and from being crushed; gloves to protect the hands from abrasion; and many others.

**Chemical Protective Clothing (CPC)** is designed to keep chemicals from touching your skin. CPC includes:

- Two-piece chemical splash suits.
- One-piece chemical splash suits.
- Encapsulating chemical suits.
- Vapor-resistant totally-encapsulating suits.
- Chemical-resistant gloves.
- Chemical-resistant boots.

It is often easy to ignore skin exposures. We think “I’ll just wash it off later.” Remember that in addition to damaging the skin itself, chemicals can be absorbed through the skin and carried to every part of the body where they might damage other organs, affect the nerves, cause cancer or cause reproductive effects.

## **Protective Clothing and Equipment**

29 CFR 1910.120(e)(2)(iii)

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**Clothing that is designed to keep chemicals out is called chemical protective clothing (CPC).**

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# Selection of Chemical Protective Clothing

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These are the most common materials that CPC is made of:

- Natural rubber
  - Butyl rubber
  - Neoprene
  - Nitrile
  - Polyurethane
  - Polyvinyl chloride (PVC)
  - Polyvinyl alcohol (PVA)
- 

There are several things to consider in selecting the right Chemical Protective Clothing (CPC):

- **Chemical resistance.** Since we wear CPC to keep chemicals away from our bodies, we need to know how well the CPC resists chemicals.
- **Strength.** How strong is the material? Will it tear? Will the seams split? Will the zipper get stuck?
- **Heat, cold and sunlight.** Will the material become brittle or crack if exposed to cold weather or to sunlight? Will it deteriorate in heat? Will changes in temperature affect its chemical resistance?
- **Cleaning.** Can the CPC be properly cleaned and decontaminated? In some cases, it is more practical to use single-use disposable CPC.
- **Size and Comfort.** Does the CPC come in the right size to fit you comfortably? Does its size and flexibility allow full range of motion?
- **Cost.** Your employer is required to provide adequate protection, not cut corners on CPC. Nevertheless, cost is always a consideration. Employers need to realize that although they might save money initially by buying a less expensive CPC, they may lose in the long run. Inadequate CPC does not last as long, and it may increase injuries and illnesses.

You select CPC on the basis of the manufacturers' specifications and selection charts.

There are several terms you should know in order to understand what can go wrong with CPC when it contacts chemicals:

- **Degradation.** Visible, gross damage such as blistering, cracking, swelling or dissolving.
- **Penetration.** Chemicals leaking through seams, stitching or zippers.
- **Permeation.** Chemicals soaking into and through the material.
- **Breakthrough time.** The time it takes before enough permeation occurs so that the chemical reaches the other side. This might be a few minutes, or several hours.

In order to limit penetration, the seams of some CPC are sealed with special tapes or chemical sealants. Some CPC has self-sealing zippers and/or seals which close over zippers. Gloves and boots are usually molded without seams in order to prevent penetration.

The manufacturers provide CPC selection charts which list different CPC materials, and different common industrial chemicals. The charts indicate how well the materials resist degradation by each listed chemical.

There are also CPC selection charts that list breakthrough times for different chemicals.

## **Degradation, Penetration, Permeation, Breakthrough Time**

## Gloves and Boots

We need to wear strong, chemical-resistant boots and gloves because hands and feet are the parts that most often come into contact with chemicals.

We often wear more than one layer of boots and gloves in order to:

- Protect against different kinds of chemicals.
- Protect expensive boots and gloves with less expensive boot covers and outer gloves.
- Provide greater comfort by wearing cotton glove liners.

Gloves don't protect forever. Sooner or later they degrade, or they reach their breakthrough time. Once chemicals get through a glove, they are trapped inside and may increase skin damage and skin absorption.

Consult the manufacturer's selection charts. Use the breakthrough time for the glove material and chemical exposure in order to know how long to use the gloves. Then put on new gloves before permeation can occur.



CPC can be uncomfortable and even dangerous to wear. It has important problems and limitations:

- **CPC wears out.** It doesn't last forever. Is it in good condition? Is it worn out? Does the zipper work?
- **CPC gets contaminated.** If your CPC was worn before, was it properly decontaminated? If not, you may be exposed to chemical residues.
- **CPC is uncomfortable.** It's hot and sweaty inside CPC. Your dexterity, agility and sense of balance may be affected. CPC may also affect your ability to see and to communicate.
- **CPC is not fire-proof.** There are special heat-resistant suits that offer limited protection from heat and flame. However, most CPC provides no protection, and may in fact burn easily.
- **CPC can be deadly.** Wearing CPC is not just uncomfortable, it can be life-threatening if you experience heat stress.
- **Choose the right CPC.** Your protective clothing has to match the chemicals and conditions in which you wear it. You need to know what you'll be exposed to, and whether your CPC has sufficient resistance. Picking the wrong suit gives a false sense of security.
- **Wear CPC correctly.** You need to know exactly how to wear the particular type of CPC you are using. Do the cuffs need to be taped? Do you need more than one layer of gloves and boots? Can you wear your respirator at the same time?

## Limitations of Protective Clothing

## Liquid-Protective Suits

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You might think that it ought to be called a “liquid and solid” protective suit, but we just say “liquid.” That’s because a cloth that is resistant to permeation by liquids will also keep out solids, so it’s easier to just say “liquid-protective.”

---

Your lungs are very delicate, and are designed for absorption.

Your skin is a lot tougher, and is intended to keep things out.

Skin contact with air contaminants is only a hazard if the air contaminant is especially toxic, or if there is an extremely high concentration.

---

## Fully-Encapsulated Vapor-Protective Suits

**Liquid-protective** chemical-resistant suits **protect against splashes of liquid and solid chemicals.**

These suits come in one-piece and two-piece styles. The two-piece suit has separate jacket and pants. Most liquid-protective suits do not cover you completely. Chemicals might splash in at the neck, for example.

There are also fully-encapsulating liquid-protective suits that protect every part of your body from splashes of liquid and solid chemicals.

However, **no liquid-protective suit is air-tight.** Some contaminated air can get inside (penetrate) through spaces where the suit snaps, through the zipper, or through the tiny holes around the stitches.

If you are wearing the appropriate respirator, then you won’t inhale air contaminants that get inside the suit.

The problem is: what if **air** contaminants inside the suit can be absorbed through the skin, or damage the skin?

Most of the time, this is not a problem. For most air contaminants, the amount in the air is so small that it won’t hurt you if some contacts your skin.

---

**Fully-encapsulated vapor-protective suits** have special zippers and seams that **prevent air contaminants, including gases and vapors, from getting inside the suit.**

If an air contaminant is so concentrated, or so toxic, or so irritating, or so easily absorbed through the skin that skin contact with the air is hazardous, then you need a fully-encapsulated vapor-protective suit. These suits also protect against splashes of liquids and solids.

## Levels of Protection

There are two main categories of respirators: Air-Purifying Respirators (APR) and Atmosphere-Supplying Respirators (ASR).

There are two main categories of chemical-resistant suits: liquid-protective and vapor-protective.

It is standard practice to talk of four basic combinations of suit and respirator. These are called the **four levels of protection: Level A, Level B, Level C and Level D.**

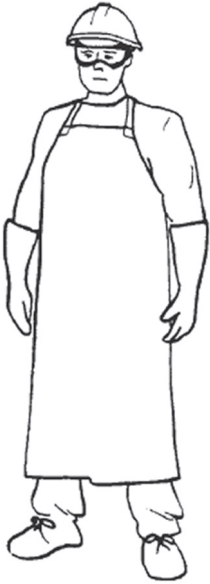
Level A and Level B use the same category of respiratory protection.

Level B and Level C use the same category of chemical protective suit.

Level D is simply regular work clothes with no respirator and no chemical-resistant suit.

	Respirator	Protective Clothing
Level A	SCBA - or - ASR with escape cylinder	Fully encapsulating vapor-protective suit
Level B	SCBA - or - ASR with escape cylinder	Liquid-protective suit
Level C	Air-Purifying Respirator (APR)	Liquid-protective suit
Level D	None	Normal work clothes

## Level D



**Level D** means **ordinary work clothes**.

- Hard hat.
- Work boots.
- No respirator.
- No chemical-resistant suit.

Level D is what workers wear when there is no air contamination hazard, and when there is very little chance of skin contact with hazardous chemicals.

Depending on the job that the worker is doing, he or she might also wear gloves, goggles or face-shield, and an apron.

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## Level C



**Level C** provides **moderate respiratory protection** and **good skin** protection:

- Air-Purifying Respirator (APR).
- Chemical-resistant suit that protects against skin contact with splashes of liquid or solid chemicals.
- Chemical-resistant gloves.
- Chemical-resistant boots.
- Hard hat.

Level C is what workers wear when there are **low levels of air contamination** and possible **skin contact with splashes** of solid or liquid chemicals.

**Level B** provides the **maximum respiratory protection** and **good skin protection**:

- Atmosphere-Supplying Respirator (SCBA or air-line with escape cylinder).
- Chemical-resistant suit that protects against skin contact with splashes of liquid or solid chemicals.
- Chemical-resistant gloves.
- Chemical-resistant boots.
- Hard hat.

Level B is what workers wear when there are **high levels of air contamination** and possible **skin contact with splashes** of solid or liquid chemicals.

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**Level A** provides the **maximum respiratory protection** and the **maximum skin protection**:

- Atmosphere-Supplying Respirator (SCBA or air-line with escape cylinder inside the suit).
- Fully-encapsulated suit that keeps out hazardous solids, liquids and vapors.
- Chemical resistant gloves.
- Chemical resistant boots.
- Hard hat (inside of suit).

Workers wear Level A when there are **high levels of air contamination**, and possible **skin contact with splashes of solid or liquid chemicals**, and **skin contact with vapors, gases or particulates is hazardous**.

## Level B



## Level A



## Which Level of Protection Should You Use?

To select the right level of protection, the first question is: What category of respiratory protection is necessary?

**Level D.** If it is safe to breathe the air without respiratory protection, then you will work in Level D. Even if you wear a protective suit to keep from getting splashed with chemicals, it's still considered Level D because you have no respirator.

**Level C.** If the following conditions exist, you can use an air-purifying respirator:

- Sufficient oxygen – at least 19½%.
- Air contaminants are known.
- Concentrations are known.
- Concentrations are not IDLH.
- There is a filter or cartridge available for the contaminants at the concentrations that exist.

If all of the above conditions exist, you can use Level C – the only level of protection with an Air-Purifying Respirator.

**Level A or Level B.** If any of these conditions might exist, you need to use an atmosphere-supplying-respirator:

- Oxygen deficiency.
- IDLH concentration.
- Unknown contaminants.
- Unknown concentrations.
- No appropriate filter or cartridge.

If any of the above conditions exist, you need Level A or Level B, because these levels of protection have an atmosphere-supplying-respirator.

**The choice between Level A and Level B.** This depends on **whether it is hazardous for the gases, vapors and particulates in the air to come in contact with your skin.**

**Level A.** If the air contaminants are so concentrated, or so toxic, or so irritating, or so easily absorbed that skin contact with the air is hazardous, then you need a fully-encapsulated vapor-protective suit – which means Level A.

**Level B.** If skin contact with gases, vapors or particulates in the air is not hazardous, then Level B is appropriate.

**Why not use Level A all the time?** Because Level A protective suits are fully encapsulated, they present the highest risk of heat stress. They are generally the most difficult and uncomfortable suits to use. They are the most likely to cause claustrophobia. They are the most difficult to get out of in an emergency. They are also the most expensive suits.

You should only use Level A in the rare situations when skin contact with air contaminants is hazardous.

**How can skin contact with air contaminants be safe if breathing them is hazardous?** The lungs can be affected by small concentrations of contaminants (measured in parts per million). The lungs are delicate, and are designed to absorb molecules.

The skin is a lot tougher than the lungs. It can be damaged by contact with liquids, because liquids can be millions of times more concentrated than the air. However, in most situations, the skin is not damaged by, and does not absorb air contaminants.

## **Which Level of Protection Should You Use?**

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**Use Level A only when skin contact with contaminants in the air is hazardous.**

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**The OSHA HAZWOPER Standard says to use Level B when the contaminants are unknown, unless there is reason to suspect that skin contact with the air contaminants is hazardous.**

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# Which Level of Protection Should You Use?



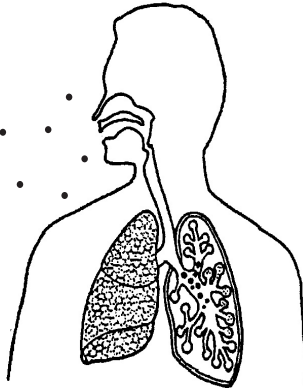
## Vapor In the Air

Even at toxic concentrations, the individual molecules of contaminant are scattered far apart in the air. They are measured in parts per million.



## Liquid Contaminant

The molecules in a liquid are close together. Often there is 100% contamination. A liquid contaminant can be millions of times more concentrated than a vapor.



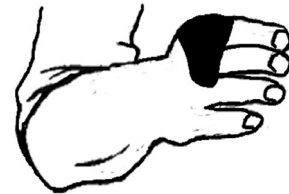
## Vapor In the Lungs

The lungs are very delicate. They are designed to absorb molecules. Even a few molecules of contaminant can damage the lungs or be absorbed.



## Vapor Touching the Skin

The skin is designed to keep things out. Unless they are really deadly, or really concentrated, a few molecules in the air won't hurt the skin, and not enough will be absorbed to be hazardous.



## Liquid Splashed On the Skin

Concentrated liquid splashed on the skin can damage the skin and can be absorbed. It could be millions of times more concentrated than vapor in the air.

## Taping

With Level C or Level B, it's common practice to tape the joints between the gloves and the sleeves, and between the boots and the pants. This prevents solid or liquid chemicals from splashing or running inside the CPC. Leave tabs so that it's easy to remove the tape.

**Tape does not make the suit vapor-protective.** Tape does not change Level B into Level A.



Inspect your CPC before you put it on. Check for:

- Tears, holes and cuts.
- Contamination.
- Damaged zippers, seals or valves.

After CPC is used, it must be either:

- Thoroughly decontaminated; or
- Disposed of properly. Contaminated CPC is considered a hazardous waste.

---

Pick the right CPC. Inspect it. Use it correctly.

- CPC must match the chemicals to which you are exposed. Use the manufacturer's selection charts to determine the best CPC for the job.
- No CPC provides protection against all hazards.
- Heat stress is a real danger when wearing CPC. Learn to recognize the signs of heat stress in yourself, and in your co-workers.
- CPC creates its own hazards. CPC can make it harder to see and communicate; more difficult to walk; and harder to use tools or to pick things up.
- Inspect CPC before you use it.
- Do not use CPC that is damaged or contaminated.
- Use the buddy system. If the job requires CPC, then it's hazardous enough to require you and your co-workers to look out for each other.

## **Inspection, Decon and Storage**

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**Do not use CPC  
that is damaged or  
contaminated.**

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**Contaminated CPC is a  
hazardous waste.**

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## **Some Things to Remember about CPC**

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**Your health and safety –  
perhaps your life – may  
depend on your CPC.**

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## **Review Questions for Chapter 8**

1. Define each of the following terms:

Permeation:

Penetration:

Degradation:

Liquid-protective:

Vapor-protective:

2. List the components of Level C.

3. List the components of Level B.



## Chapter

# 9



# Decontamination

## Learning objectives

This chapter discusses how to remove contamination from people, clothing, tools and vehicles in order to limit exposures and keep contamination from spreading.

After completing this chapter you will be able to demonstrate your ability to:

1. IDENTIFY five reasons why decontamination is important.
2. IDENTIFY two types of contamination.
3. IDENTIFY the three common methods used in decontamination.
4. DESCRIBE the layout of a decontamination line.
5. DESCRIBE the general procedures for decontaminating vehicles.

**Decontamination** means cleaning, removing or neutralizing hazardous substances that have gotten onto protective clothing, tools, equipment or vehicles.

Decontamination also includes cleaning your hands, arms or other parts of your body that may have come in contact with hazardous substances.

Decontamination is important in order to:

- Reduce your chemical exposure.
- Reduce the exposure of your family and the public.
- Protects all site personnel by minimizing the transfer of harmful materials into clean areas.
- Prevent mixing of incompatible chemicals.
- Reduce costs by allowing clothing, tools, equipment and vehicles to be safely used again.
- Reduce waste by reducing the amount of contaminated items that must be disposed of as hazardous waste.
- Reduce the chance of fire and explosion.

Chemicals left on protective clothing or on respirators can cause more exposure when you use them again.

Chemicals on clothing, tools, equipment and vehicles will be tracked to other places. They may contaminate your work site or the community, and cause exposures to fellow workers, your family, or the public.

## **Why Decon Is Important**

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**Shower and change your clothes before leaving the site. Don't take contamination home to your family.**

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## Preventing Contamination

An important part of decontamination is to **prevent contamination in the first place**. This means less chance of exposure, less chance of fire or chemical reaction, less mess to clean, and less waste to dispose of.

Use good work practices to limit chemical contact:

- Don't walk through contaminated areas.
- Don't step or kneel in puddles or spills.
- Never touch, sniff or taste a chemical.
- Never eat or drink liquids in a contaminated areas or while wearing contaminated clothing.
- Where possible, cover tools and equipment with disposable plastic or tape.

Use protective clothing properly:

- Make sure you have the right protective clothing for the chemicals you may be handling.
- Wear outer boots and gloves.
- Inspect PPE prior to each use, to ensure that it contains no cuts or punctures that could expose workers to contaminants.
- Avoid broken pallets, metal or glass that could tear or puncture your boots or clothing.
- Use the buddy system. Point out exposure hazards. Let your co-workers know if you see them getting contaminated.

There are two types of contamination:

1. **Chemicals on the surface** of clothing, tools, and equipment.
2. **Chemicals soaked in**, permeated, or embedded in clothing, tools and equipment.

Chemicals that soak into clothing, tools, and equipment (permeate) are the most difficult to remove. Often it is easier and less expensive to use disposable protective clothing.

---

There are four general methods of decontamination:

1. **Physical removal.** This includes scrubbing, scraping, washing and rinsing.
2. **Chemical removal.** This uses other chemicals to neutralize or inactivate contamination. Chemical disinfection, dry heat, steam, or gas sterilization, and irradiation are all means of chemical removal.
3. **Combination.** Remove contaminants by a combination of both physical and chemical means.

## Types of Contamination

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### 5 factors that affect permeation:

1. Contact Time
  2. Concentration
  3. Temperature
  4. Size of Contaminant molecules
  5. Physical State
- 

## Types of Decon

29 CFR 1910.120 (b) (4) (ii) (g)

## **Decon for Protective Clothing**

The most common decon method for protective clothing is scrubbing with warm (not hot) water with some type of detergent added. Washing is followed by rinsing with lots of water. The clothing is then air dried.

The more you wash and rinse, the cleaner it gets. Unfortunately, you also generate more waste water which may have to be disposed of as hazardous waste.

Protective clothing must be completely dry before it is stored. Moisture usually causes very unpleasant odors, and may promote the growth of biological contamination.



Decontamination requires the proper equipment and supplies. These are the most common types:

- Drop cloths and plastic sheeting. These are used to catch contamination and rinse water.
- Waste water collection containers. Drums, tanks, or “kiddy pools”– to catch the runoff from decon.
- Decon solutions. Soaps and detergents.
- Running water and decon shower.
- Collection containers in which to place gloves, boots, clothing, hard hats, etc.
- Absorbents. Lined box with absorbents for wiping or rinsing off gross contaminants and liquid contaminants.
- Brushes. Soft-bristled brushes to wash and scrub.
- Towels. Paper towels for drying clothing and equipment after it is rinsed.
- Personal Shower. Workers should shower before changing into clean work or street clothes.
- Lockers. To store your clean clothes to wear home.
- Storage cabinets for protective clothing after it has been decontaminated and dried.

## **Equipment Needed for Decon**

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**Never wear contaminated clothing home. You will expose your family and friends to chemical hazards.**

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## Decon Plans

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The plan should be revised whenever the type of personal protective clothing or equipment changes, the site conditions change, or the site hazards are reassessed based on new information.

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Decontamination has to be done correctly, or there will be more contamination and more chemical exposure. This means careful advance preparation.

Decontamination has to be a part of the Site Safety and Health Plan. The decontamination plan must include:

- Types of contamination that might be present.
- Safe work practices to prevent or limit contamination.
- List of decon supplies and equipment.
- Proper use of tools and equipment.
- Number and layout of decontamination areas and/or stations within the decon line.
- Personnel assignments for decon activities.
- Selection and availability of protective clothing.
- A method for determining if decon has been done adequately.
- Proper disposal of contaminated clothing, tools, and equipment.
- Proper treatment and disposal of waste water.
- Procedures to prevent contamination of clean areas.
- Methods and procedures to minimize worker contact with contaminants during removal of personal protective clothing and equipment (PPE).

## **Decon Lines and Stations**

Decontamination is carried out in an orderly, well planned process in a designated decontamination area or decon line. Only persons who are directly involved in decontamination should be at the decon line.

**The decon line moves from the contaminated area towards the clean area** – never in the opposite direction.

Contaminated workers and equipment move through the line getting cleaner, and doffing (removing) clothing at stations along the way. Decon workers are assigned to help at the stations.

When other workers and equipment have been decontaminated, then the decon workers themselves go through the line, starting at their own station.

The decon line includes these kinds of activities, in order, and often at different stations:

- Equipment drop.
- Initial rinse.
- Decon shower, wash and rinse.
- Outer boot and glove removal.
- Protective clothing removal.
- Respirator removal or exchange.
- Personal shower and a change of clothes.

