




The New England Consortium

Emergency Responders Basic Health and Safety Course

**Student Manual
Edition 3.0**

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The New England Consortium

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The New England Consortium's

STATEMENT ON MEDICAL SCREENING

You do not need to wear personal protective equipment during training in order to receive a certificate of completion of the course. Any trainee who either by doctor's order, or by personal preference, chooses not to wear a respirator or protective clothing will not be penalized for that choice. All trainees, however, must participate in all hands-on training by at least assisting a buddy who is using personal protective equipment.

The OSHA standard for hazardous waste operations and emergency response, 29 CFR 1910.120, requires that any employee who may be exposed to hazardous substances at or above the permissible exposure limit for 30 days or more a year, or, who must wear a respirator for 30 days or more a year, or, who is a member of a HAZMAT team, must be included in a medical surveillance program. Employees must be provided with a medical examination and consultation prior to job assignment and periodically thereafter. One purpose of the medical evaluation is to ensure that employees are physically capable of wearing the protective clothing and respirators that are required for their jobs.

Trainees should have had medical evaluations prior to attendance at a New England Consortium course. It is not the intent of the New England Consortium to provide medical opinions on the ability of trainees to use personal protective equipment, and the responsibility for making decisions about the use of personal protective equipment will be left to the trainees.

Please notify the instructors if you decide not to use a particular type of equipment. You do not need to tell the instructor your reason for the decision. You may change your mind about using protective equipment at any time during the course.

ACRONYMS USED IN THIS MANUAL

ACGIH	American Conference of Governmental Industrial Hygienists
AFL-CIO	American Federation of Labor/Congress of Industrial Organizations
AIDS	Acquired Immune Deficiency Syndrome
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
APF	Applied Protection Factor
APR	Air-Purifying Respirators
AREC	Anticipation, Recognition, Evaluation and Control
ASTM	American Society for Testing and Materials
CAA	Clean Air Act
CAS	Chemical Abstracts Service
CDC	Center for Disease Control
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (also called Superfund)
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CHRIS	Chemical Hazardous Response Information System
CNS	Central Nervous System
COSH	Committee (Coalition) on Occupational Safety and Health
CPC	Chemical Protective Clothing
CPE	Chlorinated Polyethylene
CPR	Cardiopulmonary Resuscitation
CRZ	Contamination Reduction Zone
CTD	Cumulative Trauma Disorders
CWA	Clean Water Act
DOT	Department of Transportation
DRI	Direct Reading Instrument
EEOC	U.S. Equal Employment Opportunity Commission
EPA	Environmental Protection Agency
ESCBA	Escape-Only Self-Contained Breathing Apparatus
FEMA	Federal Emergency Management Administration
FES	Fully Encapsulating Suit
FID	Flame Ionization Detector
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
GC	Gas Chromatography
GFCI	Ground Fault Circuit Interrupter
HASP	Health and Safety Plan
HAZMAT	Hazardous Material Response Team

HAZWOPER	Hazardous Waste Operations and Emergency Response
HBIG	Hyperimmune Globulin
HBV	Hepatitis B Virus
HIV	Human Immunodeficiency Virus
HHS	U.S. Department of Health and Human Services
HMIS	Hazardous Materials Information System
HMTA	Hazardous Materials Transportation Act
HMTUSA	Hazardous Materials Transportation and Uniform Safety Act
HNU	Name of company that manufactures a type of photoionizer used to detect organic gases and vapors.
IDLH	Immediately Dangerous to Life and Health
ISO	International Organization for Standards
LEL	Lower Explosive Limit
LFL	Lower Flammable Limit
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
MSHAct	Mine Safety and Health Act
NEPA	National Environmental Protection Act
NFPA	National Fire Protection Agency
NIOSH	National Institute for Occupational Safety and Health
NLRA	National Labor Relations Act
NLRB	National Labor Relations Board
NPL	National Priorities List
NRC	National Response Commission
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration
OSHAct	Occupational Safety and Health Act
OSHRC	Occupational Safety and Health Review Commission
OVA	Organic Vapor Analyzer
PCB	Polychlorinated Biphenyl
PE	Polyethylene
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PPE	Personal Protective Equipment
PU	Polyurethane
PVA	Polyvinyl Alcohol
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit
RSI	Repetitive Strain Injury
SARA	Superfund Amendment and Reauthorization Act
SCBA	Self-Contained Breathing Apparatus
SOP	Standard Operating Procedure

SSO	Site Safety Officer
STEL	Short-Term Exposure Limit
TDI	Toluene Diisocyanate
TLV	Threshold Limit Value
TLV - C	Threshold Limit Value - Ceiling
TSCA	Toxic Substances Control Act
TSD	Transportation, Storage and Delivery
TWA	Time-Weighted Average
UEL	Upper Explosive Limit
UFL	Upper Flammable Limit
USCG	U.S. Coast Guard
WBGT	Wet Bulb Globe Temperature

EMERGENCY RESPONSE BASIC HEALTH & SAFETY COURSE

This is a basic health and safety training course for emergency responders. The overall purpose of this course is to give you an understanding of the health and safety hazards you may face in emergency response situations. This course should enable you to appropriately protect yourself and others from such hazards during emergency response.