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**The decon line always moves from the most contaminated area toward the clean area**

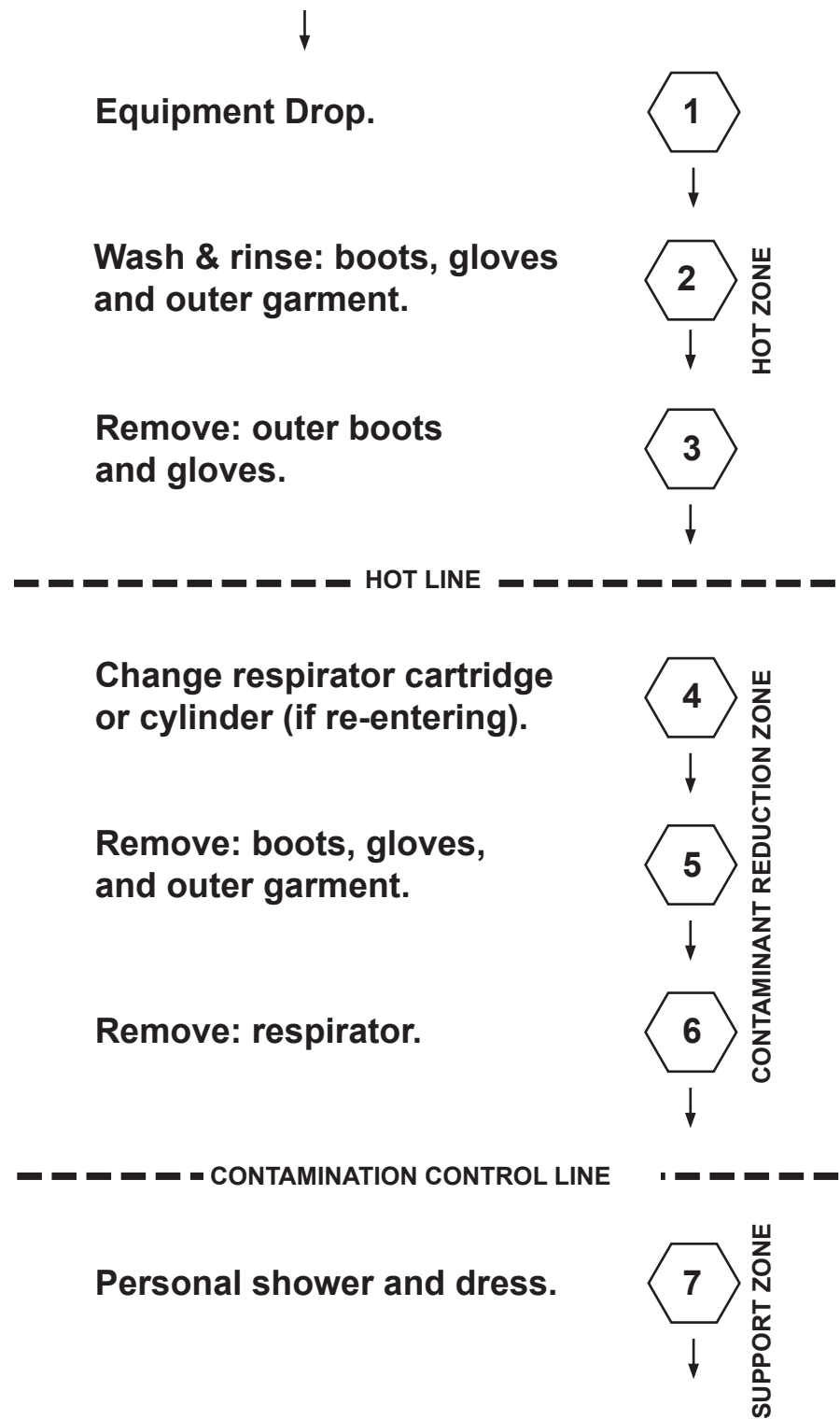
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**There are many ways to arrange the decon line. Some lines have only a few stations. Others have as many as nineteen stations.**

---

# Example Decon Line



This example is only one of many possible arrangements. The exact decon line should be planned in advance based on the kinds of contamination that are likely, and the types of equipment to be used.

Decontamination must be carried out in a safe manner:

- Allow enough time for a thorough, safe decon. If you are using SCBAs this means starting decontamination before your alarm bell rings.
- Make sure that there are enough decon workers to assist at each station.
- Be careful about slips and falls. Plastic sheeting used to contain runoff is slippery when wet.
- Provide hand-holds and benches for workers to use while doffing clothing and equipment.
- Use decon solutions that are compatible with the chemicals involved, and with the protective clothing.
- Doff clothing in the proper order.
- Do not touch the outer surface of clothing, boots or gloves with bare skin.
- Properly treat and/or dispose of waste water.
- Properly dispose of trash, including clothing and equipment that cannot be decontaminated.
- Allow only trained workers on the decon line.
- Keep personal showers, change areas and locker rooms clean and sanitary.
- Follow the decon plan.

## **Safety and Health Precautions During Decon**

## Vehicle Decon

There are some special considerations for the decontamination of vehicles and heavy equipment:

- Keep vehicles and heavy equipment from getting contaminated in the first place. Don't drive through spills or contaminated areas.
- If vehicles must be used near contaminated areas, consider covering the wheels, and other exposed parts with tape and plastic sheeting.
- Have sturdy platforms to safely get at all parts without having to climb on the vehicle.
- Workers must have the right protective clothing, respirators and eye protection during decon.
- Be careful when using pressurized sprayers.
- Use decon solutions that are compatible with the chemicals involved, and with the vehicle's paint.
- Provide a means to collect runoff water.
- Start at the top and work down.
- Pay attention to the under-carriage and other areas where contamination might not be noticed.
- Have a method to determine that decon is complete, such as taking surface wipe samples.
- Properly dispose of all waste water.

## Emergency Decon

The Site Safety and Health Plan must include procedures for **decontaminating persons who are both injured and contaminated**. The first priority is always to save human life and prevent illness and injury.

Providing first aid or moving a contaminated person causes exposure risks to the responders. However, there may be cases where medical attention cannot wait for full or even partial decontamination. Examples might include severe bleeding, cardiac arrest or heat stroke.

In other cases, it may be life threatening if the person is not decontaminated immediately. For example, if a person is lying in a pool of acid or caustic material.

There are ways to speed up the decon procedure if necessary. For example, protective clothing might be cut away, rather than washed.

Emergency Medical Technicians (EMTs) and other medical personnel should be trained in how to treat contaminated victims, and how to use their own protective clothing and equipment.

Remember that an injured or unconscious person wearing protective clothing might also be suffering the effects of heat stress. Heat stress is dangerous. Its most extreme form, heat stroke, is a life-threatening condition. Rapid medical attention is essential if there is the possibility of heat stroke.

The Emergency Response Plan must include a prior agreement with the ambulance service and hospital to deal with the possibility of a chemically contaminated patient. These services exist to provide care, but they do not want to see their expensive equipment and facilities contaminated. Make arrangements in advance.





**Review  
Questions for  
Chapter 9**

5. List the stations in a seven station decon line.

6. List seven special considerations for vehicle and heavy equipment decon.

**Chapter  
10**

**EXCLUSION  
ZONE**

**Authorized  
Personnel  
Only**

## **Site Control**

### **Key Personnel, Engineering Controls, and Emergency Response**

#### **Learning objectives**

This chapter discusses the Site Safety and Health Plan, Key Personnel on a hazardous waste site, the methods to control hazards at hazardous waste sites, and emergency response procedures.

After completing this chapter you will be able to demonstrate your ability to:

1. IDENTIFY the Key Personnel on a hazardous waste site.
2. IDENTIFY the requirements for a written Site Safety and Health Plan.
3. IDENTIFY the types of emergencies that could occur at a hazardous waste site, and identify appropriate emergency response procedures.
4. IDENTIFY these areas and control lines at a hazardous waste site:
  - a. Exclusion Zone.
  - b. Contamination Reduction Zone.
  - c. Support Zone.
  - d. Hot Line.
  - e. Contamination Reduction Corridor.
  - f. Access Control Points.
5. LIST in order of effectiveness four categories of control methods.
6. EXPLAIN the purpose of the buddy system.

The employer or contractor at a hazardous waste site must have a written **Site Safety and Health Plan**.

The site control plan should include:

1. Site Map indicating site perimeter and work zones.
2. Site Access Procedures
3. Site Security
4. Site work zones including Standard Operating Procedures (SOPs)
5. Use of the Buddy System.
6. Methods for both internal (on site) and external communications.

Your employer is required to provide site-specific training – in addition to this course – on the safety and health plan for your site.

**Drum Valley Site Safety and Health Plan  
Table of Contents**

1. Introduction.
2. Personnel Description and Duties.
3. Site Description and History.
4. Hazard Description.
5. Work Activities to Be Completed.
6. Hazard Assessment.
7. Personal Protective Equipment.
8. Areas and Boundaries.
9. Medical Surveillance Program.
10. Training Requirements.
11. Decontamination.
12. Site Standard Operating Procedures.
13. Monitoring.
14. Emergency Response Plan.
15. Confined Space Entry Procedures.

## **Written Site Safety and Health Plan**

29 CFR 1910.120(b)(4)(ii)(F) and  
29 CFR 1910.120(d)

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**You have a right to see the Site Safety and Health Plan, and you should receive training about the plan.**

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**This is the Table of Contents of an example Site Safety and Health Plan.**

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**The purpose of the plan is to make sure that the employer has identified all hazards, put qualified people in charge, trained the workers, provided medical surveillance, provided protective equipment and supplies and prepared an emergency response plan.**

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# Site Characterization

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The idea behind site characterization is to identify every possible safety and health hazard so that effective control measures can be taken.

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Often new information becomes available which must be added to the written Site Safety and Health Plan.

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Site characterization begins before any clean-up activities can begin at the site. The idea is to figure out what's there, and to identify all safety and health hazards.

The information for site characterization comes from many sources:

- Documents. This might include reports of prior inspections of the site, newspaper accounts, inventories and other records about the site.
- Physical Inspection and Monitoring. This means an inspection by a qualified person who does monitoring and sampling for hazardous substances.
- Analysis of the Proposed Activities. This means figuring out what safety and health hazards the clean-up activities might create.

Once work begins, new information often becomes available. For example, excavation may reveal hazardous wastes which were not discovered in the original site characterization. All new information must be added to the site characterization and placed in the written Site Safety and Health Plan.

There are many ways to protect workers from safety and health hazards. Some are more effective than others. Always use the most effective control method that works in the particular situation.

The best control method is to **eliminate the hazard**. Often the hazard is removed by substituting a less hazardous product.

It is often possible to use **engineering controls**. This might include local exhaust ventilation systems that trap contaminants as they are generated, before they get into the air workers breathe. Other examples are enclosures that surround the hazard, or control cabins that isolate workers from the hazard.

There are also **administrative controls**. These include limiting hours of work, scheduling work at less hazardous times, using good standard operating procedures and providing worker training.

Finally, there is **Personal Protective Equipment (PPE)** including respirators and protective clothing.

The order in which control methods are described above is called the hierarchy of controls. The control methods at the top of the list are generally more effective than the methods further down.

PPE is at the bottom of the list. PPE is the least effective means of controlling safety and health hazards.

## Hierarchy of Controls

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For example, using a citrus based cleaning solution to eliminate the hazard of organic solvent exposure.

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PPE is the least effective means of controlling safety and health hazards.

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# Engineering Controls and Other Methods at Hazardous Waste Sites

29 CFR 1910.120 (e) (2) (v)

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**We use PPE at hazardous waste sites because other, better control methods are often not possible.**

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It is always possible to have good training and good standard operating procedures. Insist on these.

There are many examples of engineering controls such as enclosed cabins on vehicles, remote sampling equipment, and drum handling equipment. However, it is usually not practical to use local exhaust ventilation systems to control air emissions at a hazardous waste site.

It is not possible to use product substitution with regard to the hazardous waste itself. The site is being cleaned up to eliminate the hazard for future users. But during the process, workers must handle the waste.

Because there is no product substitution with regard to hazardous waste, and because local exhaust ventilation is not practical, hazardous waste workers must often rely on PPE. This is why this course places such a great emphasis on PPE both in the classroom and in the hands-on activities. It's the least effective method, but it's often the **only** control method. We have to make sure we use it correctly.

## Hierarchy of Controls

1. Eliminate the hazard or substitute a less hazardous product.
2. Engineering controls (ventilation systems, control cabins, hazard enclosures).
3. Administrative controls (standard operating procedures, training, limiting hours of work, scheduling work at less hazardous times).
4. Personal Protective Equipment (PPE) including respirators and protective clothing.

The Site Safety and Health Plan tells who will do what. The person in charge of the site is the **Project Manager**.

The person in charge of safety and health is called the **Safety and Health Officer (S&HO)**. The S&HO makes sure workers have the required training and are fit-tested for respirators, decides what levels of protection are needed, supervises air monitoring, signs off on the safety and health requirements of confined space permits, coordinates the medical surveillance program, fills out accident reports, and suspends work if necessary to prevent an accident or overexposure.

The **Security Officer** is responsible for making sure that only authorized personnel enter the site, and for protecting property from theft and vandalism.

The **Supervisor** is in charge of the day-to-day work activities at the site.

There will be a **Team Leader** for each of the kinds of jobs including entering the most hazardous area (the hot zone), decontamination and support.

The **Public Relations Officer** is in charge of communicating with the press and with other persons who have questions and concerns about site activities.

Depending on the size of the site and the type of clean-up activity, one or more of these roles may be filled by the same person.

## Key Personnel and Responsibilities

29 CFR 1910.120 (e) (2) (i)

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**There may be technicians who help the S&HO by taking measurements, doing fit-testing, etc.**

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**All communication with the press should be done only by the Public Relations Officer in order to prevent inaccurate or inconsistent statements.**

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## Three Zone Plan

A hazardous waste clean-up site is divided into **three zones** as shown on the opposite page. The purpose of the zones is to control the activities and the personnel in each zone.

The specific way the zones are set up will be specified in the Site Safety and Health Plan.

**Exclusion zone or hot zone.** This is the area immediately surrounding the hazardous waste. This is the zone where contact with the hazardous substance is possible. It is where clean-up takes place. Generally protective clothing and respirators will be required in this zone. (Level C, B or A, depending on the conditions.) Only personnel with the proper training are permitted in the hot zone.

**Contamination Reduction Zone (CRZ) or warm zone.** This zone surrounds the hot zone. It is a transition area between the contaminated area of the hot zone and the clean area of the support zone. It's purpose is to reduce the possibility of contaminants reaching clean areas.

**Support zone or cold zone.** This is the clean area where support activities take place such as storage of supplies and equipment. The command post is located here.

**Hot line.** This is the border around the hot zone.

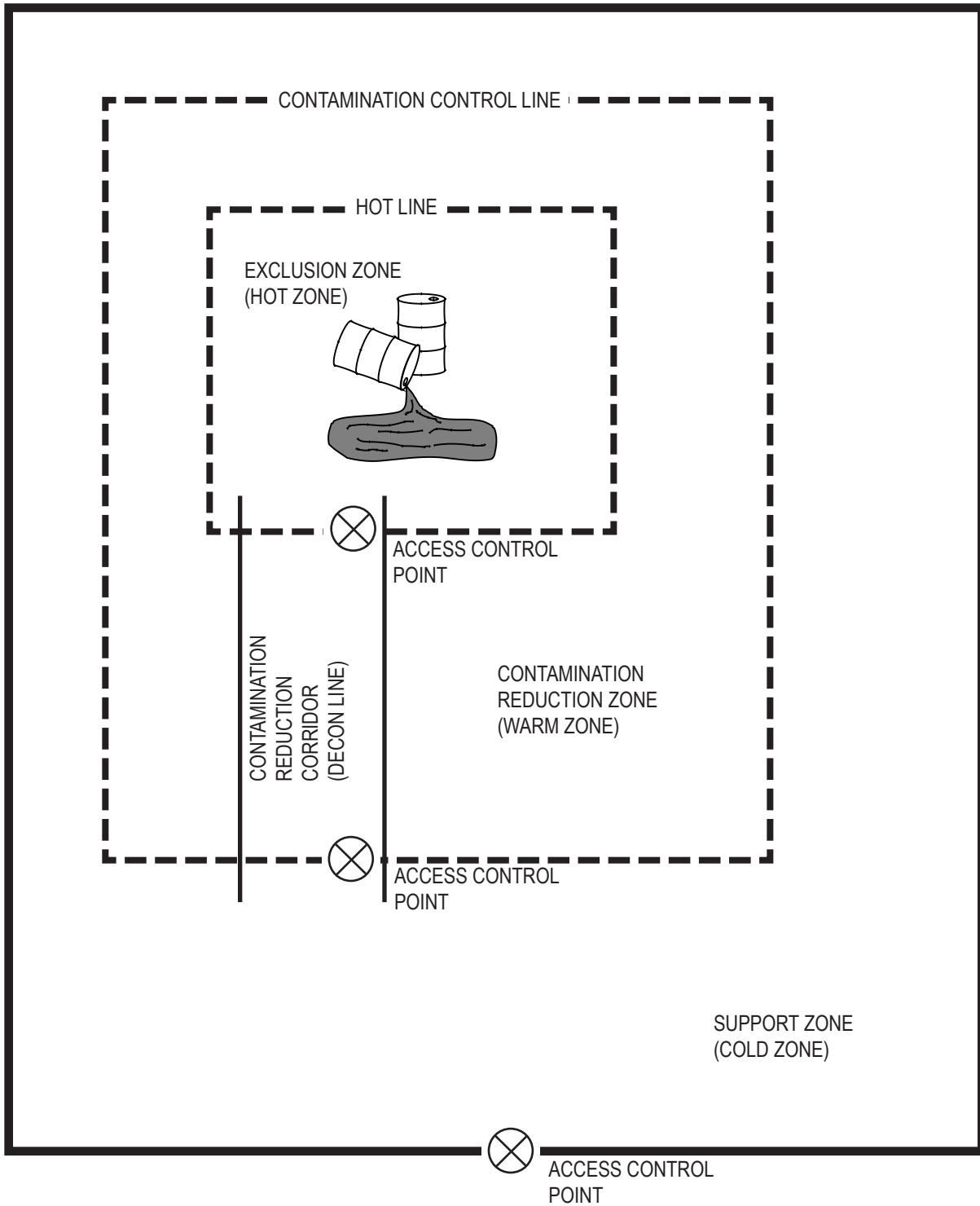
**Contamination control line.** This is the border around the contamination reduction zone.

**Contamination Reduction Corridor (CRC).** This is the passage connecting the support zone to the hot zone, passing through the CRZ. The decon line is located here.

**Access control point.** These are the only places where access to the different zones is allowed.



# Three Zone Plan



## The Buddy System

It is not safe to work alone when handling hazardous waste. If you are injured or overcome, you need someone there to help and to call for assistance.

Your co-worker can also tell you if you're showing signs of heat stress, or warn you of other hazards that you might not have noticed.

When you work in the hot zone, and at other times as specified in the Site Safety and Health Plan, you must work with one or more other workers. This is called the **buddy system**.

Buddies stick together and look out for one another. If one person has to leave the area, for example to refill his or her air supply, then all "buddies" leave together.

---

## Communication Systems and Alarms

Two kinds of communication are necessary. First, there must be **good communication among the personnel on the site**. This is especially important in case of an emergency. Often there are radios, and/or a system of hand signals that everyone understands.

In case of an emergency there must be signals to warn workers and announce an evacuation. This could be a bell, horn or other device. The important thing is that the signals are easy to understand and workers are trained to know what they mean.

There also has to be **good communication with personnel off the site**. Again, this is especially important during an emergency situation. This includes communicating with emergency medical personnel and fire department officials.

There must be a **Standard Operating Procedure (SOP)** for each activity on the site that poses a safety or health risk. Advance planning makes sure that risks are known and workers are prepared. An effective SOP is:

- Written in advance.
- Based on the best available information – taking into account prior experience and lessons learned.
- Field tested and practiced in “dry runs.”
- Used in site specific training.

Below is an example of a standard operating procedure.

## **Standard Operating Procedures (SOPs)**

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**You don't “wing it” when you work with hazardous substances.**

---

### **Standard Operating Procedure: Loading Drums in the Hot Zone**

1. Read and understand the Site Safety and Health Plan as it applies to the Hot Zone.
2. Know the evacuation alarm.
3. Enter only through the Contamination Reduction Corridor.
4. Use the PPE specified in the Site Safety and Health Plan.
5. Use the Buddy System. Maintain visual contact with your buddies at all times.
6. Do not kneel or walk in areas of obvious contamination.
7. Only a certified boom truck operator shall operate the boom truck.
8. Do not load drums by hand – use only approved drum grapplers.
9. Do not allow anyone to be under the load.
10. Load drums on pallets, not directly onto the truck bed.
11. Secure drums to the pallet with an approved securement device.
12. Secure pallets to truck bed with an approved securement device.
13. Contact the S&HO if personal contamination or overexposure is suspected.
14. No eating, drinking, chewing or smoking.
15. Follow decontamination procedures when exiting the hot zone.

## **Emergencies at Hazardous Waste Sites**

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**When an emergency happens, it's too late to figure out what to do. Advance planning is crucial, and it's the law.**

---

There are three types of **emergencies that might occur** at a hazardous waste clean-up site:

### **Waste related emergencies.**

- Fire or explosion.
- Reaction of incompatible chemicals.
- Leaks and spills.
- Release of toxic vapors and gases.

### **Worker related emergencies.**

- Injury.
- Medical emergency such as a heart attack.
- PPE failure.
- Overexposure.
- Heat stress.
- Vehicle accident.

### **Natural disasters.**

- Flood.
- Lightning.
- Earthquake.

# Emergency Response Plan

29 CFR 1910.120 (b) (4) (ii) (H)

If an emergency occurs, properly trained personnel have to act fast. It's too late to decide who's in charge, or what equipment is needed.

These decisions have to be made in advance, so that when the need arises, the response can start immediately. This is why the site must have an **Emergency Response Plan**.

The Emergency Response Plan must include:

- Planning and coordination with the fire department, the police, and the local hospital.
- Job descriptions and training requirements – who does what.
- How to recognize and prevent emergencies.
- Safe distances, places of refuge, rally points and emergency evacuation routes.
- Emergency decontamination procedures.
- Emergency medical treatment and first aid.
- Emergency alarms.
- Evaluation and follow-up after an emergency has occurred.
- Personal Protective Equipment (PPE) and other emergency equipment and supplies.
- • Discussion of the site's security procedure.

## **Emergency First Aid**

There must be personnel on site at all times who are certified in industrial first aid and CPR. The first aid station should be located near the clean end of the decontamination area. All first aid personnel should be trained to recognize heat stress and how to deal with it. Drills should be held on a regular basis.

---

## **Emergency Decon**

A worker might be injured and also contaminated. The first priority is always to save human life.

There may be cases where medical attention cannot wait for decontamination. Examples might include severe bleeding, cardiac arrest or heat stroke.

In other cases, it may be life threatening if the person is not decontaminated immediately. For example, if a person is lying in a pool of acid or caustic material.

An injured or unconscious person wearing protective clothing might also be suffering the effects of heat stress. Rapid medical attention is essential if there is the possibility of heat stroke.

Have a prior understanding with the ambulance service and hospital to deal with a chemically contaminated patient. These services do not want their equipment and facilities contaminated. Make arrangements in advance

---

## **Incident Reporting**

Federal, state and local laws require that most incidents and emergencies that occur at a hazardous waste site must be reported to the proper authorities. There can be serious criminal and civil penalties for failing to make required reports.

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If necessary, protective clothing might be cut away, rather than washed.

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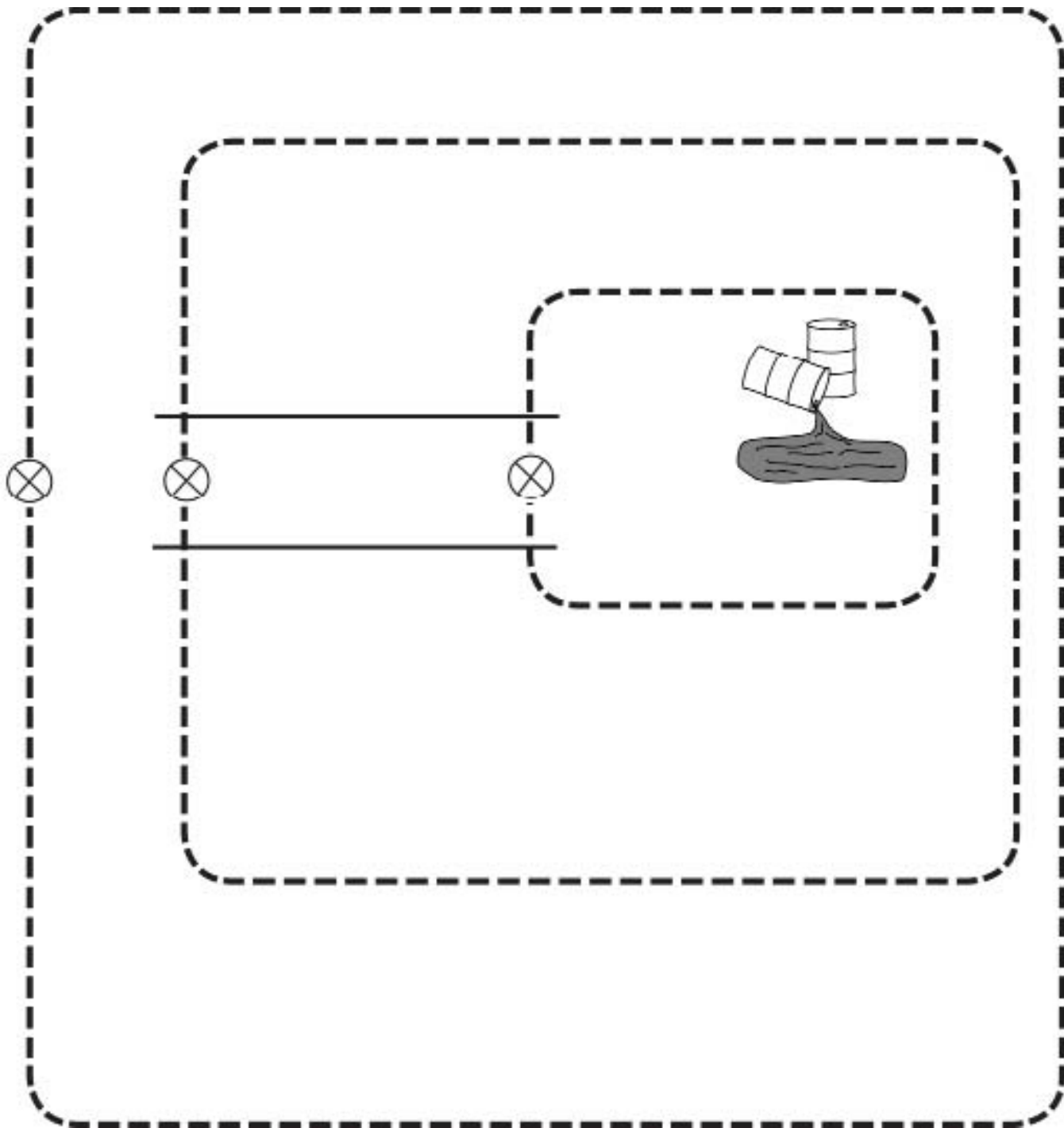
**Review  
Questions for  
Chapter 10**

1. What is the purpose of the buddy system?
2. What are three types of emergencies that might occur at a hazardous waste site?
3. List the major provisions of a Safety and Health Plan.

## **Review Questions for Chapter 10**

4. Identify the following areas and control lines on the hazardous waste site map on the next page:
  - a. Exclusion Zone.
  - b. Contamination Reduction Zone.
  - c. Support Zone.
  - d. Hot Line.
  - e. Contamination Control Line.
  - f. Contamination Reduction Corridor.
  - g. Access Control Points.
5. List in order of effectiveness four categories of control methods.

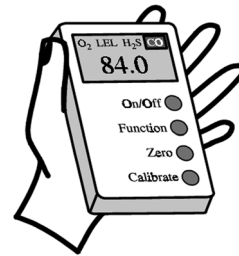




**Drum Valley Hazardous Waste Site**

## Chapter

# 11



# Air Monitoring Instruments

## Learning objectives

This chapter discusses the air monitoring instruments that we use to take measurements when hazardous waste and hazardous materials are present.

After completing this chapter you will be able to demonstrate your ability to:

1. DEFINE “direct reading.”
2. LIST the four types of measurements required at hazardous waste sites.
3. EXPLAIN what “action level” means.
4. LIST three limitations of direct reading instruments.
5. EXPLAIN the importance of:
  - a. Periodic calibration of instruments.
  - b. Proper maintenance and storage of instruments.

Before working in an area where there may be leaking containers, and before entering a confined space, we need to know:

- Is the oxygen level between 19½% and 23½%?
- Are there flammable vapors or gases?
- Are there toxic chemicals in the air?
- Are there sources of ionizing radiation?

There are instruments to help answer these questions.

Direct reading instruments take measurements right now. They provide “real time” information.

Direct reading instruments are used when we need the information right away, for example, during confined space entry. It wouldn't work to take a sample and then wait days or weeks for the laboratory to analyze it. By then the conditions would have changed.

---

The Site Safety and Health Plan must set **action levels** for each of the four conditions listed above. The action level is the point at which you take action. What action? This is simple: get out. If you're not already in, then stay out.

<b>Action Levels</b>	
<b>Oxygen:</b> No less than 19½% No more than 23½%	<b>Toxics:</b> No more than 50% PEL
<b>Flammables:</b> No more than 10% LEL	<b>Ionizing Radiation:</b> No more than 2.5 millirem/hour

## Why Take Measurements?

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Ideally, initial site monitoring is performed without periodic monitoring throughout the day to detect situational changes. Personal monitoring, after site activities begin should also be performed to accurately characterize workers exposures.

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There are also sampling instruments that collect a sample that has to be analyzed later in a laboratory to find out how much there is.

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## Action Levels

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Action levels must be at least as protective as those in this box.

---

## Direct Reading Instruments Electronic Instruments

If you've ever watched "Star Trek" then you've seen the ultimate direct reading instrument, the tri-corder. It's a device that identifies and measures just about everything. Unfortunately, it's only imaginary. The real instruments available to us are much less sophisticated.

There are electronic instruments that can measure:

- Oxygen.
- Combustible and flammable gases and vapors.
- Certain (but not all) toxic contaminants.
- Ionizing radiation.
- Noise.

Some instruments measure more than one thing. For example, an oxygen meter is often part of an instrument that also measures flammable gases and vapors.

Each instrument has a sensor that reacts to the presence of a particular condition, and a display which tells what the measurement is. The display on older instruments is a dial with a needle. Newer models have digital displays, like a calculator. Both kinds are acceptable. Some people prefer the dial display, because it's easier to notice if the reading is changing.

Personal air samplers can also be direct reading instruments. If these are used, they must be placed in the breathing zones of employees expected to have the highest exposure during the task being evaluated.

There are many brands and models. Be sure to read and understand the instructions that come with the instrument.

Colorimetric indicator tubes are glass tubes that contain special chemicals that change color if they are exposed to certain air contaminants.

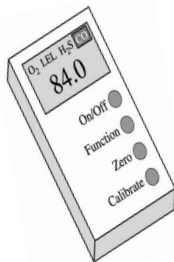
If you use an ammonia tube, for example, and there is ammonia vapor in the air, then the tube will change from yellow to purple. The longer the purple stain, the greater the concentration.

Colorimetric indicator tubes are only plus or minus 25% accurate, but that's good enough to get a rough idea of how much contaminant is in the air.

These tubes can react with more than one chemical, so they are most useful when you know what chemical is in the air, and want to get an estimate of what the concentration is.

## Colorimetric Indicator Tubes

### Direct Reading Instruments (not drawn to scale)



Multi-gas Meter



Colorimetric Indicator Tube

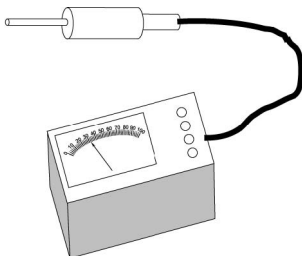
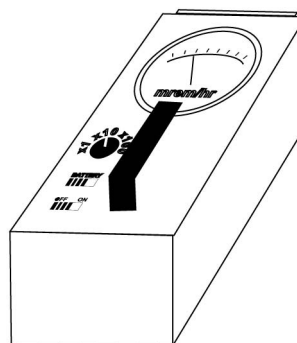
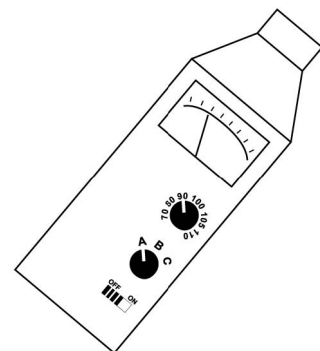


Photo Ionization Detector  
(for gases and vapors)



Radiation Survey Meter



Sound Level Meter

## What the Results Mean

Air monitoring is important, but it has limitations. No results are 100% accurate. You need to know how much faith you can put in monitoring results: what they mean – and what they don't mean.

- Conditions change. Monitoring only tells you what's happening at a specific time and place. It doesn't tell you what the situation will be later, or what it will be somewhere else. This is why repeated or continuous monitoring may be required, especially during confined space entry.
- Monitoring only measures some things. There may be other contaminants. Because you measure for one thing, and don't find it, doesn't mean that there aren't other contaminants that may be even more harmful. The type of monitoring must be appropriate for the contaminants or conditions that may be present.
- Monitoring equipment may be inaccurate. There are many reasons that monitoring equipment may give inaccurate results. For example:
  - If an instrument is not calibrated to the same contaminants that are measured, then its reading will probably be inaccurate.
  - Electronic devices rely on batteries, which can wear down. They have sensors and other components that may work less well over time, or be damaged by careless handling.

## Air Monitoring at Hazardous Waste Clean-up Sites

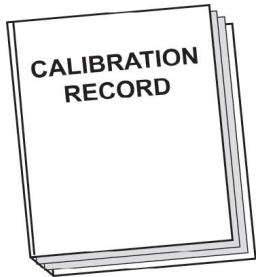
There are four types of monitoring using direct-reading instruments. OSHA requires that we measure each of these unless we know for sure that it's not present:

1. **Oxygen level.** This must always be monitored in confined space entries, and in any other situation where fire, chemical reaction or purging may have depleted the oxygen level.
2. **Lower Explosive Limit (LEL).** Check whether an explosion hazard exists, unless you know for certain that no flammable or combustible material is present.
3. **Toxics.** This is difficult, since there are thousands of toxic contaminants. The more information you have about what chemicals were used at the site, the easier it will be to pick what to measure for.
4. **Ionizing radiation.** It's not necessary to survey for ionizing radiation if you know for certain that radioactive materials were never used on the site.

Suppose that you have to clean out an abandoned tank that was used for storing toluene. Toluene is both a flammable vapor, and a toxic. You need to measure for both. You want to make certain that you are below the action level for flammables (10% LEL) and also below the action level for toxics (50% PEL).

You would use a Combustible Gas Indicator (CGI) calibrated to toluene vapor to measure %LEL. You would also use a multi-gas meter or a colorimetric indicator tube to measure the concentration in ppm and compare it to the PEL.

## Calibration and Maintenance



Your life and health may depend on the accuracy of monitoring equipment. Instruments are worthless unless you know that they are functioning properly. This means regular inspection and servicing, proper storage, and being calibrated correctly.

There should be a designated person trained to inspect and calibrate the equipment regularly, and to assure that it is stored properly. Internal adjustments or other specialized service should be done by a qualified technician, usually at the manufacturer or distributor. Keep careful records of all service.

Each person who uses an instrument should be trained to make field adjustments as needed, and to recognize obvious signs of malfunctioning.

It is all too common to lose the instructions, and to then make mistakes in operation. Make at least one extra copy. For example, the instruction sheets that come in each box of colorimetric indicator tubes have a knack for getting lost. Keep copies in a binder.

Calibration must be done with a calibration gas or source that matches the contaminant or condition that will be measured. Keep a calibration record. Ideally this is a bound book in which you record the serial number of the instrument, and the date, time, method and result of the calibration.

Many instruments can be calibrated easily every day, or each time you use them.

At a minimum, calibrate each instrument when it arrives new, after servicing, after batteries are changed, after dropping or other mishandling, and if a long time has passed since the last use.

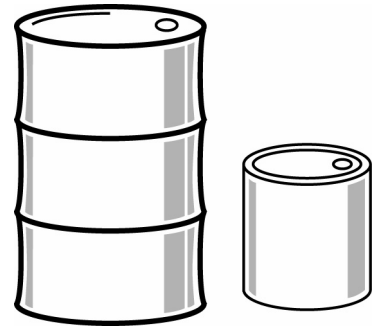


**Review  
Questions for  
Chapter 11**

1. What does “direct reading” mean?
2. What four measurements does OSHA require at hazardous waste clean-up sites?
3. What does “action level” mean?
4. List three limitations of direct reading instruments.
5. Why are calibration and maintenance important?

## Chapter

# 12



# Safe Work Practices Drum and Container Handling

## Learning objectives

This chapter discusses how to safely handle drums and other containers of hazardous waste and hazardous materials.

After completing this chapter you will be able to demonstrate your ability to:

1. IDENTIFY the proper method to inspect a drum before handling.
2. IDENTIFY the proper method to open a drum.
3. IDENTIFY the proper method to take a sample from a drum.
4. IDENTIFY the proper method for using a salvage drum.
5. IDENTIFY the purpose of staging drums.
6. IDENTIFY safe work practices to minimize risks presented by handling materials on a hazardous waste site.

Hazardous waste comes in various containers including bottles, bags, cylinders, tanks, cans and drums. The most common container at hazardous waste sites is the 55 gallon metal drum.

Cleaning up a hazardous waste site often involves finding drums, assessing their condition, identifying their contents and organizing (staging) them for shipment and disposal.

Accidents can occur when handling drums and other containers. These include fire, explosion, chemical reaction and the release of hazardous substances.

There is also the risk of physical injury from lifting and moving heavy containers by hand, and the danger that improperly stacked or hoisted containers might fall.

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Before sampling, moving or otherwise handling a drum or other container, perform a visual inspection:

- Look for labels that might identify the contents.
- Look for deterioration, corrosion, or leaks.
- Look for signs that the container is under pressure. Is it swelled or bulging? Attempting to open or move a pressurized drum could cause serious exposure and possibly an explosion.
- How does it open? Note what type of head and bungs (plugs) a drum has.

## **Safe Work Practices: Materials Handling**

29 CFR 1910.120 (e) (2) (iv)

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**Proper safe work practices are essential to prevent accidents when handling drums and other containers.**

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## **Visual Inspection**

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**If a hazardous substance was disposed of in its original container, then the label may be accurate. However, it might have been disposed of in a used container with an older, incorrect label.**

---

## Environmental Monitoring

The Site Safety and Health Plan may require air monitoring near drums. The presence of contaminants can indicate that chemicals are escaping.

If there is the possibility that a container holds radioactive material, then a radiation survey meter should be used to determine the radiation levels around the container.

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## Opening Drums

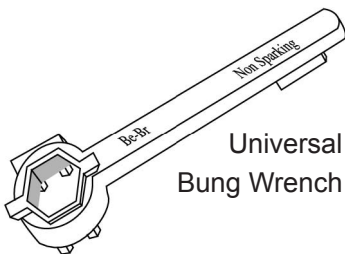
It can be very dangerous to open a drum, especially if you don't know for certain what it contains.

- Use a face shield, protective clothing and a respirator if required by the Site Safety and Health Plan.
- Use the buddy system.
- Do a visual inspection.
- Remove any water from the top of the drum.

The safest way to open a drum is to use a remote mechanical opening device.

If you have to unscrew a bung by hand:

- Use a non-sparking bung wrench to reduce the possibility of a static spark which could ignite flammable vapors.
- Turn the bung slowly. Even a non-sparking tool cannot prevent friction between the threads on the drum and the bung.
- If you hear hissing, wait for the pressure to release before continuing to turn the bung.



There are several types of remote drum opening equipment:

- A metal spike welded to the bucket of a backhoe. The backhoe itself can have steel plates to protect the operator in the event of an explosion.
- Remote hydraulic or pneumatic puncture device, drum deheader or impact bung wrench.

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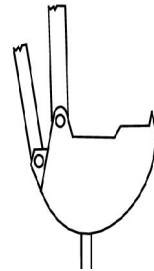
A container may require sampling to identify its contents, or determine its flash point, pH, or water solubility.

Follow the procedure in the Site Safety and Health Plan. The plan should specify:

- Which drums to sample.
- What the drums are likely to contain.
- Standard operating procedures for opening the drums and taking samples.
- Personal protective equipment including face shields, protective clothing and respirator.

In the past, “ballistic sampling” was sometimes done. This meant firing a rifle at a drum from a distance. The idea was that the bullet would relieve pressure inside the drum and would indicate whether the contents were explosive or flammable. This practice is unsafe and should not be used.

## Remote Drum Opening Equipment



## Taking a Sample From a Drum

## Handling Drums

There are two main hazards associated with handling drums and other containers:

- **Chemical hazards**, including toxic exposure, dangerous reactions, fire and explosion.
- **Ergonomic injuries** from heavy or improper lifting.

To avoid injury, whenever possible, use mechanical handling equipment. There are special drum grappler attachments available for forklifts and backhoes. There are also drum loading attachments for boom trucks.

If the drums are on pallets, tie them down with straps before moving the pallet.

Use the buddy system and follow the standard operating procedures in the Site Safety and Health Plan.

---

## Drum Staging

**Drum Staging** is the process of organizing drums:

- In an orderly manner that allows easy and safe access for personnel and equipment.
- In categories by chemical compatibility.

Staging areas should be carefully designed. The surface should be paved, or covered with gravel with a plastic liner underneath. There should be a berm or dike around the area, and a system to catch runoff.

Often we put a damaged or leaking drum inside of a larger **salvage drum**. The safest procedure is to use mechanical equipment. If you do it by hand:

1. Set both the drum and the salvage drum on their sides. Work the drum part way into the salvage drum and then roll them both on an angle until the drum is completely inside. Then turn the salvage drum upright.
2. Another procedure is to place the salvage drum upside down over the other drum, and then carefully turn them both over.