We hope you will enjoy this week of thinking about making your work as emergency responders healthier and safer.

The AREC Model

The purpose of this course can be broken down into four groups, based on the Anticipation, Recognition, Evaluation and Control (AREC) Model:

Anticipation

To motivate students to:

- become active in health and safety issues relative to their job.
- become aware of the importance of identifying community resources and planning to use them.
- understand the limitations of the systems they operate.

Recognition

To ensure that students:

- understand the hazards associated with emergency response work.
- begin to learn how to identify and assess those hazards.
- begin to understand the limitations of information about hazards and how to use that information in their planned response.



Evaluation

To ensure that students:

- understand the ways to measure the risks posed by hazards associated with emergency response work.
- understand how to evaluate risks.

Control

To ensure that students:

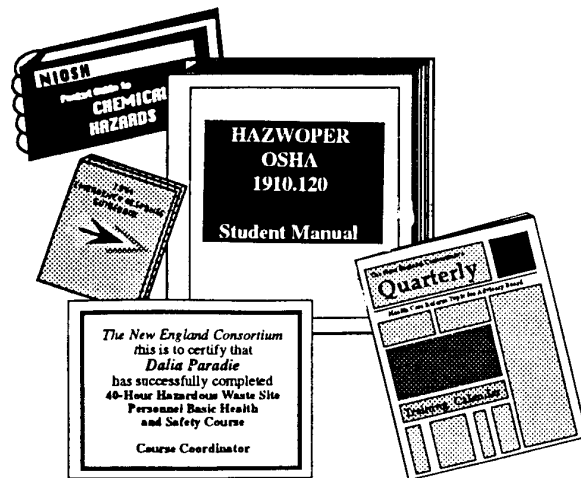
- understand various methods of controlling hazards.
- understand the limitations of personal protective equipment.
- make sure that these limitations don't increase the danger of their work in emergency response situations.

Purpose of the Manual

This manual supplements the course on emergency response basic health and safety. It contains a series of activities that we hope will help you to use your work experience and knowledge to develop practical solutions to health and safety problems. These activities are designed to get students working together and are a basic part of the training program.

This manual also provides brief outline summaries of major points and extensive resource material. We hope that you can use it as a beginning reference tool to solve workplace health and safety problems.

This manual is used throughout the training. It has been developed as a reference tool and as a guide to the technical, political and organizational issues involved in protecting worker health and safety in emergency response situations.





OBJECTIVES

In this first module you will learn about the role of the Occupational Safety and Health Administration (OSHA). Special attention will be paid to the role of the OSHA inspection. We will discuss rights and responsibilities as defined in the OSH Act. We will examine the importance of the HAZWOPER standard in protecting the health and safety of emergency responders. We will also discuss the role of health and safety committees.

The objectives of this chapter are to ensure that students understand:

- The basic role of the OSHA inspection.
- The key elements of the OSH Act: the General Duty Clause and the Discrimination Standard.
- The HAZWOPER standard.
- The role of health and safety committees.

On completion of this chapter, students will be able to:

- List four functions of the Occupational Safety and Health Administration (OSHA).
- Describe OSHA's five levels of priority for inspections.
- Describe how to register a complaint with OSHA.
- Describe three important worker rights under the OSH Act.
- Describe which categories of worker are covered by the Emergency Response standard (HAZWOPER), and what the training requirements are.
- Describe the components of a facility Emergency Response Plan.
- Describe the basic guidelines for health and safety committees.

THE U.S. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

The Occupational Safety and Health Administration (OSHA) is a federal agency located within the U.S. Department of Labor. It is responsible for regulating workplace hazards and protecting the health and safety of workers. OSHA was set up under the Occupational Safety and Health Act of 1970 (OSH Act) to:

- Make and enforce rules and standards on safety in the workplace.
- Inspect work sites.
- Respond to employee complaints concerning safety and health.
- Issue citations against employers who fail to meet standards or who violate the law.
- Require employers to provide a safe and healthy place to work.
- Encourage employers to reduce hazards and to implement safety and health programs.
- Prohibit discrimination against employees who exercise their rights under the OSH Act.



OSHA has a very important standard that we will talk about throughout this training, the HAZWOPER (Hazardous Waste Operations and Emergency Responder) Standard (29 CFR 1910.120). We will talk in more detail about that rule but let us first fill in some background about how OSHA works.

OSHA's Internet web-site is one of the best sources of information available: The home page is www.osha.gov. OSHA now has a web site that focuses on the worker's issues, rights and responsibilities (OSHA The Workers' Page). The web address is: www.osha.gov/as/opa/worker/



NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

In addition to creating the Occupational Safety and Health Administration, the OSH Act established the **National Institute for Occupational Safety and Health (NIOSH)**. NIOSH is located within the Department of Health and Human Services. Its main activity is to research health and safety hazards. In addition, NIOSH tests and certifies respirators, funds education programs for occupational health and safety specialists, develops sampling and measurement methods, and funds state-based occupational illness and injury surveillance programs. NIOSH also prepares hazard alerts and other publications for workers, employers and health professionals. It **does not set** standards but it does recommend standards for OSHA to adopt. NIOSH puts out the Pocket Guide to Chemical Hazards, which you will use during this course, and the **Recommended Exposure Limits (RELs)**.