## Salvage Drums

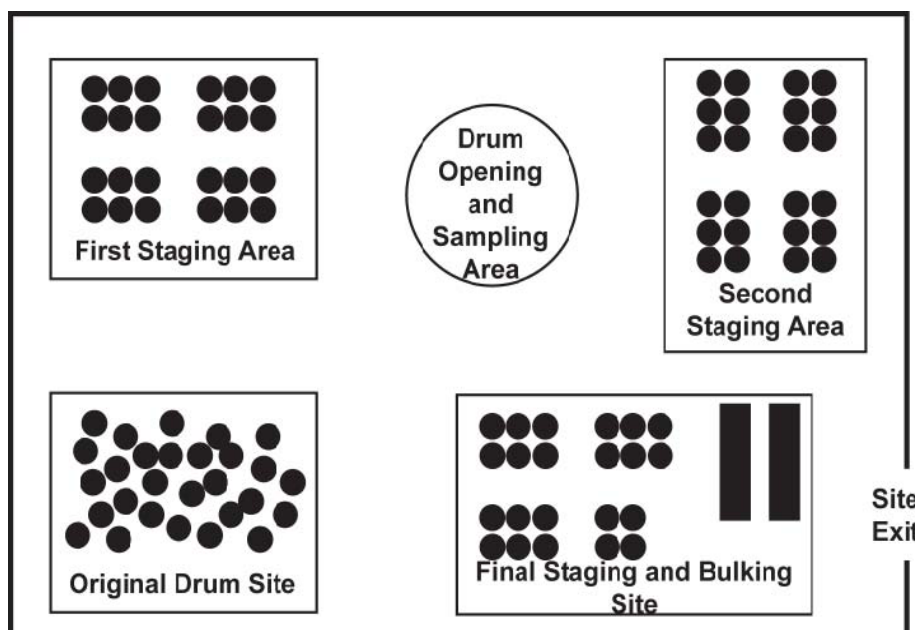


Bulking means to transfer hazardous waste into a larger (bulk) container such as a tank in order to transport the waste off site. Often several different materials are placed in the same bulk container. It is very important that only compatible materials go in the same bulk container.

## Bulking

As with other tasks, follow the procedures specified in the Site Safety and Health Plan.

## Example Staging Areas



**Review  
Questions for  
Chapter 12**

1. Describe how to inspect a drum or other container.
2. Describe the proper method to open a drum.
3. Describe the proper method to sample a drum.





## Chapter

# 13



# Confined Spaces

## Learning objectives

This chapter provides awareness training about the hazards of **confined spaces** so that you will be able to **recognize** and **avoid** them.

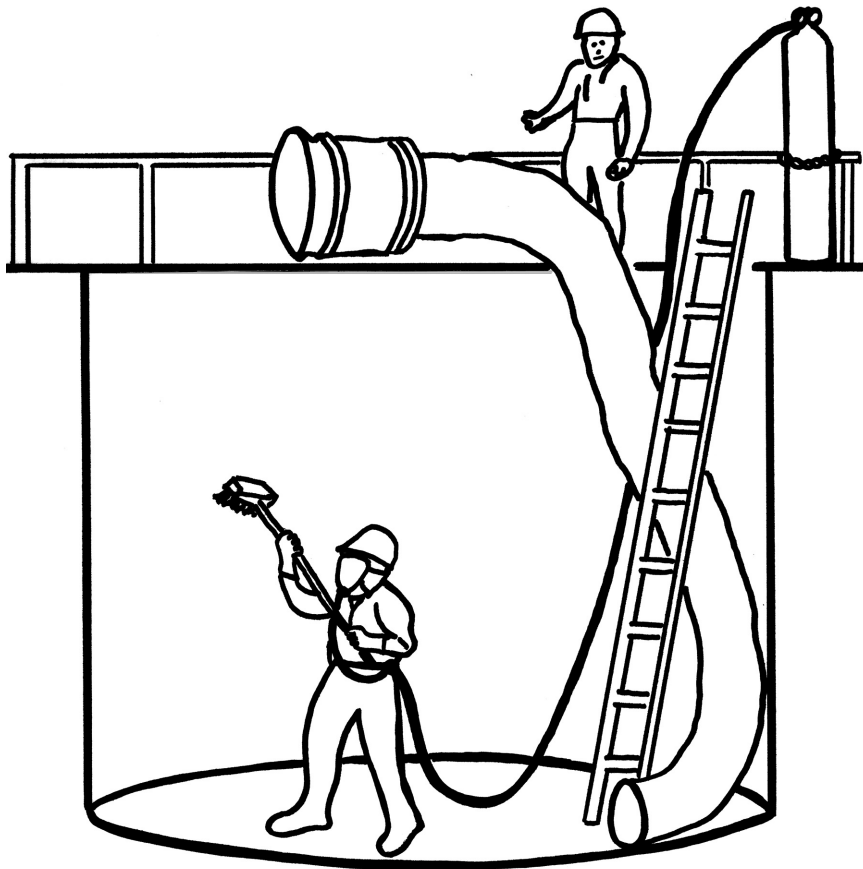
If your job requires that you enter a confined space, then you must first receive more detailed training including site specific information about your employer's confined space entry and rescue procedures.

After completing this chapter, you will be able to demonstrate your ability to:

1. IDENTIFY five characteristics that make a confined space hazardous.
2. IDENTIFY three hazardous atmospheres found in confined spaces.
3. IDENTIFY five other hazards found in confined spaces.
4. IDENTIFY the requirements for a confined space permit.
5. IDENTIFY two reasons why a confined space permit is important.

Confined space work is dangerous and results in many injuries and deaths each year. It is important that you know how to recognize a confined space and understand how hazardous it can be. Before you do work in a confined space you need to know the procedures and equipment that are required for safe entry. You also need to know the rescue procedures.

This chapter provides awareness training - how to recognize and avoid confined spaces. If your job requires you to enter a confined space, then you need additional confined space training, including your employer's entry and rescue procedures.



## Confined Spaces Are Hazardous

29 CFR 1910.146 and  
1910.120((b)(4)(ii)(I))

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**This is awareness training. It teaches you to recognize and avoid confined spaces.**

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**If you need to work in a confined space you need additional training.**

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# What Is A Confined Space?

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Any health or safety hazard might exist in a confined space.

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If anything bad occurs, it will be worse, because it's in a confined space.

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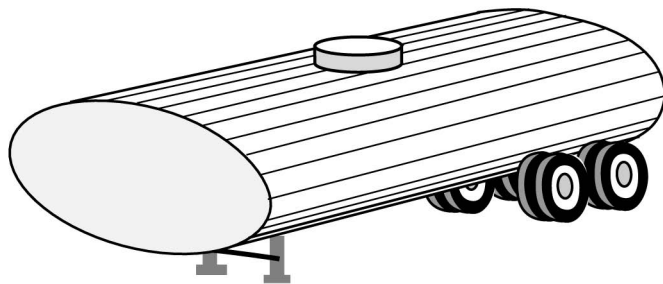
Many confined spaces are easy to recognize: tanks, tank trucks, tank cars, boilers, pipelines, septic tanks, manholes, utility vaults, sewers and ventilation ducts.

In some cases, it might be less obvious whether a work area is a confined space. For example, sumps and pits must be treated as confined spaces even though they appear to be open to the air.

Any type of health or safety hazard might be present in a confined space. However, if an accident or hazardous exposure occurs, the consequences are often worse because they occur in a confined space.

For example, using a chipping hammer to remove slag or corrosion is a noisy operation. Inside a steel tank the noise is even louder. When using a solvent to remove grease, toxic vapors may be released. In a sump pit the concentration of vapors will be greater because there is less air to dilute them.

Also, if an accident occurs in a confined space, it is more difficult to escape or to be rescued.



Several characteristics make confined spaces dangerous:

- **Restricted entry and exit.**  
It's hard to get in or out, and difficult for rescue personnel to respond quickly.
- **Not designed for continuous work.**  
The space was made for some other purpose, not for people to work there.
- **Poor ventilation.**  
It's hard for fresh air to get in or contaminants to get out.
- **May contain a hazardous atmosphere.**  
There may be **oxygen deficiency, toxic air contaminants, or flammable gases and vapors.**
- **May contain other hazards.**  
Moving machinery, electrical hazards, process liquids, engulfment hazards, extreme hot or cold temperatures.

Hazardous atmospheres are the most common cause of death in confined space accidents. Because of poor natural ventilation, fresh air does not come in easily, oxygen is not replaced and the level of toxic or flammable materials in the air may build up.

## What Makes Confined Spaces Dangerous ?

---

Three types of air hazards:

1. Oxygen deficiency
  2. Flammables/Vapors
  3. Toxic contaminants
-

# Oxygen Deficiency

Normal air contains 21% oxygen. This is the level that our bodies are designed to live with. Any level below 19½% is oxygen deficient and is unsafe for entry without an atmosphere supplying respirator.

You won't die at 19½%. However, you will probably begin to experience tiredness, delayed reflexes and poor coordination. At lower levels more serious effects occur.

The confined space must be tested for oxygen before anyone enters. It must also be tested during the time that workers are inside, because conditions may change.

- Welding or other activities can use up oxygen.
- Other gases such as carbon dioxide or nitrogen might displace oxygen.

It is also possible to have too much oxygen. Greater than 23½% is also not allowed. Extra oxygen is an extreme fire hazard because it makes combustible materials burn much more easily.

<b>Oxygen Levels</b>	
<b>23½%</b>	<b>OSHA maximum for safe entry</b>
<b>21%</b>	<b>Normal</b>
<b>19½%</b>	<b>OSHA minimum for safe entry</b>
<b>16%</b>	<b>Impaired breathing and judgement</b>
<b>14%</b>	<b>Rapid fatigue, faulty judgement</b>
<b>6%</b>	<b>Death in minutes</b>

Flammable gases and vapors can accumulate in a confined space. They may come from material stored in the space. They might also be generated by workers in the space, for example, using cleaning solvents.

If there is enough of a flammable material in the air – but not too much – then the concentration is in the explosive (or flammable) range. Any ignition source, even a small spark, can start a fire or explosion. In a confined space the result can be deadly.

OSHA does not allow entry into a confined space if the concentration is greater than 10% of the LEL. Use the Combustible Gas Indicator (CGI) or a multigas meter to measure the flammable concentration.

What if the actual concentration were above the UEL? That doesn't mean it's safe to enter. Activity in the space might allow some vapor to escape and more air to come in. The concentration would drop into the explosive (or flammable) range.

---

Any toxic air contaminant might be encountered in a confined space, depending on what the space was used for, or what products workers bring into the space:

- Gases produced by decomposition or decay.
- Residues and sludges from stored materials.
- Cleaning solvents.
- Welding or burning that releases toxic fumes.
- Materials that enter the space through pipes that have not been properly disconnected.

## Flammables

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**No entry is allowed if the concentration is greater than one tenth of the LEL.**

---

## Toxic Atmospheres

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**Toxic contaminants come in two forms:**

- 1. Gases / vapors**
- 2. Particulates**

---

# Safety With Hazardous Atmospheres

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To know it's safe,  
air monitoring must be  
done:

1. Before anyone enters.
  2. During the time that workers are inside.
- 

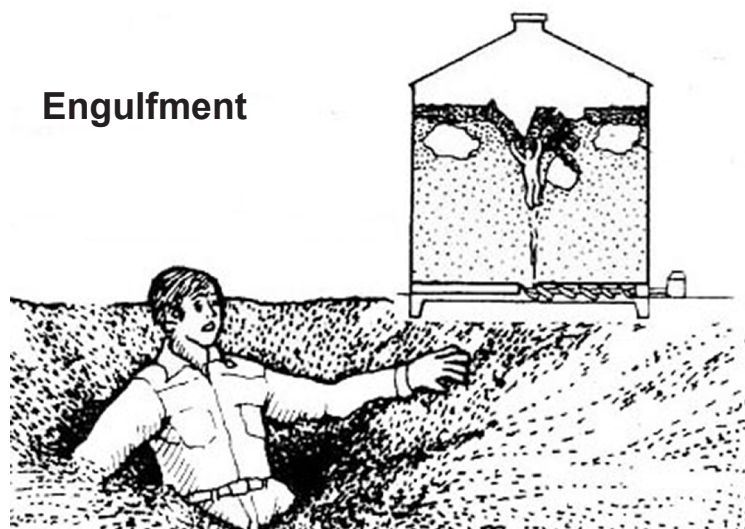
Never enter a confined space unless proper monitoring is being done. **Stay out, or get out, if there is:**

- **Less than 19½% oxygen.**  
Unless you are wearing an SCBA or an air-line respirator with escape cylinder.
- **More than 10% of the LEL of a flammable material.**
- **More than 50% of the PEL of an air contaminant.**  
Unless you are wearing the proper respirator.
- **More than the IDLH of a toxic air contaminant.**  
Unless you are wearing an SCBA or an air line respirator with escape cylinder.

Do not enter to do the initial testing. Use equipment with a hose or other remote capability.

Continue monitoring while workers are inside.  
Conditions may change!

All monitoring must be done by a properly trained person using the appropriate, calibrated equipment.





## Other Confined Space Hazards

**Electrical Hazards:** Electrically-operated equipment such as pumps, heating coils, electric tools and temporary lighting create the risk of electric shock. The risk is greater if there are wet surfaces or standing water.

**Sparks:** Electrical equipment can create sparks that ignite a flammable atmosphere. If there is any possibility of a flammable atmosphere, use explosion-proof lighting and wiring, and air driven-tools.

**Moving Machinery:** All moving parts such as mixing blades must be properly locked out so that the equipment does not start up accidentally.

**Process Liquids:** Liquids create hazards of drowning or toxic exposure. Pipes must be blocked off so that liquids cannot accidentally enter while workers are inside.

**Engulfment Hazards:** Loose material such as sand, grain, or coal can engulf and suffocate a person. The material can “bridge over”, creating what looks like a safe surface, but which breaks and swallows a worker who steps on it.

**Extreme Temperatures:** Extremely hot or cold temperatures can be a hazard. If the space has been steam-cleaned, allow it to cool before workers enter. Any heating or cooling equipment should be properly locked out so that it cannot activate accidentally.

**Noise:** Reverberation makes noise even louder in a confined space. Loud noise can damage hearing and interfere with communication.

**Falling Objects:** Watch out for the possibility of falling objects, especially in spaces with overhead openings.

# Confined Space Program

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The OSHA Standard  
for Confined Spaces in  
general industry is 29  
CFR 1910.146.

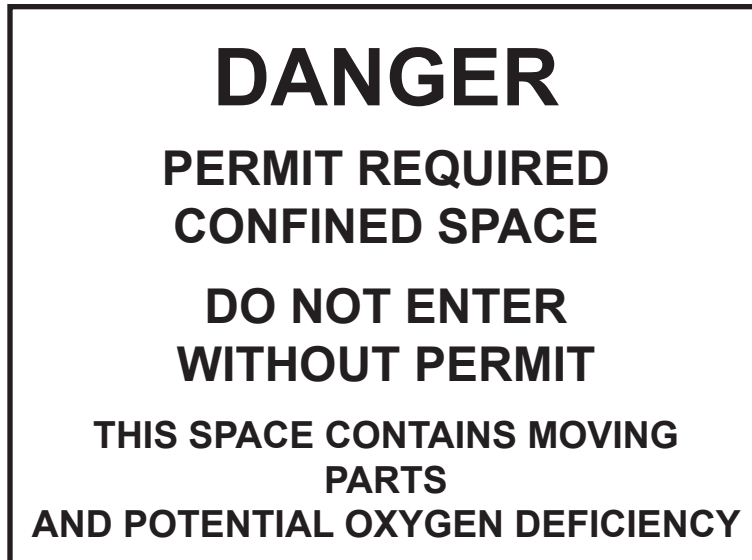
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Working in a confined space is dangerous. Your employer must provide you with the proper training, equipment and supervision to reduce the risks involved in confined space entry. This means that your employer must have a comprehensive Confined Space Program.

OSHA requires a Confined Space Program that includes:

- Identifying and labeling confined spaces.
- A Confined Space Permit System.
- Evaluation of the hazards before anyone enters.
- Air monitoring before and during the entry.
- Specific safe work practices.
- All necessary safety equipment.
- Standby personnel to monitor workers inside and to summon the rescue team if an accident occurs.
- Training for all workers and supervisors involved.
- Close-out procedures to make sure that all workers have left safely and it is OK to return the space to its intended purpose.
- A rescue plan.
- Procedures for sharing information about confined spaces if there are multiple contractors.

OSHA requires your employer to determine if there are any confined spaces in the workplace. Each confined space must be posted with a sign. This is an example:



Although not specifically required by OSHA, a confined space sign might also include specific work practices such as what type of respirator to wear. The sign might also include an emergency phone number.

Entry means putting any part of your body into the confined space. If you stick your head through the opening to get a quick look or to sniff the air inside, you have just entered the confined space. These are unsafe work practices unless all safe entry procedures have been followed, including, if necessary, wearing the proper respirator.

## Labeling and Posting

29 CFR 1910.120 (b) (4) (ii) (I)

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In many cases, it is appropriate to lock the confined space to prevent unauthorized entry.

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## What Does “Entry” Mean?

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Never stick your head inside to get a quick look or sniff the air. One breath could be fatal.

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# **Confined Space Permits**

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**All confined spaces should be treated as permit spaces until it is determined otherwise.**

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**A Confined Space Permit takes time to fill out properly.**

**Don't cut corners. Failure to carefully complete the permit could cost lives.**

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**If the work will be continued by a different crew, or by the same crew on a different shift, this is a new entry and a new permit should be issued.**

---

The Confined Space Permit authorizes the work to be done and certifies that all necessary safety procedures are in place. The permit must include:

- The location of the confined space.
- The purpose of the entry.
- The date and duration of the entry.
- Names of all workers who will enter.
- Names of standby personnel.
- Supervisor's name and signature.
- Identification of all present or potential hazards.
- Specific procedures such as lock-out, ventilation and purging.
- Air testing to be done before and during entry.
- How to summon the Rescue Team.
- Communication procedures.
- List of all required PPE, including respirators.
- If "hot work" such as welding is to be done, an additional Hot Work Permit must be issued.

The permit is not just a piece of paper. It serves two very important purposes:

- Assures that time is taken to identify all hazards and to take all necessary precautions to protect the lives of workers. It's like the checklist that a pilot goes through before taking off.
- Requires the supervisor to take responsibility, in writing, for assuring that safe work practices are followed. It holds the supervisor accountable.

---

If monitoring reveals oxygen deficiency, toxic contaminants, or flammables then the space must be ventilated and tested again before workers enter.

Ventilation works best if clean air is blown into the space at one end and allowed to exit at the other end. If the space has only one opening, blow air in through a hose located as far into the space as possible. Fresh air will travel through the space and push out contaminants on its way out.

Use clean air. Make certain the blower's intake is not near a source of contaminants such as vehicle exhaust.

Sometimes an inert gas such as argon or carbon dioxide is used to purge a confined space. Even if the material used for purging is not toxic, it can cause oxygen deficiency by displacing the air inside the space. Ventilate with fresh air and monitor before entering.

## **Why Is The Permit So Important?**

## **Ventilation and Purging**

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**For example, to ventilate a manhole, run the hose to the bottom so that contaminated air is forced up and out.**

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## **Lock-Out/ Tag-Out**

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**Each worker should have their own lock. Equipment can only be turned on after each worker has removed their own lock.**

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## **Standby Attendant**

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**More than 50% of all the workers who die in confined space accidents are would-be rescuers who enter without the proper equipment and training.**

---

It is essential to isolate a confined space from sources of hazardous energy. The best method is lock-out:

- Lock-out electrical circuits by removing circuit breakers and putting locks on the switches.
- Lock-out pipes by removing a section of pipe and sealing both exposed ends with solid plates. This is called “double blank and block.”
- Lock-out mechanical equipment by removing gears, drive shafts or chain drives.

Also tag-out the equipment with a sign to alert others that the equipment must remain out of service.

Remember that tag-out by itself – without lock-out – does not prevent an accidental start-up.

---

A trained attendant (standby person) must be assigned to remain outside the confined space while workers are inside. The attendant should not have any other duties such as operating equipment or moving supplies that prevent giving his or her full attention to the workers inside the confined space.

The attendant is responsible for starting the rescue procedure that is described in the employer’s Site Safety and Health Plan. Usually this means calling the rescue team.

The attendant should only enter the confined space if he or she is part of the rescue team and is properly trained and equipped.

## Rescue

More than one-half of all the workers who die in confined space accidents are would-be rescuers. They die because they do not have the training or equipment to perform a safe rescue. It is normal to want to help your fellow worker. However, you are not helping if you only add to the list of fatalities.

The only effective way to protect confined space workers is to have a Rescue Plan and specially-trained and equipped rescue personnel.

The rescue team must practice or drill regularly in the various situations which might occur. This includes entering different kinds of confined spaces and extracting actual workers or mannequins.

In many cases, it is best to provide for non-entry rescue. This means that the workers entering the confined space are equipped with harnesses that will allow them to be extracted without anyone else actually entering.

OSHA allows the employer to rely on an off-site rescue team such as a fire department. However, these rescuers might arrive too late.

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**Many confined space accidents result in multiple deaths when would-be rescuers enter without the right training and equipment.**

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**You have the best protection if your employer maintains a properly trained and equipped on-site rescue team.**

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## **Review Questions for Chapter 13**

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**This chapter is not a substitute for the specific confined space training required by OSHA for workers who actually enter confined spaces.**

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1. Identify five characteristics that make confined spaces hazardous.
2. Identify three hazardous atmospheres that might be found in a confined space.
3. Identify five other hazards that might be found in a confined space.



4. Identify eight requirements for a proper confined space program.

## **Review Questions for Chapter 13**

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**This chapter is not a substitute for the specific confined space training required by OSHA for workers who actually enter confined spaces.**

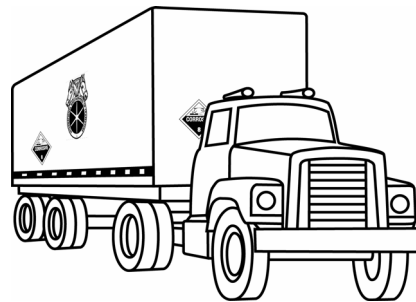
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5. Identify two reasons why a confined space permit is important.

## Chapter

# 14

## Hazmat Transportation and Spill Containment



### Learning objectives

This chapter discusses DOT safety and security requirements for transporting hazardous materials, including hazardous waste.

After completing this chapter, you will be able to demonstrate your ability to:

1. IDENTIFY the DOT and OSHA training requirements for workers involved in the transportation of hazmat.
2. IDENTIFY the proper shipping name of a hazardous material.
3. IDENTIFY the proper markings and labels for a hazardous material.
4. IDENTIFY the proper placard for a hazardous material.
5. IDENTIFY two DOT tables used to determine how to segregate incompatible hazardous materials.
6. IDENTIFY the proper procedures to follow in the event of a leak or spill of hazmat.

## What does Hazmat Mean?

The U.S. Department of Transportation (DOT) has detailed regulations for the safe transportation of hazardous materials (hazmat).

This is how DOT defines hazmat:

**Hazardous material means a substance or material, which has been determined ... to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce ... [49 CFR §171.8]**

In other words, hazmat means chemicals, radioactive materials and biological materials which – if they leak or spill during transportation – could injure or kill people, damage property, or harm the environment.

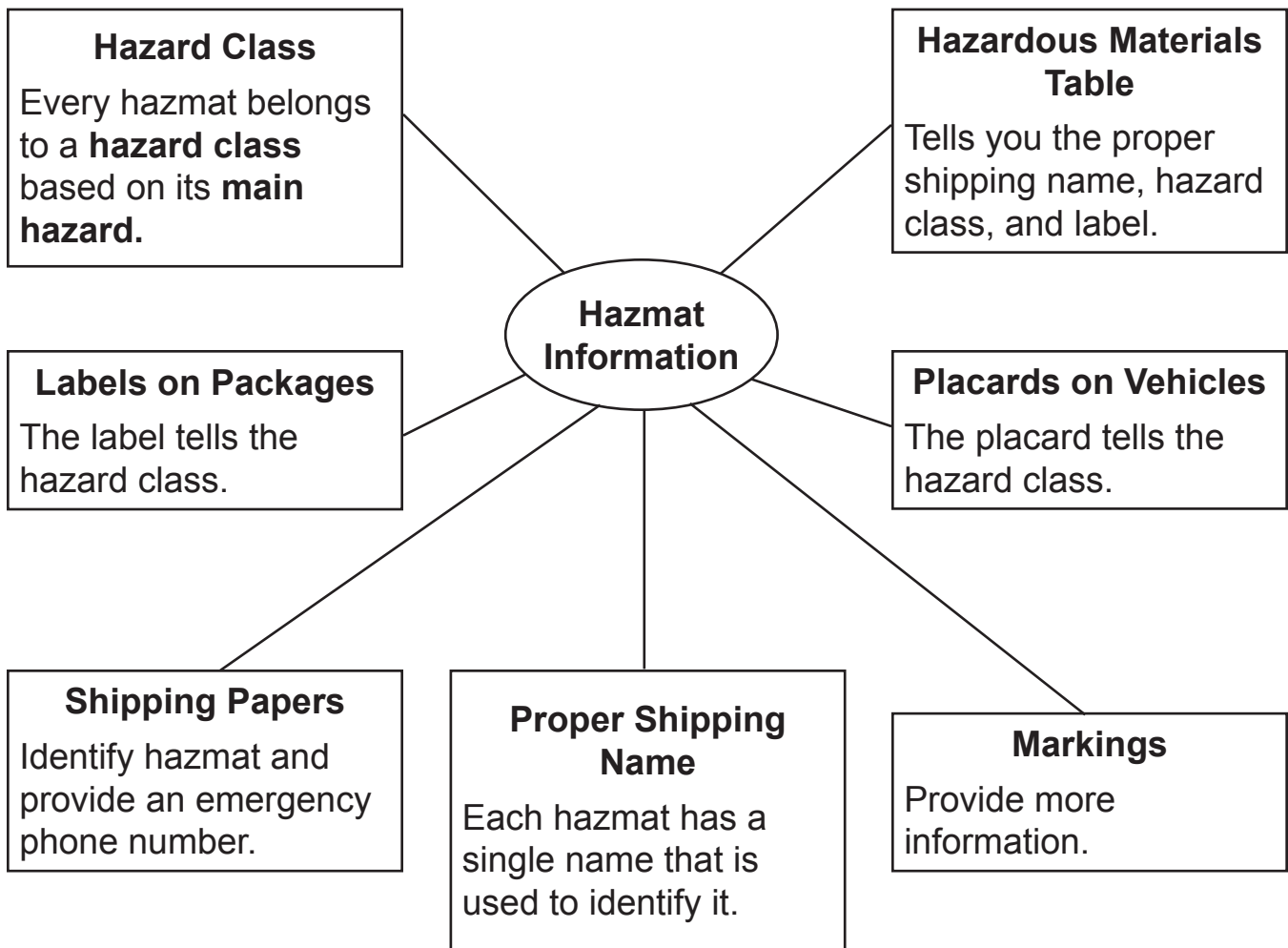
Hazmat includes all of the following:

- **Hazardous chemicals.**
- **Hazardous substances.**
- **Hazardous waste.**
- **Radioactive materials.**
- **Infectious substances.**

# Hazmat Regulations

The DOT regulations include requirements for:

- Package and container specifications for hazmat.
- Putting labels and markings on hazmat packages.
- Loading hazmat vehicles.
- Putting placards and markings on hazmat vehicles.
- Driving and parking hazmat vehicles.
- Storing hazmat.
- What do to – and not do – if there is a leak, spill, or traffic accident.



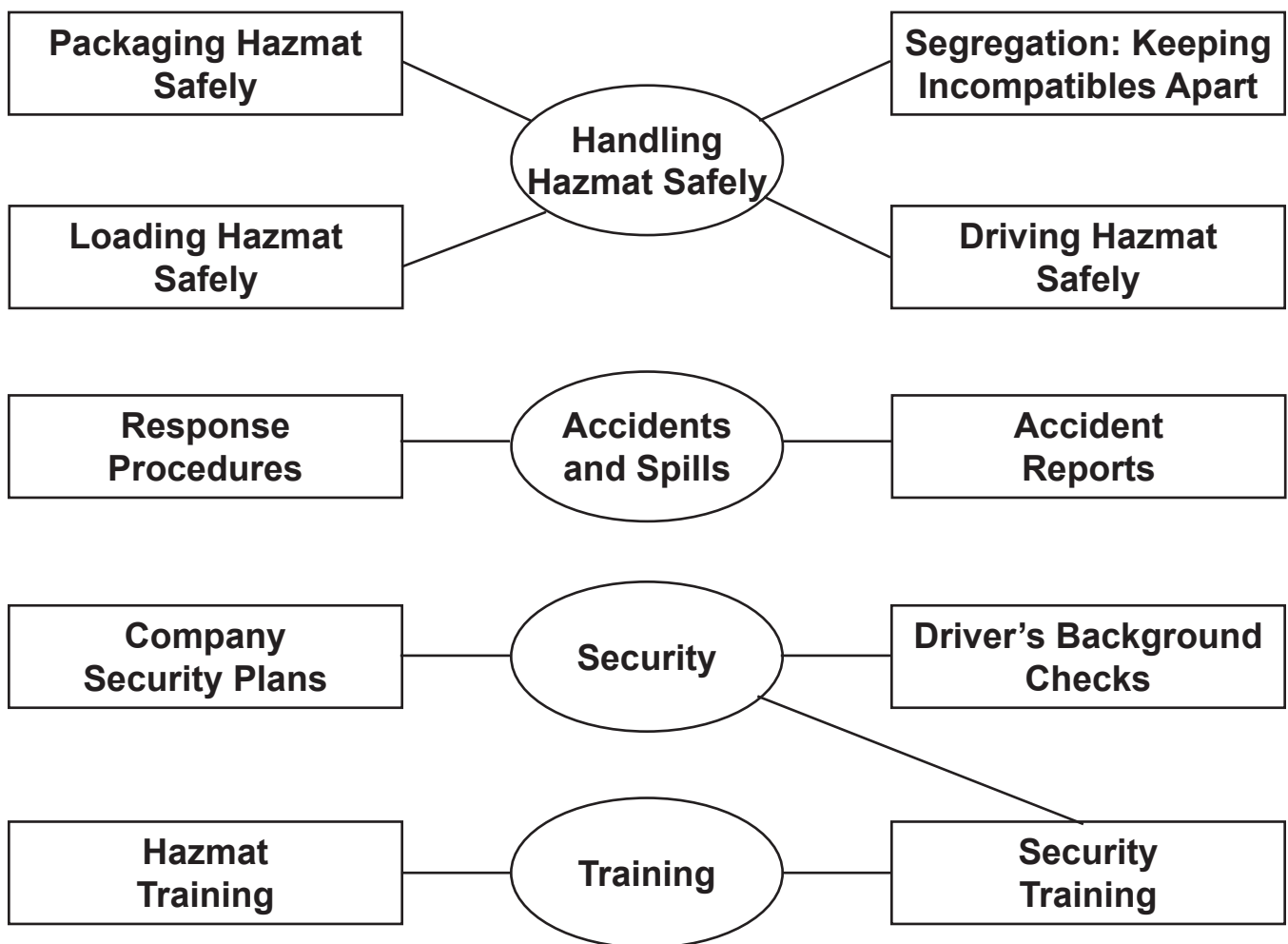
DOT also requires:

- **Training** for all hazmat transportation workers.
- **Background checks** for hazmat drivers.

If your job involves hazmat transportation (for example, if you are a driver or dock worker) then you need to know the DOT rules for handling hazmat safely – and you need to follow those rules.

We will discuss the regulations for the subjects shown in this chart.

## Hazmat Regulations



# DOT Hazard Classes and Divisions

There are many kinds of hazmat. DOT classifies them according to the **type of hazard** they present. There are **nine hazard classes** and one other category called "Otherwise Regulated Materials (ORM-D)."

Some hazard classes are also divided into **divisions**.

## Class 1: Explosives

The explosives class has six divisions:

- Division 1.1 Mass explosion hazard
- Division 1.2 Projection hazard
- Division 1.3 Fire hazard
- Division 1.4 No significant blast hazard
- Division 1.5 Very insensitive; mass explosion hazard
- Division 1.6 Extremely insensitive



## Class 2: Compressed Gases

The compressed gases class has three divisions:

- Division 2.1 Flammable gas
- Division 2.2 Non-flammable gas, non-toxic gas
- Division 2.3 Poisonous gas (inhalation hazard)



### Class 3: Flammable (and Combustible) Liquids



Red



Red

### DOT Hazard Classes and Divisions

### Class 4: Reactive material

This class has three divisions:

- Division 4.1 Flammable solid
- Division 4.2 Spontaneously combustible
- Division 4.3 Dangerous when wet



Blue



Red



Red stripes

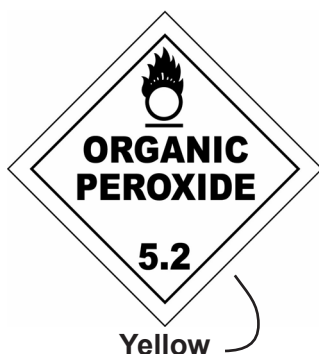
### Class 5: Oxidizing substances and organic peroxide

This class has two divisions:

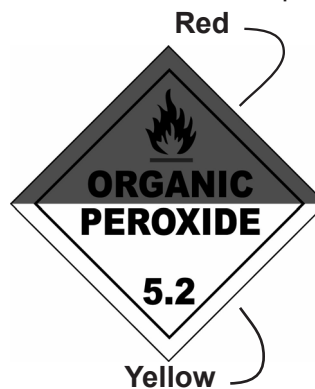
- Division 5.1 Oxidizer
- Division 5.2 Organic peroxide (Three different placards and labels in use.)



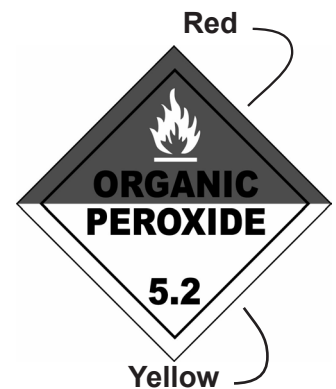
Yellow



Yellow



Yellow



Yellow

## DOT Hazard Classes and Divisions

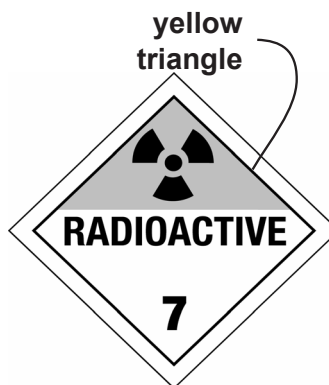
### Class 6: Poisonous materials and Infectious substances

This class has two divisions:

- Division 6.1 Poisonous materials
- Division 6.2 Infectious substances



### Class 7: Radioactive Material



### Class 8: Corrosive Material





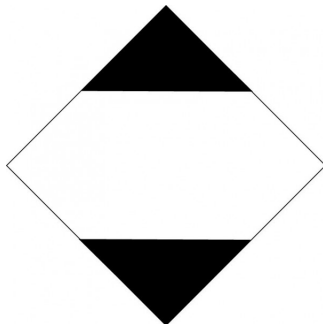
## Class 9: Miscellaneous Hazardous Material

Examples of Class 9 Hazardous Materials include asbestos and dry ice. For Class 9 Hazmat, placards are not required for transportation within the United States. However, bulk amounts of Class 9 Hazmats must be marked with the appropriate ID number (UN or NA) on a Class 9 Placard, an orange panel, or a white square-on-point.

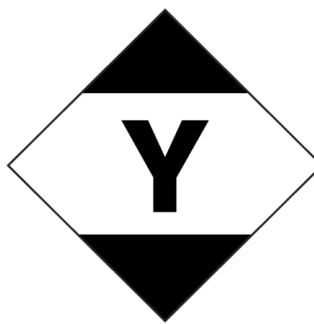


ORM-D includes consumer commodities such as aerosol sprays or other hazardous materials that are packaged for retail sale. Although the total quantity of the shipment may be significant, if the packages are packed for resell, they don't require a placard.

Since January 2011, a new limited quantity marking designates hazardous material packages. The ORM-D classification and the use of packagings marked "Consumer commodity, ORM-D" is authorized until December 31, 2020, for domestic highway, rail, and vessel transportation. After that, the Limited Quantities placard is required. [49 CFR §172.315]



Limited Quantities Placard



Limited Quantities  
(by Air) Placard

## DOT Hazard Classes and Divisions

## Other Regulated Materials (ORM-D) and Limited Quantities



### DOT Hazard Classes and Divisions

<b>Class 1</b>	<b>Division 1.1</b>	<b>Explosive (with a mass explosion hazard)</b>
	<b>Division 1.2</b>	<b>Explosive (with a projection hazard)</b>
	<b>Division 1.3</b>	<b>Explosive (with predominately a fire hazard)</b>
	<b>Division 1.4</b>	<b>Explosive (with no significant blast hazard)</b>
	<b>Division 1.5</b>	<b>Very insensitive explosive, blasting agents</b>
	<b>Division 1.6</b>	<b>Extremely insensitive detonating substance</b>
<b>Class 2</b>	<b>Division 2.1</b>	<b>Flammable gas</b>
	<b>Division 2.2</b>	<b>Nonflammable compressed gas and oxygen</b>
	<b>Division 2.3</b>	<b>Poisonous gas</b>
<b>Class 3</b>	.....	<b>Flammable liquid or combustible liquid</b>
<b>Class 4</b>	<b>Division 4.1</b>	<b>Flammable solid</b>
	<b>Division 4.2</b>	<b>Spontaneously combustible material</b>
	<b>Division 4.3</b>	<b>Dangerous when wet</b>
<b>Class 5</b>	<b>Division 5.1</b>	<b>Oxidizer</b>
	<b>Division 5.2</b>	<b>Organic peroxide</b>
<b>Class 6</b>	<b>Division 6.1</b>	<b>Poisonous material</b>
	<b>Division 6.2</b>	<b>Infectious substance (etiologic agent)</b>
<b>Class 7</b>	.....	<b>Radioactive material</b>
<b>Class 8</b>	.....	<b>Corrosive material</b>
<b>Class 9</b>	.....	<b>Miscellaneous hazardous material</b>
<b>ORM-D</b>	.....	<b>Other regulated material</b>

The **proper shipping name** is the correct name that has to be used to describe a hazmat on shipping papers and packages. The only proper shipping names allowed are the names listed in the DOT Hazardous Materials Table. [49 CFR 171.8]

People often use many names for the same chemical, but not every name is a proper shipping name.

For example, the following names all refer to the same chemical: carbinol, methyl hydrate, methyl hydroxide, methyl alcohol, and wood alcohol. However, none of these is the DOT proper shipping name. The proper shipping name for this chemical is methanol. Why? Because that is the name that DOT put in its table for this chemical.

---

Each hazmat has a four-digit **identification number**. Most are “UN” numbers. A **UN number** is the number assigned to the hazmat by a United Nations treaty that assured that all countries use the same identification number when they ship a hazmat to another country.

Some hazmats have an **NA number**. These numbers can only be used for shipments in North America (Canada, United States and Mexico.)

## Proper Shipping Names

## UN and NA Identification Number

# Packing Groups

Several hazard classes and divisions are further divided into **packing groups (PG)** according to the degree of danger that the materials present. These are called packing groups because different degrees of danger require different kinds of packaging:

**PG I:** Great danger.

**PG II:** Medium danger.

**PG III:** Minor danger. [49 CFR §173.121]

# Hazard Zones

Division 2.3 (poisonous gas) and division 6.1 (poisonous substances) are also divided into **hazard zones (HZ)**. There are four types: A, B, C and D.

Hazard zone A is the most toxic. Hazard zone D is the least toxic. [49 CFR §173.116 and 49 CFR §173.133]

# Compatibility Groups

Explosives are further divided into 13 compatibility groups that determine which explosives can be shipped and stored together – and which cannot.

[49 CFR §173.52(b) and 49 CFR §177.848(f)]

These classes and divisions are divided into packing groups (PG):	3, 4.1, 4.2, 4.3, 5.1, 5.2, 6.1, and 8
These divisions are divided into hazard zones (HZ):	2.3 and 6.1 (only PG I)
These explosives are divided into compatibility groups:	1.1, 1.2, 1.3, 1.4, 1.5, and 1.6

The **DOT Hazardous Materials Table** is where to look in order to find the correct information about a hazmat:

- Proper shipping name.
- Hazard class.
- UN or NA Identification Number.
- Packing Group (PG) if there is one.
- Which label or labels to use.
- Which package specifications to use.
- Any special requirements.

## The DOT Hazardous Materials Table

49 CFR 172.101 Hazardous Materials Table (example entries)									
Symbols	Hazardous Materials Description and Proper Shipping Names	Hazard Class or Division	Identification Numbers	PG	Label Codes	Special Provisions (172.102)	Packaging (173.***)		
							Excep-tions	Non-Bulk	Bulk
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)
D	Diesel fuel	3	NA1993		None	144, B1, IB3, T4, TP1, TP29	150	203	242
I	Diesel fuel	3	UN1202		3	144, B1, IB3, T4, TP1, TP29	150	203	242
D G	Hazardous waste, liquid, n.o.s.	9	NA3082	III	9	IB3, T2, T1	155	203	241
	<i>Hydrofluoric acid, anhydrous, see Hydrogen fluoride, anhydrous</i>								
	Hydrogen fluoride, anhydrous	8	UN1052	I	8, 6.1	3, B7, B46, B71, B77, T10, TP2	None	163	243
	Lead nitrate	5.1	UN1469	II	5.1, 6.1	IB8, IP2, IP4, T3, TP33	152	212	242
G	Ketones, liquid, n.o.s.	3	UN1224	I	3	T11, TP1, TP8, TP27	None	201	243
	Toluene	3	UN1294	II	3	IB2, T4, TP1	153	202	242

# The DOT Hazardous Materials Table

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If the word “forbidden” appears in column (3), it means that the hazmat cannot be transported.

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If there is no “D” and no “I” then the information applies to both domestic and international shipments.

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If there is no “A” and no “W” then the information applies to all modes of transportation (truck, rail, airplane and boat.)

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**Column (2).** The **DOT Hazardous Materials Table** lists all the different hazmats in alphabetical order according to their proper shipping name.

The proper shipping name is printed in **Roman print** (straight up and down letters). Any information in slanted letters is not part of a proper shipping name.

**Column (3)** tells which hazard class or division the hazmat belongs to.

**Column (4)** shows the UN or NA identification number.

**Column (5) shows the Packing Group (PG).**

**Column (6)** tells which label or labels have to be on packages or containers of the hazmat.

**Column (7)** indicates special provisions. The number and letter codes in this column refer to notes that are printed after the DOT Hazardous Materials Table.

**Columns (8A), (8B) and (8C)** indicate regulations that explain what kind of packaging the hazmat requires.

**Column (1)** may be empty, or may have one or more special code letters:

- A** means that the hazmat information applies only to shipments by airplane.
- D** means that the hazmat information applies only to domestic shipments (with in the U.S.).
- I** means that the hazmat information is for international shipments.
- G** means that the proper shipping name is a generic name – one that can be used for more than one specific hazardous material.
- W** means that the information only applies to shipments by water.

## Hazardous Substance and Reportable Quantity

The Environmental Protection Agency (EPA) also has transportation rules for certain hazardous items. EPA calls these **hazardous substances**. EPA is concerned about those types of hazmat that could damage the environment.

The hazmats that are EPA hazardous substances are listed after the DOT Hazardous Materials Table in a section called **Appendix A - List of Hazardous Substances and Reportable Quantities**. Appendix A has two parts. The first part (Table 1) lists chemical substances and the second part (Table 2) lists radioactive materials.