Another key NIOSH activity is its Health Hazard Evaluations (HHE) program. This is a targeted review of a site or facility where unusual problems have been uncovered. NIOSH investigators try to see what is at the root of these situations. Published results are an excellent source of information. NIOSH may be called in at the request of workers, unions, employers or medical professionals.

**CALL 1-800-35-NIOSH
for information
on workplace hazards**



* Source of Graphic: Pesticide Safety for Non-Certified Mixers, Loaders, and Applicators, EPA, 1986.

OSHA INSPECTIONS

How OSHA Performs Inspections

OSHA is best known for its role of inspecting workplaces for hazards and enforcing safety and health regulations in the workplace. However, there are only about 1700 inspectors — combining OSHA and state agencies — and over 10 million workplaces to inspect. OSHA’s annual budget hovers around \$300 million — while that for wildlife protection is over \$1 billion. OSHA has limited resources and certainly cannot cover all workplaces. The agency has to figure out how and when to use its resources. Here is how OSHA sets its inspection priorities:

- **Imminent danger situations:** The most harmful situations need attention first. An imminent danger means there is some condition where death or serious physical harm could occur immediately.
- **Fatal accidents or catastrophes** where three or more employees are hospitalized as in-patients. Such situations must be reported by the employer within 8 hours.
- **Employee complaints:** OSHA will respond to formal employee complaints of alleged violations of standards, or of unsafe or unhealthful working conditions. These usually must be in writing.
- **Follow-up inspections,** to see if a violation that was cited in an earlier inspection was corrected.
- **Programmed inspections:** OSHA picks certain industries, hazards or occupations to inspect because they think that is where the biggest dangers are. OSHA has been trying to sort out better ways to focus their efforts. In OSHA’s Cooperative Compliance Program (CCP), OSHA will contact “high risk” companies and offer them a chance to develop a health and safety program and to correct hazards, with the threat of traditional enforcement if the company does not. Cooperative Compliance Programs vary from one region of the country to another.



* Source of Graphic: Safety, Health and Welfare on Construction Sites, International Labor Office, Geneva.

There are other situations when OSHA will get involved. OSHA responds to referrals from other agencies, state officials, doctors and local fire departments and to formal complaints filed by union representatives. OSHA treats these referrals the same as employee complaints. If there is something in the news, such as a chemical spill, OSHA will also respond.

Complaints, Investigations, and Inspections

If OSHA receives a complaint over the phone, the agency will rarely send an inspector out right away. Instead, OSHA will send a letter or fax to the employer outlining the nature of the complaint and asking that it be corrected. They will ask the employer to show documentation of the correction. OSHA gives the employer a limited amount of time to present his or her view of the situation. The employer's response to OSHA will be repeated to the complaining employee or union representative. If they are satisfied, then the file is closed. OSHA calls this an **investigation**.

If the complainant rejects the employer's claim of correction and signs an official complaint, OSHA will visit the site as soon as possible. This is called an official **inspection**.

An inspection will also take place when:

a) The complainant -- even if it is over the phone -- says there is an imminent danger. If it sounds legitimate, OSHA will get out to the site right away.

b) An employee or union representative signs a complaint form, or puts in writing a valid complaint. An OSHA inspection will be conducted as soon as possible.

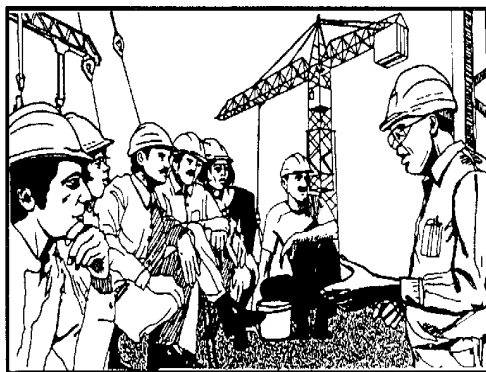
c) OSHA is not satisfied with the employer's response to the complaint. OSHA will not reveal to an employer who made the complaint. Employees are protected by the OSH Act: OSHA **cannot** tell the employer who made the complaint. But, generally, OSHA will not accept an anonymous complaint. OSHA usually has to know who is placing the complaint. In some cases, depending upon the nature of the complaint, OSHA might not ask for the identity of the complainant.

Before You Request an OSHA Inspection

The first thing to do is to bring your concern to the attention of your supervisor/ employer. This can be done through a health and safety committee or a union steward if you belong to a union. However, if you feel that by complaining you will be punished, or if you have brought up the problem and nothing has been done, then you can contact OSHA. If you find yourself in this situation and you belong to a union, before contacting OSHA you should bring your concern to the next higher official above the union steward.

During the Inspection

OSHA usually conducts inspections without letting the employer know ahead of time. OSHA will give limited advanced notice for a number of special circumstances, such as if the inspection must take place after regular business hours. If an employer is given advance notice of an OSHA inspection, they must inform their employees' representative, or let OSHA do so.



* Source of Graphic: Safety, Health and Welfare on Construction Sites, International Labor Office, Geneva.