Each substance on the list has an amount called the **reportable quantity (RQ)**. If you are carrying this amount or greater, the shipping paper will say "RQ" in the hazmat column. If there is a spill equal to the reportable quantity (or more) it must be reported as soon as possible to the National Response Center.

### It's confusing . . .

DOT says hazardous material.

EPA uses the term hazardous substance. EPA also has regulations for hazardous waste.

OSHA talks about hazardous chemicals.

The names are slightly different. The legal definitions are slightly different.

However, for the purposes of hazmat transportation, a hazardous material is something that is listed in the DOT Hazardous Materials Table or in Appendix A. If it's on the list, then it's hazmat and it's covered by DOT regulations.

# Shipping Papers

The **shipping paper** is a document that describes the hazmat being transported. A shipping paper is sometimes also called a bill of lading or a manifest.

The shipper prepares the shipping paper, but the **driver has to check** that the shipment and its labels and placards match what's described in the shipping paper.

The shipping paper must contain an accurate description of each hazmat carried in the vehicle. This includes all of the following for each hazmat:

- UN or NA Identification Number.
- Proper shipping name.
- Hazard class.
- Packing Group (PG) if there is one.
- Total quantity.
- "RQ" if it is a reportable quantity.
- "Poison" if it is a poison.

The shipping paper must also include:

- The shipper's signature certifying that the shipment has been prepared properly.
- An emergency phone number.

DOT also requires that for each hazmat there must be, attached to the shipping papers, a copy of the ERG guide for that hazardous material, or an SDS, or a similar document which contains emergency response information for that hazardous material.

On the next page is an example of a shipping paper for hazmat.



If the shipping paper describes both hazmat and non-hazmat, then the hazmat must be either:

- Listed first,
- Highlighted with a contrasting color,
- Identified with an “X” in the “HM” column, or
- If the shipment is a reportable quantity, identified by “RQ” in the “HM” column.

The hazmat description must appear in the following order: [49 CFR §172.202]

- **ID Number**
- **Proper Shipping Name**
- **Hazard Class**
- **Packing Group**

## Shipping Papers

You should make sure that the shipping paper description agrees with the proper shipping name and other information in the DOT Hazardous Materials Table. If there is an error, or something that you do not understand, contact your supervisor.

Union Trucking, Inc									
To Consignee: Solvent World 22 Springdale St. Nutley, NJ 12345				From Shipper: Acme Chemical Company 32 Grandville Rd. Cincinnati, OH 45223					
Route (if route controlled material)				Hazardous Materials Registration Numbers State: 00 Federal: 00-007					
Quantity	HM RQ	I.D. Number	Proper Shipping Name	Hazard Class	PG	Con- tainer	Gross Wgt.	Required Labels	
275 gal	X	UN 1993	Flammable liquid n.o.s. (Acetone, Methyl ethyl ketone, Xylene)	3	II	5 55-gal drums	1925 lbs	Flammable Liquid	
SDS or ERG page or ERG information required with hazardous materials shipments. Proper Shipping Name from column 2 of the Hazardous Materials Table. Hazard Class Name from column 3 of the Hazardous Materials Table. I.D. Number (UN#, NA#) from column 4 of the Hazardous Materials Table. Packing Group Number (PG#) from column 5 of the Hazardous Materials Table. Required Labels from column 6 of the Hazardous Materials Table.				Emergency Phone Number: 1-800 123-4567					
				This is to certify that the above named materials are properly classified, described, packaged, marked and in proper condition for transportation according to the applicable regulations of the Department of Transportation.  Signed: _____					

**n. o. s.  
Not Otherwise  
Specified**

Most of the proper shipping names in the DOT Hazardous Materials Table refer to individual, specific substances. However, some proper shipping names refer to a general group of materials. For example:

**Flammable liquids, n.o.s.  
Hazardous waste, solid, n.o.s.**

The abbreviation **n.o.s.** means that the chemical being shipped is **not otherwise specified** in the Table.

If a hazardous material does not have an individual, specific name in the Table, then the shipper is supposed to use the “n.o.s.” proper shipping name that best fits. For example, caprylyl chloride is a corrosive liquid which is not individually listed. Its proper shipping name is:

**Corrosive liquid, n.o.s.**

On the shipping paper the technical name of the material must appear after an “n.o.s.” name. This tells you what the material actually is:

**Corrosive liquid, n.o.s., (Caprylyl chloride), 8,  
UN 1760 , PG II.**

In some cases an n.o.s. name is used for hazardous waste. In this case the word “waste” must be written before the proper shipping name, and the EPA hazardous waste code number may be used instead of the technical name:

**Waste, Liquid, n.o.s., (D001), 9, NA 3082 , PG III**

You can find the correct EPA hazardous waste code number in Appendix A - List of Hazardous Substances and Reportable Quantities.

Packages and containers with a capacity of 119 gallons or less are called **non-bulk**.

Non-bulk packages and containers of hazmat must be marked with:

- Proper shipping name of the hazardous material.
- UN or NA Identification number.
- Gross weight.
- Name and address of the shipper.
- Reportable quantity (RQ) (if applicable).
- Special markings such as “Inhalation Hazard”, “Dangerous When Wet”, “Marine Pollutant”, etc. (if applicable).
- “This End Up” (if applicable).
- Transport index (for radioactive materials).

All marking used in the United States must be in English and printed on the container or package, or on an attached label or tag.



## Markings on Non-Bulk Containers and Packages

This End Up



# Labels on Non-Bulk Containers and Packages

All non-bulk packages and containers must have a **hazard class label**. This label is diamond shaped, with each side measuring 4 inches.

Hazard class labels look like small placards.

To find out which labels are required, look in column (6) of the DOT Hazardous Materials Table. If more than one label is listed in the table, then the labels must be placed close together on the package or container.

If more than one hazardous material is packed in the same package or container, then the outside package must have all the labels required for each of the hazardous materials that are packed inside.



The labels required under the OSHA Hazard Communication Standard do not necessarily comply with DOT requirements.

DOT labels and markings do not provide all of the information required under HAZCOM. Hazmat containers and packages may need two kinds of labels, one for DOT and one for OSHA.

OSHA requires that after a package arrives – and is no longer in transportation – the DOT labels must not be removed. The labels continue to provide hazard information to the workers using the product.

The correct **placards** must be attached to the vehicle before you drive it. You need four of each so you can put a placard on **both sides and both ends**. The shipper is required to provide the correct placards for the shipment, unless the vehicle already has those placards.

Do not drive the truck without its required placards.

To make sure the placards are correct, you must check:

- The hazard class or division of each hazmat.
- The quantity of each hazmat.
- Whether the container is a bulk carrier or a non-bulk carrier.
- The total quantity of all the hazmats in each hazard class or division loaded on the vehicle.

---

A **bulk carrier** is a vehicle or container such as a tanker that has a capacity of over 119 gallons or over 1000 pounds.

All bulk carriers are required to have placards regardless of the amount actually loaded.

A tanker with several compartments with different hazmats requires separate placards for each hazmat.

Placards on bulk carriers of hazmat must remain until the vehicle is washed and purged of the hazmat.

## Placards

---

The shipper is required to provide the correct placards for the shipment, unless the vehicle already has those placards.

---

## Placards for Bulk Carriers

# Placards for Non-Bulk Carriers

If a vehicle contains only packages or containers that each have a capacity of 119 gallons or less, or 1000 pounds or less, then the vehicle is a **non-bulk carrier**.

Whether a non-bulk carrier needs placards depends on:

- Some classes and divisions of hazmat **always require placards** when any amount — no matter how small — is loaded. These materials are listed in **DOT Table 1**.
- Some classes and divisions of hazmat require placards **if more than a certain amount is loaded**. These materials are listed in **DOT Table 2**.

**DOT Table 1.**

**(Placards are required for any quantity of these materials.)**

<b>Hazard Class or Division</b>	<b>Placard to Use</b>
1.1 . . . . .	<b>EXPLOSIVES 1.1</b>
1.2 . . . . .	<b>EXPLOSIVES 1.2</b>
1.3 . . . . .	<b>EXPLOSIVES 1.3</b>
2.3 . . . . .	<b>INHALATION HAZARD</b>
4.3 . . . . .	<b>DANGEROUS WHEN WET</b>
5.2(Organic Peroxide, Type B, liquid or solid,temperature controlled) . . . . .	<b>ORGANIC PEROXIDE</b>
6.1(materials poisonous by inhalation) . . .	<b>INHALATION HAZARD</b>
7(Radioactive Yellow III label only) . . . . .	<b>RADIOACTIVE 7</b>

For a non-bulk carrier, the hazard classes and divisions listed in DOT Table 2 require a placard only if the total amount of the hazmat in a particular class or division is 1001 lb. (454 kg) or more. To determine the total amount of hazmat in each class or division, add the weights listed for each separate hazmat in each class or division on the shipping papers.

**1,001  
Pound  
Rule**

**DOT Table 2**

**49 CFR §173.2**

**(Placards are required only if the vehicle contains 1,001 pounds or more aggregate gross weight of these materials.)**

<b>Hazard Class or Division</b>	<b>Placard to Use</b>
1.4 . . . . .	<b>EXPLOSIVES 1.4</b>
1.5 . . . . .	<b>EXPLOSIVES 1.5</b>
1.6 . . . . .	<b>EXPLOSIVES 1.6</b>
2.1 . . . . .	<b>FLAMMABLE GAS</b>
2.2 . . . . .	<b>NONFLAMMABLE GAS</b>
3 (Flammable liquid) . . . . .	<b>FLAMMABLE</b>
3 (Combustible liquid) . . . . .	<b>COMBUSTIBLE</b>
4.1 . . . . .	<b>FLAMMABLE SOLID</b>
4.2 . . . . .	<b>SPONTANEOUSLY COMBUSTIBLE</b>
5.1 . . . . .	<b>OXIDIZER</b>
5.2 (Other than Organic Peroxide, Type B, liquid or solid, temperature controlled) . . . . .	<b>ORGANIC PEROXIDE</b>
6.1 (Other than materials poisonous by inhalation) . . . . .	<b>POISON</b>
8 . . . . .	<b>CORROSIVE</b>
9 . . . . .	<b>CLASS 9</b>

## **DANGEROUS Placard**

If a non-bulk vehicle has a load that includes more than one kind of hazmat that would require placards, then the vehicle may use either of the following:

- Display the placards for each of the hazmats that requires placarding, or
- Display just the DANGEROUS placard



## **1,000 Kilogram Rule**

However, if a vehicle is carrying several hazmats, and has more than 1,000 kg (2,205 lbs.) of any one kind – that was loaded at a single facility – then the vehicle must have the specific placard for that material, not just the dangerous placard.

## **Placard Exceptions**

The DOT regulations contain many specific exceptions to the placard requirements. Here a few of the more common situations in which placards are not required:

- Combustible liquids in non-bulk containers with a capacity of less than 119 gallons.
- Class 9 hazmat in domestic (within the United States) transport.
- Consumer commodities (ORM-D materials).
- Residue of Table 2 hazmat in a bulk carrier.
- Infectious substances.
- “Flammable” can substitute for “Combustible” on bulk carriers.

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Placards can be used when not required if they are the correct placards for the hazmat.

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## Summary of Placard Requirements

A placard is a “square-on-point” sign, approximately 12 inches on each edge, placed on both sides and both ends of a vehicle.

The placard identifies the hazard class of a hazmat transported in the vehicle.

These vehicles must have **placards always**:

- Bulk carriers – such as tankers – regardless of how full they are actually loaded.
- Non-bulk vehicles that carry any of the hazmat classes or divisions listed in DOT Table 1.

These vehicles must have **placards sometimes**

– depending on how much hazmat they carry:

- Non-bulk vehicles that carry hazmats listed in DOT Table 2 – and do not have hazmats listed in Table 1. These vehicles must be placarded only if they have 1,001 pounds (454 kilograms) or more of any hazmat class or division listed in Table 2.

These vehicles may use the **DANGEROUS placard**:

- Non-bulk vehicles with a mixed load containing different hazmats.
- However, if the vehicle loads 1,000 kg (2,205 lbs.) or more of any one hazmat, at one facility, it must have the specific placard for that hazmat.

---

It is prohibited to put anything other than a hazmat placard in a placard holder. No “happy face” or “Have a nice day.” There is not supposed to be any sign on the vehicle that might be confused with a placard.

**No  
Happy  
Face**

## Hazmat Identification Numbers on Vehicles



Bulk carriers – such as tankers– must have the UN or NA identification number on both sides and both ends. You might see the ID number displayed:

- On an orange panel with black numbers.
- On the placard.
- On a white “square-on-point” display.

The identification number must also be on vehicles:

- Loaded at one facility with 4,000 kg (8,820 lbs.) or more of only one hazmat in non-bulk packages.
- Containing 1,000 kg (2,205 lbs.) in non-bulk packages of a poison inhalation hazards (PIH).
- A closed vehicle that contains cargo tanks.

## Marine Pollutants



Some hazmats are designated by the EPA as **marine pollutants** because they are especially harmful if they accidentally get into the water. The marine pollutants are listed in Appendix B of the DOT Hazardous Materials Table.

On the shipping paper, “Marine Pollutant” must be added after the proper shipping name of the hazmat. The MARINE POLLUTANT marking must be placed on both sides and both ends of a bulk carrier that contains a marine pollutant.

A **hazardous waste**, is a **material intended for disposal or recycling** that poses a significant threat to human health or the environment.

What's the difference between hazardous waste and hazardous material? The material itself may be identical. The difference is **what the person who has the material intends to do with it.**

If a material is shipped to someone who will use it to make a product, then it's a hazmat. If it is intended to be disposed of – buried, burned, recycled, etc., in order to get rid of it – then it's a hazardous waste.

---

To make sure that hazardous waste goes to the proper facility and is not disposed of illegally, there is a **special shipping paper** called a **Uniform Hazardous Waste Manifest (UHWM).**

The generator (EPA's name for the shipper of hazardous waste) fills out the UHWM. The generator must keep a copy for three years. The generator also gives at least two copies to the transporter (EPA's name for the carrier).

The transporter gives a copy to the disposal facility. The disposal facility sends a copy back to the generator. The generator, shipper and disposal facility each sign the UHWM by hand. This process proves that the hazardous waste went to a legal facility.

Most hazardous wastes are materials that have proper shipping names listed in the DOT Hazardous Materials Table. The word "waste" must be written before the proper shipping name on the UHWM, for example:

**waste acetone 3 1090 II**

## Hazardous Waste

## Uniform Hazardous Waste Manifest (UHWM)

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**"Waste"** must be written in front of the proper shipping name on the UHWM.

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<b>UNIFORM HAZARDOUS WASTE MANIFEST</b>		1. Generator ID Number		2. Page 1 of		3. Emergency Response Phone		4. Manifest Tracking Number	
		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	
Facility's Phone:		8. Designated Facility Name and Site Address		U.S. EPA ID Number		9a. HM		9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	
				10. Containers		11. Total Quantity		12. Unit Wt./Vol.	
				No. Type				13. Waste Codes	
		1.							
		2.							
		3.							
		4.							
14. Special Handling Instructions and Additional Information									
15. <b>GENERATOR'S/OFFEROR'S CERTIFICATION:</b> 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	
16. International Shipments <input type="checkbox"/> Import to U.S. <input type="checkbox"/> Export from U.S. Port of entry/exit: _____									
Transporter signature (for exports only): _____						Date leaving U.S.: _____			
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	
18. Discrepancy									
18a. Discrepancy Indication Space <input type="checkbox"/> Quantity <input type="checkbox"/> Type <input type="checkbox"/> Residue <input type="checkbox"/> Partial Rejection <input type="checkbox"/> Full Rejection									
18b. Alternate Facility (or Generator)						Manifest Reference Number: _____			
Facility's Phone:						U.S. EPA ID Number			
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	

The reason there is a special manifest for hazardous waste is that if a person is just trying to get rid of something, they might be motivated to dispose of it illegally in a way that harms the environment. Therefore special procedures are required to make sure that the waste is tracked “from cradle to grave,” and is not illegally dumped.

Hazardous waste must meet the same DOT requirements for placards, labels and markings as hazmat that is not a waste.

In addition, any container of hazardous waste that is 110 gallons or less must have a **hazardous waste label** like the one shown below. [EPA 40 CFR 262.32]

## To Prevent Illegal Disposal of Hazardous Waste

## Hazardous Waste Placards and Labels

<h1>HAZARDOUS WASTE</h1>		
<b>STATE &amp; FEDERAL LAW PROHIBITS IMPROPER DISPOSAL</b> IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY, OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY OR THE CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL.		
GENERATOR INFORMATION:		
NAME _____		
ADDRESS _____		PHONE _____
CITY _____	STATE _____	ZIP _____
EPA / MANIFEST ID NO. / DOCUMENT NO. _____ / _____		
EPA WASTE NO. _____	CA WASTE NO. _____	ACCUMULATION START DATE _____
CONTENTS, COMPOSITION: _____		
PHYSICAL STATE:      HAZARDOUS PROPERTIES: <input type="checkbox"/> FLAMMABLE <input type="checkbox"/> TOXIC		
<input type="checkbox"/> SOLID <input type="checkbox"/> LIQUID     <input type="checkbox"/> CORROSIVE <input type="checkbox"/> REACTIVITY <input type="checkbox"/> OTHER _____		
<div style="border: 1px solid black; padding: 5px; margin: 5px auto; width: 80%;">           _____            _____            _____         </div>		
D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX		
<b>HANDLE WITH CARE!</b>		
CONTAINS HAZARDOUS OR TOXIC WASTES		
CP-3		

## **Loading Hazmat Packages and Containers**

It is important to load hazmat packages and containers properly so they will not be damaged and will not leak.

**Before loading hazmat** into a vehicle, make sure:

- The brake is set and the wheels are blocked.
- There are no exposed nails or other things that could damage packages or containers.
- Absorbent material and a fire extinguisher are on hand.
- No smoking!

**Check the hazmat packages** to make sure they are:

- Not leaking.
- Free of damage.
- Compatible with each other.

**Loading hazmat** containers and packages:

- Don't throw or drop hazmat.
- Don't use pry bars that could damage containers.
- Obey orientation arrows (This side up).
- Block and brace cargo against movement.
- Make sure hazmat is protected from falling, and from other cargo falling on it.

If **incompatible** hazardous materials come in contact with each other, they could explode, start a fire, or produce toxic vapors and gases.

In order to prevent the dangerous **commingling** of incompatible hazmats, follow these loading practices:

- Understand and follow the DOT Segregation Table for Hazardous Materials (see next page).
- Keep containers upright. Don't roll or drop.
- Do not stack containers unless you are certain that the lower level can hold the weight.
- Be very careful with Class 8 corrosive liquids. They can damage the vehicle, and can eat through certain containers, causing other materials to leak.
- Load storage batteries right side up. Make sure other cargo cannot short out the contacts.
- Keep compressed gas cylinders upright and braced, or in boxes or racks designed to keep them secure.
- Keep bottles of cryogenic liquids (extremely cold, liquefied gases) upright and braced.
- Do not carry hazmat packages in the cab or sleeper.
- Keep packages labeled POISON or POISON GAS away from food.

## **Keep Incompatible Materials Apart**

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**Even cylinders of non-flammable gasses can explode because they are under extreme pressure.**

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# DOT Segregation Table

The **DOT Segregation Table for Hazardous Materials** tells which hazmats may – and may not – be loaded together in the same vehicle. [49 CFR §177.848(d)]

- A blank space in the table means that the combination is allowed in the same vehicle.
- **X** means do not load in the same vehicle.
- **O** means separate in a manner that will prevent the materials from commingling if a spill or leak occurs.
- \* means refer to the Compatibility Table for Class 1 explosives (on the next page).

DOT Segregation Table for Hazardous Materials																		[49 CFR 177.848(d)]
	1.1 & 1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3 gas Z A	2.3 gas Z B	3	4.1	4.2	4.3	5.1	5.2	6.1 PG 1 Z A	7	8 li- quid
Explosives 1.1&1.2	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Explosives 1.3	*	*	*	*	*	X		X	X	X		X	X	X	X	X		X
Explosives 1.4	*	*	*	*	*	O		O	O	O		O				O		O
Very insensitive explosives 1.5	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Extremely insensitive explosives 1.6	*	*	*	*	*													
Flammable gases 2.1	X	X	O	X				X	O							O	O	
Non-toxic, non-flammable gases 2.2	X			X														
Poisonous gases Zone A 2.3	X	X	O	X		X				X	X	X	X	X	X			X
Poisonous gases Zone B 2.3	X	X	O	X		O				O	O	O	O	O	O			O
Flammable liquids 3	X	X	O	X				X	O					O		X		
Flammable solids 4.1	X			X				X	O							X		O
Spontaneously combustible 4.2	X	X	O	X				X	O							X		X
Dangerous when wet 4.3	X	X		X				X	O							X		O
Oxidizers 5.1	X	X		X				X	O	O						X		O
Organic peroxides 5.2	X	X		X				X	O							X		O
Poisonous liquids P.G. I, Zone A 6.1	X	X	O	X		O				X	X	X	X	X	X			X
Radioactive materials 7	X			X		O												
Corrosive liquids 8	X	X	O	X				X	O		O	X	O	O	O	X		



It is dangerous to load certain kinds of explosives together with a different kind of explosive.

There are 13 **compatibility groups** for explosives. These are called A, B, C, D, E, F, G, H, J, K, L, N, and S.

The **DOT Compatibility Table for Class 1 Explosives** tells which explosives may – and may not – be loaded together in the same vehicle. [49 CFR §177.848(f)]

<b>DOT Compatibility Table for Class 1 Explosives</b>													
[49 CFR 177.848(f)]													
<b>Group</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>N</b>	<b>S</b>
<b>A</b>		X	X	X	X	X	X	X	X	X	X	X	X
<b>B</b>	X		X	4	X	X	X	X	X	X	X	X	4/5
<b>C</b>	X	X		2	2	X	X	X	X	X	X	3	4/5
<b>D</b>	X	4	2		2	X	X	X	X	X	X	3	4/5
<b>E</b>	X	X	2	2		X	X	X	X	X	X	3	4/5
<b>F</b>	X	X	X	X	X		X	X	X	X	X	X	4/5
<b>G</b>	X	X	X	X	X	X		X	X	X	X	X	4/5
<b>H</b>	X	X	X	X	X	X	X		X	X	X	X	4/5
<b>J</b>	X	X	X	X	X	X	X	X		X	X	X	4/5
<b>K</b>	X	X	X	X	X	X	X	X	X		X	X	4/5
<b>L</b>	X	X	X	X	X	X	X	X	X	X		1	X
<b>N</b>	X	X	3	3	3	X	X	X	X	X	X		4/5
<b>S</b>	X	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	X	4/5

A blank space means that no restrictions apply.

An **X** means that this combination may not be transported in the same vehicle.

The numbers refer to detailed notes in the DOT regulations that we have not printed here.

If you transport explosives, then you must have additional function-specific training about specific rules and procedures for the explosives you handle.

## Loading Explosives

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**Example:** black powder is “1.1D”, which means Division 1.1, compatibility group D. The shipping paper will also say “1.1D”.

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**If you transport explosives, then you need additional function-specific training.**

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# Radioactive Materials

yellow triangle



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The transport index (TI) is a number that indicates how much radiation the package gives off. The higher the number, the greater the amount of radiation.

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Some radioactive materials give off **ionizing radiation** that can pass through the package. You can be exposed if you are nearby – even if you do not touch, inhale or ingest the material.

Exposure to ionizing radiation increases the risk of cancer and effects reproductive organs.

Ionizing radiation can also damage unexposed film.

There are three label categories for radioactive materials: White I, Yellow II and Yellow III.

Yellow III packages give off more radiation than Yellow II packages. White I packages give off the least radiation.

**Transport Index.** The shipper measures the radiation given off by each package of radioactive material. The shipper uses this measurement to calculate the **transport index (TI)** for each package. The higher the TI, the greater the amount of radiation it gives off.

The shipper writes the transport index on the label of Yellow II or Yellow III packages.

In order to protect yourself:

- **Limit your exposure.** Don't spend more time than necessary in a trailer or truck compartment containing Yellow II or Yellow III packages.
- **Total transport index.** Never load packages that have a total transport index of more than 50 into a single vehicle.
- **Not in the cab.** Don't carry radioactive materials in the vehicle's cab.

The shipper is the company who sends hazmat from one place to another. The shipper is responsible for:

- Assigning the proper shipping name, hazard class and identification number (from the DOT Hazardous Materials Table).
- Using the correct packaging, labeling and marking.
- Determining which placards to use.
- Preparing the shipping papers.
- Certifying on the shipping paper that the shipment has been prepared in compliance with the regulations.

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The carrier is the company that transports hazmat from one place to another. The carrier is responsible for:

- Transporting the hazmat from the shipper to the destination.
- Using the proper placards.
- Refusing to accept improper shipments that do not comply with the regulations.
- Reporting accidents and spills involving hazmat.

## **The Shipper's Responsibility**

## **The Carrier's Responsibility**

## The Driver's Responsibility

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**The DOT hazmat rules are complicated, but you need to know them. Pleading ignorance will not prevent you from receiving a citation.**

---

The driver is the person who drives the vehicle containing hazmat from one place to another. The driver is responsible for:

- Checking the shipping papers, labels and placards to make sure that they agree with each other.
- Refusing to load improper shipments of hazmat.
- Hauling the hazmat.
- Following all rules for transporting hazmat.
- Keeping a copy of the Emergency Response Guidebook (ERG) in an accessible place.
- Keeping the shipping papers in the proper, accessible place.
- Making sure the vehicle has the proper placards.
- Knowing where to find your company's hazardous materials registration number.

Some of these responsibilities are the same as those of the carrier. This is because the driver is an employee of the carrier, and is often the person who actually does the carrier's duties. As a driver you have serious responsibilities. You need to understand the regulations for packaging, labeling, loading, placarding and transporting hazmat. Pleading ignorance will not prevent you from receiving a citation.

If you are given a sealed vehicle to drive, DOT does not expect you to verify that the packaging, labeling and loading are correct. You are still responsible for making sure that the placards agree with the shipping papers, and that the shipment is transported safely.

## Driving Hazmat Vehicles

**Rules for hazmat drivers.** There are rules that you must follow when you drive a vehicle with hazmat:

- Refuel with the engine off. Someone must be at the nozzle at all times.
- Carry a fire extinguisher with a UL rating of at least 10 B:C in the power unit at all times.
- Check the tires at the start of your trip, and each time that you stop for a break. (It is no longer required that you check the tires every 100 miles or every two hours.)
- Stop before crossing railroad tracks. Do not shift gears while crossing the tracks.

**Route plans.** If you transport explosives 1.1 or 1.2, or large amounts of radioactive materials, then your company is required to have a written route plan. You must follow the routes on the plan.

**Bridges and tunnels.** Many bridges and tunnels are posted “no hazmat.” As a driver, it is your responsibility to know which bridges and tunnels are restricted, and follow alternative, safe routes.

**Local permits and routes.** Some state, local or tribal governments have special rules for transporting hazmat. They might require a local hazmat permit or limit the routes you can take. It is your responsibility to know and obey these rules.

## **Parking Hazmat Vehicles**

**Rules for parking hazmat vehicles.** There are rules that you must follow to safely park a hazmat vehicle:

- Do not park hazmat on a public street or highway.
- Do not park hazmat within 300 feet of an open fire.
- Do not park hazmat within 5 feet of a travel lane.
- Someone must be there to watch a placarded vehicle whenever it is parked alongside a public roadway. The person watching the vehicle must:
  - Be awake.
  - Be within 100 feet and be able to see the vehicle.
  - Be aware of what hazmat is in the vehicle.
  - Be able to move the vehicle if necessary.
  - Know what to do if an emergency arises.

The emergency response training that you receive in this course is **awareness level training**.

If an accident involving hazmat happens, **your responsibility** as an awareness level responder is to:

- **Protect yourself**
- **Alert the proper authorities**
- **Help to keep others away.**

**Traffic accidents.** If you are driving a vehicle with hazmat and there is a traffic accident, do all of the following that you can without risking your own safety:

- Park as safely as possible and turn off the engine.
- Take the shipping papers and Emergency Response Guidebook when you leave the vehicle.
- Put out warning signs. Do not put flares near the vehicle if it carries flammables or explosives.
- Contact emergency response. Use your cell phone or radio – if you have one. Otherwise, send someone else to phone.
- Keep a safe distance away, but do not leave the scene until emergency responders arrive.
- Keep people away and upwind from the vehicle.
- Notify your employer (supervisor) by radio or phone as soon as possible.
- Provide information to the emergency response personnel when they arrive.

## **If You Have an Accident Driving Hazmat**

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**Parking safely means:**

**Away from traffic**

**Away from people**

**Away from water**

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# Spill Containment

29 CFR 1910.120 (b) (4) (ii) (J)

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**Remember your job:**

**Protect yourself**

**Alert the proper  
authorities**

**Help to keep others  
away**

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**This training does not  
prepare you to stop  
a spill in a hazmat  
emergency. It does not  
prepare you to fight a  
fire.**

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**Leaks and spills.** If you discover that hazmat is leaking from your vehicle, or leaking from a container:

- Do not continue to load or handle materials.
- Do not continue to drive any further than safety requires. Park safely as soon as possible.
- Call your supervisor or the authorities.
- Keep others away from the area.
- Use the shipping papers, placards, labels and markings to identify the hazmat that is leaking.
- Do not touch, sniff or taste the leaking materials.
- Keep a safe distance away, but do not leave the scene until emergency responders arrive.

**Provide Information.** Lives depend on the information you provide to other responders, such as the fire department. You need to know what hazmat you are carrying, and have the shipping papers accessible.

**Controlling the hazard.** Stopping a leak or fighting a fire are jobs for operations-level responders.

Do not do the following unless you have operations-level response training and have the proper equipment:

- Do not try to contain the material unless you can do it without exposing yourself to the material.
- Do not try to stop a leak unless you can do it without exposing yourself to hazardous material.
- Do not try to put out a fire around hazmat.



## Using the ERG

The DOT Emergency Response Guidebook (ERG) provides information to **identify hazardous materials and make decisions about response and evacuation during the initial response to a hazmat incident.**

The ERG contains **guides**, which are two-page descriptions of how to respond. Each guide is for a different set of circumstances. The guides are the “guts” of the book.

The ERG has six color-coded sections:

**White:  
(Front)** The white section at the front of the book has pictures of all the different placards, and pictures of different kinds of vehicles.

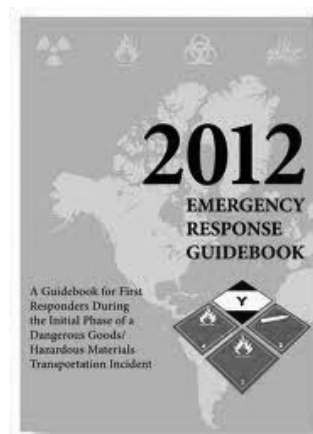
The purpose of the white section is to help you find the right guide if you only know the placard or the type of vehicle.

**Yellow:** The yellow section is a list of all of the UN/NA identification numbers. For each number it tells the name of the hazmat and also tells which guide to use.

The purpose of the yellow section is to help you identify the hazmat and find the right guide to use – if you know the UN/NA identification number.

**Blue:** The blue section is a list of the names of different hazmats. For each name it tells the UN/NA identification number and also tells which guide to use.

The purpose of the blue section is to help you identify the hazmat and find the right guide to use – if you know the name.



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**The ERG is intended to assist emergency responders during the first half hour of their response. After that it is assumed that more complete information, such as expert consultation and computer databases will be available.**

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## Using the ERG

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If the name and UN/NA number of the hazmat was highlighted in the yellow and blue sections, then there is more information about that hazmat in the green section.

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Both the front and back white sections contain a list of emergency phone numbers

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**Orange:** The orange section contains the guides. Each guide gives information about:

- Health hazards.
- Fire hazards.
- Protective clothing.
- Evacuation.
- Fire response.
- Spill response.
- First aid.

**Green:** The green section contains more detailed information about isolation and protective distances for certain hazmats.

The green section also has a list of hazmats that produce toxic gases if they react with water. This is important information that fire fighters need before they use water to suppress a fire or to dilute a spill.

**White:  
(Back)** The white section at the back of the book contains a glossary of words used to describe hazmat and emergency response.

This white section also has information about protective clothing, fire and spill control, and indications that the situation involves criminal or terrorist activity.

You should be familiar with the ERG – and practice using it – so that you can quickly get information if you are involved in a hazmat incident.

Keep the ERG with you when you transport hazmat.

## Incident Reports

If a an accident happens with hazmat, the company is required to send a written report to DOT or to the state transportation agency.

This includes leaks and spills during loading, driving, unloading and temporary storage. The company has up to 30 days to send in the report. [49 CFR §171.16]

In serious hazmat incidents the company also has to **report immediately by telephone to the National Response Center (NRC)**. [49 CFR §171.15]

There has to be an immediate telephone report if:

- Someone is killed.
- Someone is hospitalized.
- The public is evacuated for one hour or more.
- A traffic artery is shut down for one hour or more.
- Possible release of radioactive material.
- Possible release of an infectious substance.
- There is a spill of a marine pollutant.  
(more than 119 gallons or 882 pounds)
- There is a spill of a hazardous substance.  
(equal to or greater than its reportable quantity)

If there is any doubt whether immediate reporting is required, assume that it is: make the call.

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**Report these incidents immediately to National Response Center (NRC):**  
**(800) 424-8802**  
**(202) 267-2675**

These numbers are also on page 11 of the 2008 Emergency Response Guidebook (ERG).

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**If there is a possible release of an infectious substance, you can call the Centers for Disease Control:**  
**(800) 232-0124**  
instead of, or in addition to calling the NRC.

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## **Awareness of Hazmat Security Threats**

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**The materials used in the  
Oklahoma City bombing  
were DOT regulated  
hazmats.**

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There are over 800,000 shipments of hazardous materials every day in the United States. The majority of individual shipments travel by truck.

It is possible to imagine several ways in which hazmat and hazmat vehicles could be used as:

- Targets of a criminal or terrorist attack, or
- Weapons in a criminal or terrorist attack.

Several incidents of this nature have occurred. A significant example was the 1995 bombing of the Federal Building in Oklahoma, which used a truck containing an explosive mixture of ammonium nitrate and diesel fuel.

Specific security practices for drivers include:

- **Know your company's hazmat security plan.**
- **Check seals and cargo compartment locks.**
- **Do not discuss cargo, routes or security with unauthorized persons.**
- **Do not discuss hazmat over the CB radio.**
- **Lock the vehicle when not attended.**
- **Park where you will be able to watch the vehicle.**
- **Do not pick up hitch hikers.**
- **Maintain communication with the dispatcher.**
- **Follow a safe, assigned route and report delays.**
- **Ask for identification and verify that only an authorized person receives the shipment.**

## **Methods to Enhance Hazmat Security**

## Recognizing and Responding to Hazmat Security Threats

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Use common sense. Preparation and response to hazmat security threats are similar to what you should do in any case to avoid theft or hijacking.

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## In-Depth Security Training

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In-depth training about the specifics of your company's hazmat security plan is additional training beyond what this manual provides.

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You are best prepared if the company has a comprehensive security plan and you are familiar with it.

If you notice suspicious activity or feel that your facility or vehicle is threatened, consider these responses:

- **Notify the dispatcher or supervisor.**
  - **Call 911.**
  - **Avoid being boxed in.**
  - **Do not stop in an isolated area.**
  - **Keep moving, if possible, and drive to a well lit, safe location.**
- 

DOT requires your employer to provide you with training about the company's security plan and procedures:

- **Company security objectives:** What the company seeks to accomplish with its hazmat security plan.
- **Specific security procedures:** Specifically what to do to prevent, recognize and respond to threats.
- **Employee responsibilities:** What your specific security responsibilities are.
- **Actions to take:** Specific procedures in the event of a hazmat security incident.
- **Organizational structure:** Who is responsible for what with regard to hazmat security.

## **Hazmat Security Plans**

Companies that are shippers or carriers of hazardous materials are required to have a **hazmat security plan**. The plan must be in writing. In order to prepare its security plan, the company needs to analyze what potential security threats exist, and how to address those threats.

### **These companies must have a hazmat security plan:**

Companies involved in the transportation of certain quantities and types of hazardous materials are required to have a written hazmat security plan:

- Shippers (companies that offer hazardous materials for transportation).
- Carriers (companies that transport hazardous materials).

The security plan requirement applies to shippers and carriers of hazardous materials, not receivers. If your company receives hazardous materials shipments and uses the hazardous materials - but does not offer them for further shipment and does not transport them - then it is not required to have a hazmat security plan.

### **The types of hazmat that trigger the security plan requirement are:**

- Classes and quantities that are required to be placarded.
- Large bulk quantities of hazardous materials (even if they are not required to be placarded).
- Any select agent or toxin regulated by the Centers for Disease Control.

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**If a company ships or transports any of these three categories of hazmat, then it must have a written security plan.**

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# Hazmat Security Plans

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To the TSA, “personnel security” means making sure that workers are not security threats.

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The hazmat security plan must address three issues:

- Personnel security.
- Preventing unauthorized access.
- Security en route.

## **Personnel Security.**

- Verification of the employee's identity, references, work history, etc.
- Employee background checks.

## **Preventing unauthorized access.**

- Locks and control of who has keys.
- Identification and badges.
- Inventory records and controls.
- Alarms and video monitoring.
- Security guards and watch people.

## **En-route Security.**

- Driver and receiver identification.
- Vehicle locks and cargo compartment seals.
- Planned routes and stops.
- Communication with the dispatcher and police.
- Satellite tracking.



## **Background Checks for Hazmat Drivers**

In order to obtain a hazmat endorsement for a Commercial Driver's Licence (CDL) or to renew a hazmat endorsement, the driver must:

- Submit fingerprints.
- Pass a background check.

### **Fingerprints.**

Drivers applying for a hazmat endorsement must submit their fingerprints.

### **Citizenship or legal right to work in the United States.**

The applicant must be either:

- A citizen of the United States, or
- A lawful permanent resident of the United States.

### **Criminal record.**

The applicant must not have a disqualifying criminal offense for which he or she:

- Was convicted (or found not guilty by reason of insanity) within the past seven years, or
- Was released from incarceration within the past five years, or
- Is wanted or under indictment.

### **Mental Health.**

The applicant must not have a mental defect. A person with a mental defect is someone who has been:

- Adjudicated to have a mental defect, or
- Involuntarily committed to a mental institution.

## **Background Checks for Hazmat Drivers**

### **Whether the person poses a security threat.**

The Transportation Security Administration can find that the applicant poses a security threat if the TSA determines or suspects that the person poses a threat involving:

- National security, or
- Transportation security, or
- Terrorism.

### **The driver pays the fees.**

The state agency that processes the application may charge a fee for fingerprinting and for the background check. The driver is responsible for paying this fee. Many employers will pay this fee for their drivers.

### **Hazmat Endorsement - Disqualifying Criminal Offenses**

- |   |  |
|---|--|
| (1) Terrorism                                   | (12) Arson   |
| (2) Murder                                      | (13) Controlled substances                                   |
| (3) Assault with intent to murder               | (14) Fraud   |
| (4) Espionage                                   | (15) Severe transportation security incident                 |
| (5) Sedition                                    | (16) Improper transport of hazmat                            |
| (6) Kidnapping or hostage taking                | (17) Bribery   |
| (7) Treason                                     | (18) Smuggling   |
| (8) Rape or aggravated sexual abuse             | (19) Immigration violations                                  |
| (9) Explosives, firearms, or weapons violations | (20) RICO  |
| (10) Extortion                                  | (21) Conspiracy or attempt to commit any of (1) through (20) |
| (11) Robbery                                    |  |

## **Government Agencies and Hazmat**

### **Department of Transportation (DOT).**

This is the federal agency that enforces regulations for safe transportation of hazmat by road, rail, airplane and water. Most states have a state agency that also enforces transportation regulations.

### **Pipeline and Hazardous Materials Safety Administration.**

This agency is the part of the DOT that writes the hazardous materials regulations.

### **Department of Homeland Security (DHS).**

This is the branch of the federal government that coordinates security efforts throughout the country.

### **Transportation Security Administration (TSA).**

This agency is part of the Department of Homeland Security. It is responsible for security in all modes of transportation, although it is best known for its role in screening passengers and baggage at airports. This agency makes the rules for background checks of commercial vehicle drivers who transport hazmat.

### **Occupational Safety and Health Administration (OSHA).**

This is the federal government agency that regulates safety and health in the workplace. Part of the OSHA HAZWOPER Standard applies to transportation workers who might be first responders - the first person to be aware of a hazmat accident, leak or spill.

# DOT Hazmat Training Requirements

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This training is in addition to the hazmat endorsement on your CDL. You must maintain that endorsement separate from this training.

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Training is required for all hazmat employees. This includes full-time workers, part-time workers and “casual” employees.

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If you do any of the following jobs, then you are a hazmat employee and your company is required to make sure you have DOT safety and security training:

- Load, unload or handle hazmat.
- Drive a vehicle that carries hazmat.
- Prepare hazmat for transportation.
- Supervise the transportation of hazmat.
- Recondition or test hazmat transport containers.

DOT requires three types of safety training and two types of security training: [49 CFR §172.704(a)]

- **General awareness training:** general hazmat safety training (this course).
- **Function-specific training:** site-specific training about DOT regulations that apply to your job.
- **Safety training:** site-specific training about safety and emergency response procedures for the types of hazmat that your company handles.
- **Hazmat security awareness training:** general security training (this course).
- **In-depth hazmat security training:** specific training that your employer must provide about the procedures in the written hazmat security plan.

You must receive these five types of training within 90 days after you start working. Until you get trained, you may work with hazmat only under the direct supervision of another worker who is properly trained.

You must receive this training again **every three years**.

# OSHA Training Requirements

OSHA considers drivers, dock hands and other hazmat workers to be **first responders at the awareness level**. This means that you might be the first person who notices an accident or spill. You need to know how to:

- Recognize an emergency.
- Identify the materials involved.
- Keep from being contaminated.
- Summon the proper authorities.
- Warn others to stay away.

The material in this manual provides first responder - awareness level training.

**As a first responder at the awareness level, your only responsibilities are to:**

1. **Protect yourself by leaving the area,**
2. **Warn others to stay away, and**
3. **Call the proper authorities.**

Whom you summon depends on the emergency response plan for your work site. It might be your supervisor, an on-site hazmat team, or the fire department.

You are not allowed to actually try to contain a leak or spill unless you have additional “operations level” hazmat emergency response training.

The Teamsters provide operations-level emergency response training, but it is a separate course.

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This is the “ER” part of the HAZWOPER Standard, which requires training for employees engaged in emergency response.  
[29 CFR 1910.120(q)]

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This course does not provide operations level training.

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## **About OSHA and DOT Jurisdiction**

OSHA standards do not apply to working conditions that are covered by the regulations of other federal agencies.

Transportation workers are employees, and are entitled to a safe and healthy work place that complies with OSHA regulations. But much of what they do is also covered by DOT regulations.