An OSHA inspector may check the following items during the walkaround:

- Labeling.
- Storage and handling of flammables.
- Whether engineering controls, such as ventilation, are working properly.
- Dust, chemicals, or noise levels by placing sampling equipment in an area or attaching it to employees.
- If respirators are needed, ensure they are right for the hazards, and if they are used, maintained, stored and selected properly.
- If machines have guards to prevent hand injuries.
- For damaged or slippery walking surfaces.
- For defective electrical outlets and wiring.
- If there are holes in floor or other tripping hazards.
- If there are areas or activities where employees could fall from heights.
- If training has been done.
- If a Hazard Communication Program is in place.

What an inspector will look at depends on the type of facility, its hazards and the purpose of the inspection. When OSHA arrives at a worksite, the inspector will hold an opening conference to explain to management why they are there: in response to a complaint; on a follow-up inspection; due to a referral from another agency; or as part of it's "emphasis program". Sometimes they will focus on a specific process or equipment. Other times, OSHA will conduct a comprehensive wall-to-wall inspection. During a conference, applicable OSHA rules and regulations will be explained. The OSHA inspector will ask to have an employee representative at the conference and at the inspection.

Depending on the reason for the inspection, OSHA may focus on safety issues, such as electrical hazards, falls from heights, being struck by equipment or hazards from moving parts. This usually is called a **safety inspection**. Alternatively, the inspection may focus on chemical, physical, or biological hazards. This usually is called a **health inspection**. Some inspections will cover both safety and health problems. The inspection may take less than a day or can take several days. It may involve one inspector or several.

During the inspection the inspector will observe safety and health conditions and work practices. He/she will talk to employees privately and, if necessary, take photos and videotape. Depending on why the inspection is taking place, OSHA may sample the air or measure noise. The inspector may examine injury records and scrutinize the facility's hazard communication plan, emergency procedures and posting requirements.

During the inspection, the OSHA official may also point out hazards, and if the employer desires, discuss some remedies. Some hazards may be corrected during the inspection. If so, the inspector will note this in his/her estimate of the employer's efforts to provide a workplace free of recognized hazards.

ENFORCEMENT

The inspection ends with a closing conference which employee representatives have the right to attend. If management complains, employees can have separate opening and closing conferences. OSHA inspectors will hold these away from the work place if the employees ask - even in an employee's home. At these conferences, the OSHA compliance officer explains what he/she has discovered and the types of violations. A full report of the final inspection will be sent by mail to the employer and the union representing the employee.

Employees can request separate opening and closing conferences during an OSHA inspection.

OSHA will send the employer citations, listing the OSHA standards or rules that have been violated and the proposed penalties. The citations will indicate by what date violations must be corrected. This is called the abatement date. The citations must be posted in the workplace for three days or until the violations are corrected, whichever is longer.



Be aware of OSHA citations at your workplace.



Types of Penalties

OSHA has several types of penalties:

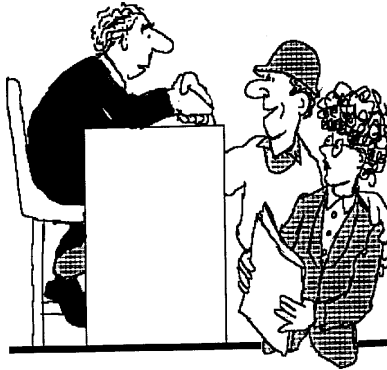
- **Other than serious:** Usually a violation of a paperwork requirement and one that would not cause direct injury or death. The maximum fine is \$7,000 per violation. These are often reduced during settlement conferences if the employer shows a genuine effort to come into compliance. There is no minimum penalty and most “other than serious” violations do not carry a penalty.
- **Serious:** A violation where there is a strong possibility of injury and/or death. Fines can range from \$1,500 to \$7,000. These may be reduced, depending on the size of the company, its efforts to correct any problems, and its history of compliance.
- **Repeat:** This is a violation of any OSHA rule that upon reinspection has been violated once again. It does not have to be the exact same situation, but may be a hazard that is “substantially similar” to the one OSHA found before. Penalties can go as high as \$70,000 per violation.
- **Willful:** This means that the employer intentionally and knowingly disregarded an OSHA rule or obligation of the OSH Act. Penalties can go as high as \$70,000 for each violation. In rare instances, an employer may be charged with criminal violation for willfully ignoring an OSHA rule if an employee dies as a result. Penalties may range from \$250,000 to \$500,000 and/or imprisonment for 6 months.
- **Failure to Abate:** Failure to correct a violation may bring a civil penalty of up to \$7000 for each day of violation.

Contesting Penalties

An employer may ask to meet with OSHA to talk about the citations and especially the penalties. Fines may be reduced based on the size of the company, efforts to correct hazards, or for other reasons. OSHA almost always reduces penalties. In a unionized site OSHA will invite the union to participate informally in this process. If an employer goes back to the old way of doing things after OSHA has reduced its penalties for good faith efforts, then the employees should notify OSHA.

Employers can appeal citations and penalties. This will be heard by a separate **Occupational Safety and Health Review Commission (OSHRC)**. When an appeal is filed with OSHA, it is assigned to an Administrative Law Judge. The

judge issues a decision, and if either party objects to the decision, it can be appealed to the Review Commission. If the Review Commission refuses to hear a case or issues a decision which is not acceptable to one of the parties, the case can be appealed to the U.S. Court of Appeals and from there to the U.S. Supreme Court.



* Source of Graphic: [Chemical and Radioactive Hazardous Materials Workbook](#), OCAW/Labor Institute.

OSHA Jurisdiction

Most, but not all, workers are covered by OSHA. Those **not** covered include:

- State, county, and municipal government workers, unless they have a state OSHA plan (see below).
- Workers in workplaces regulated by another federal agency, such as the Nuclear Regulatory Commission, the Mine Safety and Health Administration, and the Department of Transportation.
- Self-employed persons.
- In 1998 the OSHA Act was amended to include the U.S. Postal Service as an employer subject to OSHA enforcement.

OSHA covers federal employees and can inspect federal agencies and issue citations, based on agreements between agencies. However, OSHA cannot fine federal employers for violations.

State OSHA Plans

Under the OSHA Act, states are permitted to operate their own occupational safety and health enforcement programs. Such state plans must be equal to or more restrictive than the Federal OSHA Act. OSHA approves and monitors these state plans.



There are about 25 such plans. OSHA coverage for New England states is as follows:

- **Vermont** has a state OSHA plan.
- **Connecticut** has a joint plan. Federal OSHA covers private sector workers and Connecticut OSHA covers public sector workers.
- **Maine, New Hampshire, Massachusetts, and Rhode Island** are covered only by federal OSHA. Public workers in these states do not have OSHA protection.
- **Rhode Island, New Hampshire and Massachusetts** public sector workers are covered by state labor agencies in their respective states.



A list of addresses, OSHA offices and state occupational safety and health agencies is located in Appendix A.

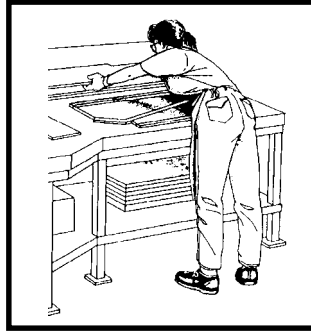
WORKER HEALTH AND SAFETY RIGHTS UNDER OSHA

The General Duty Clause (5(a))

One of the most important parts of the OSH Act is the **General Duty Clause**. This clause requires that the employer:

“Shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees...”

This clause covers hazards that are not regulated by a specific OSHA standard.



For example, ergonomics violations are enforced using the General Duty Clause.

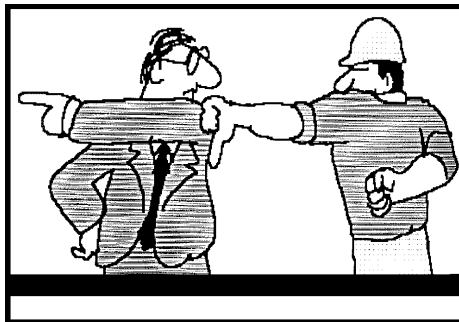
* Source of graphic: Ergonomics Awareness Manual, UAW.

According to OSHA, a hazard found in the workplace is a violation of this clause only if:

- It is a “serious” hazard (OSHA cannot cite the General Duty Clause for other than serious hazards).
- It is a hazard about which there is good scientific evidence.
- The employer either knew or should have known about the hazard.
- There are ways to correct the hazard.

Your Right to Refuse Hazardous Work

The OSHA Act does provide limited protections for workers who refuse unsafe work. However, you are better protected when you refuse unsafe work if you have a union contract (or are in a union). OSHA will investigate and seek remedy from the employer if you are fired or disciplined for your refusal, provided OSHA thinks your refusal was valid.



* Source of graphic: Hazardous Material Workbook, OCAW/Labor Institute, 1992.

If an employee refuses dangerous work under these conditions, OSHA may move to protect that employee from discipline or firing. First, the dangerous condition must be one that a reasonable person would conclude is a real danger. Secondly, there must not be



enough time to eliminate the danger through normal OSHA procedures. Lastly, employees must have asked their employer to eliminate the danger. Although this is an important right, it may take several years of legal proceedings for a worker to obtain justice, such as reinstatement after being fired.

Before refusing to do unsafe work:

- Inform your employer of the condition and ask that he/she correct the situation before you get hurt. Document reasons why you think the situation is unsafe. Let your co-workers know about the unsafe condition (and if you are in a union, notify your steward). Keep records of all meetings and discussions regarding the unsafe conditions.
- Explain to your employer that you are willing to do the work when the danger is corrected. Meanwhile, ask that you be assigned to work in a safer area.



* Source of Graphic: Entrenamiento Sobre Salud y Seguridad Para Los Trabajadores de Desperdicios Peligrosos, University of California at Berkeley, December, 1991

Your Right Not to be Discriminated Against for Exercising Health and Safety Rights - Section 11(c) Protection

You have a right to demand safe and healthy working conditions on the job without fear of punishment. That right is spelled out in Section 11(c) of the OSH Act. The law says employers shall not punish or discriminate against workers for exercising rights such as:

- Complaining to an employer, union, OSHA or any other government agency about job safety and health hazards.
- Filing safety or health grievances.
- Participating in a workplace safety and health committee or in union activities concerning job safety and health.
- Participating in OSHA inspections, conferences, hearings, or other OSHA related activities.