Which agency should you call? It depends on the specific case. The Teamsters use these rules-of-thumb:

- Activities related to driving are generally covered by DOT. (Driver qualifications, shipping papers, placards, labels, driving, parking, reporting traffic accidents, and so forth.)
- Non-driving activities are generally covered by OSHA. (Warehouse and dock work, use of personal protective equipment, right to safety and health information, and so forth.)

## **DOT Safety Complaints**

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You may also call the  
IBT Safety and Health  
Department at (202) 624-  
6960 for assistance.

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If your employer fails to comply with transportation safety regulations you may file a complaint with the US DOT– or with your state transportation agency.

- Put it in writing. Keep a copy for yourself.
- Describe the hazard or unsafe condition.
- If you know, include the specific DOT regulation that's being violated.
- Contact your union business representative or agent.

## **Review Questions**

1. What are the five DOT training requirements for workers involved in the transportation of hazmat?
2. What are the responsibilities of a first responder at the awareness level under OSHA?
3. In what DOT table do you look to find the proper shipping name of a hazardous material?
4. In what DOT table do you look to find out the correct identification number, labels and placards for a hazardous material?

## **Review Questions**

5. What are two DOT tables used to determine how to segregate incompatible hazardous materials?
6. What are the proper procedures to follow in the event of a leak or spill of hazmat?



## Glossary

# GL

## Safety and Health Terms

**American Conference of Governmental Industrial Hygienists (ACGIH).** A non-governmental organization of industrial hygienists that establishes the TLV's.

**Acute effect.** A harmful effect on the body following a short exposure to a chemical or physical agent. An acute effect generally occurs immediately after exposure or within a few hours.

**Additive effect.** A biological response to exposure to more than one chemical that is the sum of the effects of the individual chemicals.

**ALARA program.** The program that contractors at a radiological site are required to implement to keep exposures to ionizing radiation As Low As Reasonably Achievable (ALARA). The ALARA Program includes an ALARA committee and ALARA goals. The ALARA Program is a fundamental requirement of every radiological control program.

**Alpha particle.** A charged particle emitted at high velocity from the nucleus of a radioactive atom. An alpha particle consists of two protons and two neutrons. It has a mass of four atomic mass units and a positive charge of two (+2).

**Alpha radiation.** Ionizing radiation in the form of alpha particles. Alpha radiation is an internal radiation hazard. Because alpha radiation cannot penetrate the dead layer of skin cells on the surface of the body, it is not an external radiation hazard. Alpha radiation has a range in air of only one or two inches because it quickly deposits its energy as it collides with air molecules.

**As Low As Reasonably Achievable (ALARA).** The concept of keeping exposures to ionizing radiation As Low As Reasonably Achievable (ALARA). ALARA is not a dose limit, but an ongoing process to keep exposures As Low As Reasonably Achievable.

**Atom.** The smallest piece or unit of an element. An atom consists of a nucleus surrounded by an electron cloud. The nucleus contains one or more protons. The nucleus of each atom except normal hydrogen also has one or more neutrons.

**Attendant.** An individual stationed outside a confined space who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's confined space program.

**Beta particle.** A charged particle emitted at great velocity from the nucleus of a radioactive atom. A beta particle is the same size and weight as an electron, and usually has a charge of minus one (-1). Beta particles are sometimes referred to as fast moving electrons, although they come from the nucleus, not from the atom's electron cloud. A beta particle with a positive charge (+1) is called a positron.

**Beta radiation.** Ionizing radiation made up of beta particles. Beta radiation is an internal hazard if material that emits beta radiation is absorbed into the body. Beta radiation can penetrate the first few layers of skin cells. This makes it an external hazard to the skin and eyes. Beta radiation has a range of several inches in air.

**Biological hazard.** An organism or the product of an organism that poses a health threat to humans or animals.

**Calibration.** The process of adjusting a measuring or monitoring instrument by comparing its reading to a known standard.

**Carcinogen.** A chemical or physical agent that can cause cancer.

**Ceiling limit.** The concentration of an air contaminant that should never be exceeded, even for a moment. Written as TLV-C (Threshold Limit Value-Ceiling).

**Cell.** The basic unit of all living organisms.

**Cell membrane.** The surface or wall that surrounds and encloses a cell.

**Cell nucleus.** A structure inside of a cell containing the cell's chromosomes.

**Chemical Abstract Service (CAS) Number: A unique identifying number assigned to each chemical.**

**Chromosome.** A structure in the cell's nucleus that contains the genetic material (DNA), and which transmits genetic information when the cell divides to form two new cells.

**Central Nervous System (CNS).** The system in the body made up of the brain and the spinal cord. It is often referred to as the CNS.

**Chemical name.** The scientific name of a chemical. For example, "benzene" and "3,3'dimethylbenzidine" are chemical names.

**Chronic effect.** An adverse effect on the body which occurs after a long term exposure to a chemical or physical agent such as a carcinogen. A chronic effect or disease may not show up for many years after exposure.

**Combustible.** Any material, chemical, solid, liquid or gas, that can burn. A DOT Combustible Liquid is a liquid with a flash point above 141° F. Combustible liquids do not ignite as easily as Flammable Liquids. However they can ignite under certain circumstances, and must be handled with caution.

**Command post.** The centralized base of operations at a hazmat incident.

**Concentration.** The amount of a chemical (gas, vapor or particulate) in the air. For example, 5ppm of acetone is 5 parts of acetone in every 1,000,000 parts of air.

**Contamination Reduction Corridor (CRC).** A designated area within the contamination reduction zone where decontamination takes place.

**Contamination Reduction Zone (CRZ).** The area between the exclusion zone and the support zone.

**Control line.** Line between the contamination reduction zone and support zone.

**Corrosive.** A substance that can eat away other substances. Corrosives such as acids and alkalis (caustics) can severely burn or damage the skin and eyes.

**Department of Energy (DOE).** The U.S. government agency responsible for the nation's nuclear weapons facilities.

**Dermatitis.** Inflammation of the skin, such as redness, rash, dryness or cracking, blisters, swelling or pain.

**Electron.** A negatively charged particle which orbits the nucleus of an atom.

**Engineering controls.** Prevention of worker exposures to contaminants by means of work process controls, mechanical equipment or ventilation, rather than by requiring workers to wear protective equipment (PPE). OSHA regulations require that exposure to airborne contaminants be reduced by engineering controls wherever possible, rather than by the use of respirators.

**Evaporation.** The process by which a liquid changes into a vapor and mixes with the surrounding air.

**Exclusion zone.** The contaminated area. Also called the Hot Zone.

**Explosive material.** A material that can react rapidly resulting in a sudden and violent release of energy.

**External radiation exposure.** Exposure to radiation from sources located outside of the body.

**Film badge.** A personnel monitoring device which used photographic film inside a badge to measure radiation exposure. When the film is developed, the darker the film, the greater the exposure.

**Flammable.** A liquid that has a flash point of 141°F or less (as defined by the DOT). A flammable liquid ignites easily at normal temperatures in the presence of a spark or other ignition source.

**Frisk, frisking.** The process of monitoring a person to determine whether they are contaminated with radioactive material.

**Gamma radiation.** Ionizing radiation in the form of gamma rays. Gamma radiation has high penetrating power, so it is an external radiation hazard. If radioactive material that emits gamma radiation gets into the body, then the gamma radiation is also an internal hazard.

**Gamma ray.** Pure energy emitted from the nucleus of certain radioactive atoms.

**Gene:** A small section of DNA containing genetic information for a particular trait.

**Genetic effect:** A biological effect on the genetic material (DNA) in a cell. This effect causes changes in other cells produced by that cell. This is also called a mutation. Note that a genetic effect can occur in any cell of the body. If the effect occurs in a cell involved in human reproduction (a sperm or an egg), it is called a heritable effect. This might lead to an adverse reproductive effect. If a genetic effect occurs in a cell which is not involved in human reproduction, it is called a somatic effect. This might lead to cancer.

**Gestation period:** The time from conception to birth, about nine months.

**Hazard class.** A group of materials that, as designated by the DOT, share a common major hazardous property such as flammability, corrosivity or radioactivity.

**Hazardous Materials Information System (HMIS).** A voluntary system of hazard identification that some manufacturers use on chemical labels. This system includes number codes for hazards and symbols to indicate various types of personal protective equipment.

**HEPA filter (High Efficiency Particulate Air filter):** A filter that can remove tiny particulates from the air. HEPA filters are used in respirators and in ventilation filtration systems. The technical specification for a HEPA filter is that it is capable of removing 99.97% of particulates having an average diameter of 0.3 micrometers (millionths of a meter). A HEPA filter is also called a P-100 filter.

**Hot line.** The boundary line around the exclusion zone.

**Inflammation.** A condition of the body, or part of the body, characterized by swelling, redness, pain or heat.

**Ingestion.** The process of taking a substance into the body through the mouth and the digestive system.

**Inhalation.** The process of breathing something into the lungs.

**Internal exposure.** Exposure to radiation from radioactive materials which have been inhaled, ingested, absorbed through the skin or through a wound.

**Ionization.** A process by which one or more electrons is removed from an atom.

**Ionizing radiation.** Energy, in the form of a wave or a very fast moving particle, that is capable of ionizing an atom.

**Isotopes.** Atoms that have the same number of protons (so they are the same element), but have a different number of neutrons.

**Latency period.** The time between when a chemical exposure occurs and when a disease or other health effect occurs.

**Local effect.** A chemical action that takes place at the point where the chemical comes into contact with the body.

**Lower Explosive Limit (LEL).** The lowest concentration of a gas or vapor in air that can explode. Also called the Lower Flammable Limit (LFL).

**mg/m<sup>3</sup>.** Milligrams of contaminant per cubic meter of air. This is a way of measuring the concentration of a contaminant in the air.

**Maximum Use Concentration (MUC).** The theoretical highest concentration of a contaminant that a worker should be exposed to when wearing a respirator. To calculate the MUC, multiply the permissible exposure level times the respirator's protection factor. (MUC = PEL x PF). The idea is that if the respirator makes the air that the worker breathes 10 times cleaner, then you ought to be able to work in an atmosphere that is 10 times dirtier than would be allowed without the respirator. However, rather than try to figure out what is the worst possible level of contamination that a worker should work in, it would be better to improve work conditions and keep contaminant concentrations as low as possible.

**Mixed waste.** Contains both radioactive and hazardous chemical components.

**Mutagen.** A substance which can cause changes (usually adverse) in the genetic material of a cell. If the change occurs in a sperm or an egg, the damage can be passed on to the offspring. The change is called a mutation.

**National Institute for Environmental Health Sciences (NIEHS).** The U.S. government agency that does research on environmental issues. NIEHS also provides grant funding for worker safety and health training.

**National Institute for Occupational Safety and Health (NIOSH).** The U.S. government agency that does research on occupational safety and health and makes recommendations for safe practices and for OSHA standards.

**Neutron.** One of the basic particles found in the nucleus of an atom. It is called “neutron” because it is electrically neutral (has no electrical charge).

**Neutron radiation.** Ionizing radiation consisting of neutron particles produced during the fission process in a nuclear reactor or particle accelerator. Neutron radiation has a high penetrating ability and requires shielding material that has a high hydrogen content, such as plastic or water.

**Non-ionizing radiation.** Radiation such as radio, micro waves, radar, infrared, visible light, or ultra violet that does not have enough energy to ionize atoms.

**Nuclear Regulatory Commission (NRC).** Federal agency that regulates civilian nuclear power plants and other civilian uses of radioactive materials.

**Nucleus.** 1. The core of an atom, where protons and neutrons are found. If the nucleus is unstable, then the atom is radioactive. The nucleus of a radioactive atom is the source of ionizing radiation (alpha, beta or neutron particles, or gamma rays). -or- 2. The part of a living cell that contains the genetic material DNA.

**Occupational Safety and Health Administration (OSHA).** The U.S. government agency that makes regulations and enforces those regulations for safety and health in the workplace.

**Odor threshold.** The lowest concentration of a substance at which a person can begin to detect the characteristic odor of the substance.

**Organic compound.** A chemical that contains carbon. Volatile organic compounds vaporize easily at room temperature. They are found in many industrial and household materials.

**Oxidation.** The process of combining oxygen with another substance. Examples include combustion and the rusting of iron.

**Oxidizer.** A substance that provides oxygen and supports combustion.

**Oxygen deficient atmosphere.** An atmosphere having less than 19.5 % available oxygen by volume. Normal air contains about 21% oxygen by volume.

**Oxygen enriched atmosphere.** An atmosphere with more than 23.5% oxygen by volume.

**Parts Per Million (ppm).** A way of expressing the concentration of a contaminant. Ratio the amount of the contaminant to the total amount of air or water.

**Permissible Exposure Limit (PEL).** Maximum exposure to a chemical allowed by OSHA. Commonly called the PEL. Most PEL's are time weighted averages (TWA). Some are short term exposure limits (STEL), while others are ceiling limits (C) .

**Personal Protective Equipment (PPE).** Clothing and devices worn by workers to protect against hazards in the environment, including respirators, safety glasses, protective clothing, etc. The common abbreviation is PPE.

**Poison.** A chemical that is able to produce an adverse health reaction even when only a small amount gets into or on the body.

**Protection Factor.** A term used to indicate the assumed effectiveness of a respirator. For example, PF = 10 means that the air inside the respirator should be 10 times cleaner than the air outside the respirator.

**Proton.** A positively charged particle located in the nucleus of the atom.

**Radiation.** Energy that radiates out from a source. This includes both ionizing and non-ionizing radiation. Note that in this manual, "radiation" means "ionizing radiation" unless the context clearly indicates otherwise.

**Reactivity.** Ability of a chemical to have a reaction that causes an explosion, fire or poison emission. The condition that causes the reaction, such as heat or shock, is usually specified as "conditions to avoid" on the SDS.

**Radioactive.** A word that describes an unstable atom that can emit ionizing radiation.

**Radioactive contamination.** Radioactive material in an unwanted place. Contamination may be in the form of a liquid, solid or gas. Remember that



the words “radiation” and “contamination” do not mean the same thing. Contamination is a material. Radiation is a form of energy.

**Radioactive decay.** Radioactive decay is the process of radioactive atoms releasing radiation over a period of time. They do this in order to become stable (nonradioactive). Radioactive decay is also known as disintegration.

**Radioactive half-life.** Radioactive half-life is the time it takes for one half of the radioactive atoms present to decay.

**Radioactive material.** Any material containing (unstable) radioactive atoms that emit radiation.

**Radioactivity.** Radioactivity is the process of unstable (or radioactive) atoms trying to become stable. This is done by emitting radiation from the nucleus.

**Radon:** A naturally occurring radioactive gas present in some soil and rocks. Radon can accumulate in unventilated areas such as basements. Radon is an alpha emitter.

**Sensitizer.** A substance that might not cause any harmful reaction in a person following the initial exposures, but after repeated exposures the person may develop an allergic response.

**Short Term Exposure Limit (STEL).** Maximum average exposure to an air contaminant allowed by OSHA during a 15 minute period. Only four such exposures are permitted in an 8 hour work day, and they must be at least 50 minutes apart.

**Solvent.** Liquid capable of dissolving other substances.

**Superfund.** The federal law that provides money to clean up uncontrolled hazardous waste sites. The official name of this law is the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

**Support zone.** The uncontaminated area where workers shouldn't be exposed to hazardous conditions. The clean area.

**Synergistic effect.** The biological response to an exposure to two or more chemicals which is greater than the sum of the effects of the individual chemicals.

**Systemic effect.** An effect which takes place in a part of the body that is different from the point at which the chemical first comes in contact with the body. For example, some pesticides are absorbed through the skin (the point of contact), but affect the nervous system (the site of action).

**Teratogen.** A substance that causes birth defects or other anomalies in the offspring of a person exposed to the substance.

**Threshold Limit Value.** A chemical exposure limit recommended by the ACGIH. Commonly called the TLV. A TLV is not always the same value as the OSHA PEL. The TLV's are recommendations only. They do not have the force of law.

**Time Weighted Average.** The average concentration of an air contaminant during a period of time, usually 8 hours. The common abbreviation is TWA.

**Trade Name.** The commercial name which a company uses for its chemical products, either for advertising purposes or to keep the actual ingredients secret. For example, «Stripeze®» is a trade name.

**Uncontrolled hazardous waste site (uncontrolled site).** An area where improperly disposed hazardous substances create a threat to the health and safety of people or the environment. Some sites are on public lands such as former landfills where illegal or poorly managed waste disposal has taken place. Other sites are on private property, often belonging to generators or former generators of hazardous wastes. Examples include landfills, dumps, waste lagoons and tank farms.

**Upper Explosive Limit (UEL).** The greatest concentration of a gas or vapor in air that can explode. Also called the UFL, Upper Flammable Limit.

**Volatile.** A liquid that has the ability to evaporate quickly or easily.

## Abbreviations and Acronyms

<b>ACGIH</b>	American Conference of Governmental Industrial Hygienists
<b>AIHA</b>	American Industrial Hygiene Association
<b>ALARA</b>	As Low As Reasonably Achievable
<b>ANSI</b>	American National Standards Institute
<b>APR</b>	Air Purifying Respirator
<b>CDC</b>	Centers for Disease Control
<b>CDL</b>	Commercial Drivers License
<b>CERCLA</b>	Comprehensive Environmental Response, Compensation and Liability Act (The Superfund Law)
<b>CFR</b>	Code of Federal Regulations
<b>CGI</b>	Combustible Gas Indicator
<b>CHEMTREC</b>	Chemical Transportation Emergency Center
<b>CHRIS</b>	Chemical Hazard Response Information System
<b>cc</b>	Cubic centimeter
<b>CNS</b>	Central Nervous System
<b>CPC</b>	Chemical Protective Clothing
<b>CPR</b>	Cardiopulmonary Resuscitation
<b>CRC</b>	Contamination Reduction Corridor
<b>CPZ</b>	Contamination Reduction Zone
<b>dB</b>	Decibel
<b>DHS</b>	U.S. Department of Homeland Security
<b>DOD</b>	U.S. Department of Defense
<b>DOL</b>	U.S. Department of Labor
<b>DOT</b>	U.S. Department of Transportation
<b>EPA</b>	U.S. Environmental Protection Agency

<b>ESLI</b>	End of Service Life Indicator
<b>FEMA</b>	Federal Emergency Management Agency
<b>FF</b>	Fit Factor
<b>HAZWOPER</b>	Hazardous Waste Operations and Emergency Response Standard
<b>HEPA</b>	High Efficiency Particulate Air (Filter)
<b>HMIS</b>	Hazardous Materials Identification System
<b>IARC</b>	International Agency for Research on Cancer
<b>IDLH</b>	Immediately Dangerous to Life or Health
<b>LC<sub>50</sub> LD<sub>50</sub></b>	Lethal Concentration, 50%; Lethal Dose, 50%
<b>LEL</b>	Lower Explosive Limit (Also LFL = Lower Flammable Limit)
<b>mg/m<sup>3</sup></b>	Milligrams per meter cubed
<b>MUC</b>	Maximum Use Concentration (also <b>MUL</b> , maximum use level)
<b>NFPA</b>	National Fire Protection Association
<b>NIEHS</b>	National Institute for Environmental Health Sciences
<b>NIOSH</b>	National Institute for Occupational Safety and Health
<b>NLRA</b>	National Labor Relations Act
<b>NLRB</b>	National Labor Relations Board
<b>n.o.s.</b>	Not Otherwise Specified
<b>NPL</b>	National Priority List
<b>NRC</b>	National Response Center
<b>NRC</b>	Nuclear Regulatory Commission
<b>NTP</b>	National Toxicology Program
<b>ORM-D</b>	Other Regulated Material - Domestic
<b>OSC</b>	On Scene Coordinator
<b>OSHA</b>	Occupational Safety and Health Administration

<b>OSHRC</b>	Occupational Safety and Health Review Commission
<b>OVA</b>	Organic Vapor Analyzer
<b>PAPR</b>	Powered Air Purifying Respirator
<b>PDS</b>	Personal Decontamination Station
<b>PEL</b>	Permissible Exposure Limit
<b>PF</b>	Protection Factor
<b>PID</b>	Photo Ionization Detector
<b>PIH</b>	Poison Inhalation Hazard
<b>ppb</b>	Parts Per Billion
<b>PPE</b>	Personal Protective Equipment
<b>ppm</b>	Parts Per Million
<b>psi</b>	Pounds Per Square Inch
<b>RCRA</b>	Resource Conservation and Recovery Act
<b>REL</b>	Recommended Exposure Limit
<b>RSPA</b>	Research and Special Programs Administration - U.S. DOT
<b>SAR</b>	Supplied Air Respirator
<b>SARA</b>	Superfund Amendments and Reauthorization Act
<b>SCBA</b>	Self Contained Breathing Apparatus
<b>SDS</b>	Safety Data Sheet
<b>S&amp;HO</b>	Safety and Health Officer
<b>SLM</b>	Sound Level Meter
<b>SOP</b>	Standard Operating Procedure
<b>STEL</b>	Short Term Exposure Limit
<b>TC</b>	Tested and Certified (NIOSH approved respirator)
<b>TLA</b>	Three Letter Acronym
<b>TLV</b>	Threshold Limit Value

<b>TLV-C</b>	Threshold Limit Value - Ceiling
<b>TSA</b>	Transportation Security Administration
<b>TSD</b>	Treatment, Storage and Disposal (Facility)
<b>TWA</b>	Time Weighted Average
<b>UEL</b>	Upper Explosive Limit (Also UFL = Upper Flammable Limit)
<b>UHWM</b>	Uniform Hazardous Waste Manifest
<b>UL</b>	Underwriters Laboratories
<b>UN/NA</b>	United Nations/North America (hazmat identification number)
<b>USCG</b>	U.S. Coast Guard
<b>UV</b>	Ultra Violet
<b>VP</b>	Vapor Pressure

**- Notes -**