If you believe that you are being punished for exercising safety and health rights, contact the nearest OSHA office **within 30 days of the time you realize that this has started**. If you are in a union, get your union involved. If the 30 day period has lapsed, you are not covered by Section 11 (c).

Worker Responsibilities Under OSHA

As an employee, you have the responsibility to comply with all OSHA standards, rules, regulations and orders applying to your job. While there are no legal sanctions for employees who violate OSHA rules, the Review Commission has thrown out citations for employee misconduct.

CHEMICAL EMERGENCY RESPONSE STANDARDS

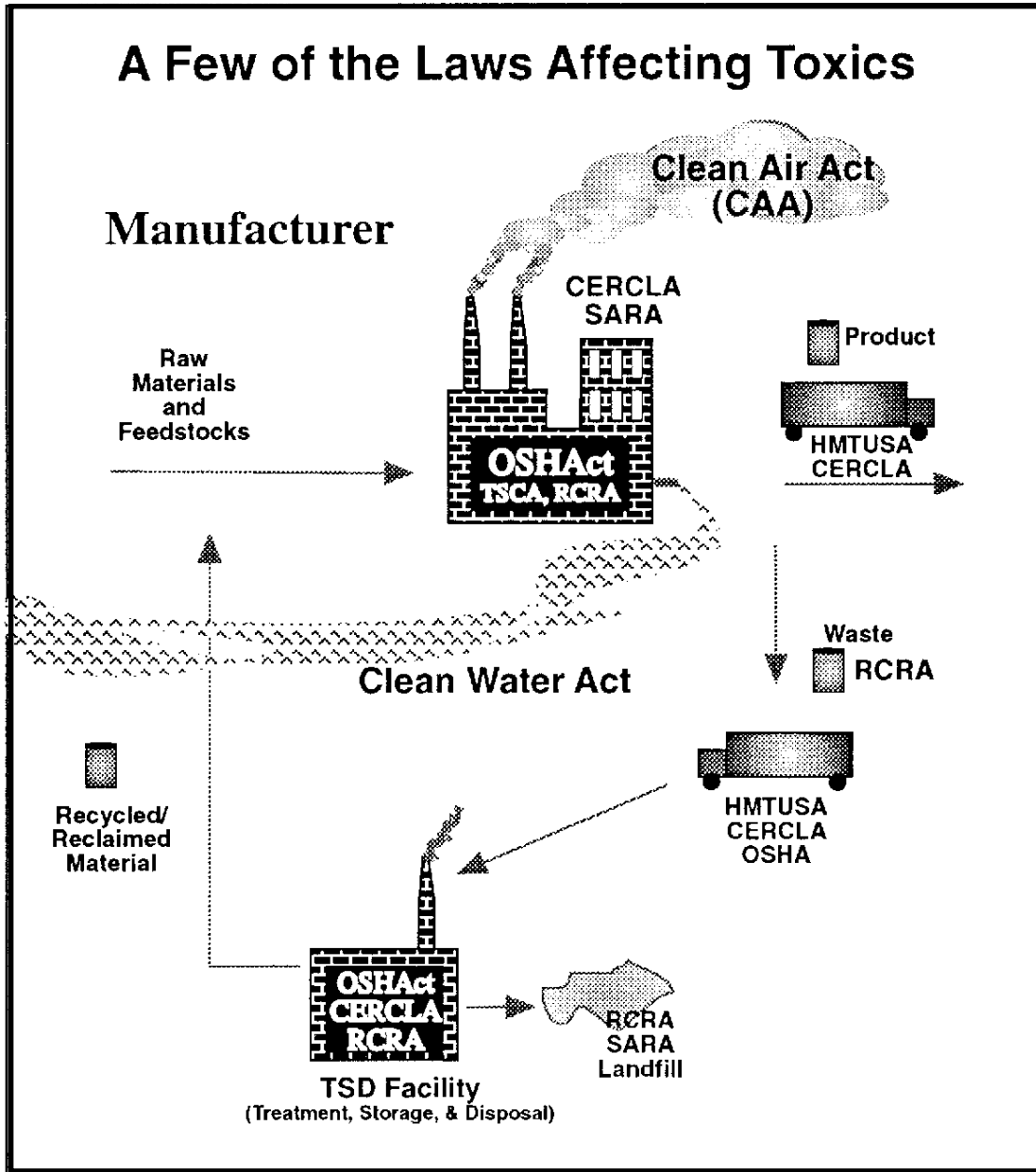
There have been many important regulations and legal requirements about chemical spills and releases in the last few years.

The **Superfund Amendments and Reauthorization Act (SARA)** was passed due to public concern about the Bhopal, India disaster of 1984 and fear that such a catastrophe could happen in the United States. In Bhopal more than 3,000 people died and thousands more were injured in a chemical accident at a Union Carbide chemical plant.

SARA emphasizes emergency preparedness and community right-to-know. It requires that State and Local Emergency Planning Committees (LEPCs) be established. The committees must draft plans for emergency response, emergency notification, and evacuation procedures. Facilities and transportation routes for extremely hazardous substances must be identified. Under this law companies must provide information to the LEPCs about chemicals they use, store, and transport.

Companies are also required to report accidental spills or releases immediately to local, state, and national agencies including the Environmental Protection Agency (EPA).

Companies must also submit a list of the hazardous substances and the quantities that are routinely released into the air, water, and soil to the EPA and state officials.



- CAA - Clean Air Act**
- CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)**
- HMTUSA - Hazardous Materials Transportation Uniform Safety Act**
- OSHA - Occupational Safety and Health Act**
- RCRA - Resource Conservation and Recovery Act**
- SARA - Superfund Amendments Reauthorization Act**
- TSCA - Toxic Substances Control Act**

OSHA RULE: THE HAZWOPER 1910.120(q) EMERGENCY RESPONSE STANDARD

SARA required OSHA to create health and safety regulations on chemical spills. OSHA developed 29 CFR 1910.120, the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard. Under HAZWOPER, companies must anticipate and plan for potential emergencies. Companies are permitted to decide whether they will have an in-house spill team. A company may decide not to have personnel respond to chemical incidents, and evacuate everyone. If the company decides to deal with spills in-house, it must develop an approach that meets specific OSHA requirements. In either case, the company must review the potential for chemical accidents and explain in writing what it plans to do.

HAZWOPER Standard -- Who is Covered?

There are two broad categories of workers covered by the emergency response requirements:

1. Workers employed by an **emergency response agency**: This group includes fire, police, and emergency medical personnel. Also included in this group are employees of state and federal regulatory agencies responsible for responding to chemical incidents, road crews who may play a role in an incident, and subcontractors called by a municipality to mitigate a chemical accident or emergency. (Because OSHA has limited jurisdiction in the public sector, OSHA will not directly enforce the HAZWOPER standard for most public sector workers. Where a state has a special OSHA state plan program covering public sector workers, that state will enforce the standard. Where there is no special state plan, the Environmental Protection Agency (EPA) is supposed to enforce the standard, though often is reluctant to do so.)
2. Workers in the **private sector** who actively and aggressively respond to, control or mitigate chemical accidents or spills in the facility where they work. All potentially involved workers are required to have training for hazardous materials spills, as defined in both the emergency response (1910.120)(q) and hazard communication (1910.1200) standards.



What is an Emergency Response?

A janitor who cleans up a spill of paint thinner is not performing an emergency response according to OSHA. However, if enough thinner was spilled that it threatened a fire, then OSHA would insist on an emergency response. In another scenario, OSHA makes the distinction in the following way. A spill of toluene in a facility that makes toluene may not be an emergency response because personnel in the immediate area are already familiar with the material and have the equipment and knowledge to handle the situation. This would be called an incidental release. However, the same spill inside a furniture factory might require an emergency response if workers in the area did not have the same equipment and knowledge as the other group.

According to the OSHA Emergency Response Standard, **whether emergency response is required will depend on the particular hazard and work circumstances.**

OSHA mandates that the employer:

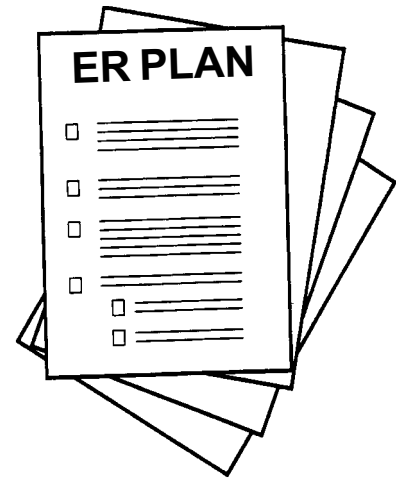
1. Develop an emergency response plan that lays out chain of command, responsibilities, and emergency procedures;
2. **Train all personnel to a degree that will protect them from hazards faced in an emergency.** (Almost 70 percent of OSHA'S HAZWOPER citations are for failure to have an adequate emergency plan and appropriate training, as spelled out in this section, paragraph {q} of the standard.)

In other words, employees must be given clear and accurate information about the potential hazards of releases in their facility and the appropriate methods to safely mitigate and control them. These issues must be addressed in the planning process. If there is a spill of toluene in my facility, can we handle it? How big a spill? Where? When? What do we need for equipment, for worker safety?

The Emergency Response Plan

If the employer decides they will have an in-house response, then they will have to address all of the following:

- Planning and cooperation with outside parties like the local fire department and Local Emergency Preparedness Committee (LEPC)
- Chain of command, communications, and personnel roles
- Emergency recognition and prevention
- Personal protective equipment and emergency equipment
- Evacuation procedures, safe distances and safe areas;
- Emergency medical treatment
- Site security
- Decontamination
- Evaluation of plans.



Emergency Response Procedures

Procedures for handling an emergency must meet some specific OSHA requirements:

1. The **chain of command** must be set up so that responders and communications are controlled through an **Incident Command System (ICS)**. (ICS is a system developed within the fire service to identify hazardous conditions and to designate appropriate controls and procedures during an emergency.)
2. Emergency responders shall use a **buddy system** -- working in teams of two or more in the hazardous zone.
3. Certain employees may play a role in an emergency even though they are **not emergency responders**. These employees need to be briefed on what chemical hazards are involved, on what they as skilled support personnel are expected to do during an emergency, and instructed on the wearing of any required PPE.
4. Workers shall also receive appropriate safety and health training for the tasks they are expected to perform **during clean-up following an emergency operation**.



Training

Many people have become fixated with the number of hours of training. An employer will ask: how many hours do I need to get? This is the wrong approach. No training should be solely based on getting a minimum number of hours: it should be based on the expected duties and potential risks. If an employer expects a group of workers to identify an incident, round up mitigation equipment and control the incident, then they must be trained up to a level where they can do this competently and safely.

This also is important when it comes to clean-up **after the emergency**. Someone must remove the hazardous materials and return the site to normal. Usually this will be in-plant workers. OSHA states that these employees must receive training and be properly protected based on the tasks they are expected to perform.

Training Requirements

OSHA has specified certain levels of training and corresponding training requirements for emergency responders. Each level has a minimum number of required training hours:

- At the **First Responder Awareness Level** are those personnel who act as “spotters.” They are expected to identify an incident or emergency, recognize the associated hazards and notify appropriate authorities. These folks must know risks associated with hazardous substances and their role during such an emergency. They are not expected to respond to or abate the incident. OSHA does not specify a minimum number of training hours for responders at this level.



* Source of Graphic: Lead Abatement Manual, Mass. Respiratory Hospital, 1991.

- The **First Responder Operations Level** involves personnel who will set up a “defensive perimeter.” Their primary responsibility is to contain a spill or release from a distance and to keep it from spreading. They should receive at least **8 hours of initial training** to recognize an incident and associated hazards. This training should help them understand their role as first responders and the standard operating procedures of the appropriate ER plan.
- **Hazardous Material Technicians/Specialists** are the personnel dedicated to controlling and stopping the release or emergency. They are divided into two groups. The Hazardous Material Technicians are personnel designated to handle, rescue and to enter the hot zone to patch, plug and otherwise control the release. The second group are Hazardous Materials Specialists who have parallel duties, but who also have more specialized training or experience in specific chemicals (chlorine or ammonia, for example), or in handling a specific item of equipment (rail car, tanker truck, chemical storage tank, piping, etc.). They also have more duties during an incident. For both groups OSHA requires a minimum of **24 hours of training** equal to the first responder operations level, as well as training -- or proof of competency -- in the additional duties.
- **On-Scene Incident Commander** is the person in charge of the emergency. They must receive at least **24 hours of training** equal to the first responder operations level, and be competent to run the local/facility incident command system and the local/facility ER plan.

All personnel should receive annual refresher training to maintain their effectiveness in the field, or they should be able to demonstrate competency.

Workers handling emergencies or post-emergency cleanup should receive sufficient training so that they can perform their duties safely. Hours of training has little to do with this goal. What counts is that you have enough training—and retraining—to tackle the tasks you are asked to do. One value of preplanning and running drills is that you can discover gaps in your abilities before you have to respond to a real emergency. “What if” analyses or drills are especially useful for training personnel.

At Armco Steel in Kansas City, Missouri, a new joint safety committee helped save the company approximately \$1 million during one year and another \$500,000 during the following year. Over the same two-year period, the company experienced a drop in OSHA recordable accidents from 428 to 218.



HEALTH AND SAFETY COMMITTEES

A health and safety committee is one of the best ways to prevent costly injuries and accidents at work. The safety committee is vital because it is always present in the workplace. An active safety committee is the agent in the workplace that gives the highest priority to safety.

Federal OSHA sees the presence of a safety committee as a critical factor during inspections. Many states have laws mandating workplace safety committees. Several unions have contracts that establish safety committees.

What Should a Health and Safety Committee Do?

There is no blueprint that fits every work site. Each committee will need to be tailored to its specific circumstances. There are some basic guidelines, however, for any safety committee.

1. Take regular safety tours. Regular monthly inspections are the best way to detect unsafe conditions. The workplace is always changing. A number of potential problems can be identified and evaluated during a walk around safety tour:

- Make sure that employees and supervisors are following safety policies and programs.
- Make sure that all safety equipment, goggles, respirators, and gloves are in working order and being used properly.
- Make sure that controls like guards on machines or ventilation are working.

2. Investigate serious incidents. Why did the injury happen? How was the chemical spilled? What can be done to prevent it from happening again? Don't just focus on actual accidents - take near misses and complaints seriously. Aside from incidents, the committee should try to target problem areas such as:

- Review Workers' Comp and OSHA injury and illness records. They may help to identify a problem.
- Review measurements of things like hazardous substances or noise in the workplace.

The safety committee should take an active role in any inspections by OSHA, local or state agencies, or the insurance company.

3. Training. The safety committee can play a key role by reviewing and/or suggesting safety programs and training. The committee should:

- Keep management informed about new federal or state regulations.
- Develop fact sheets or a newsletter to present information or to discuss important issues.
- Receive training and education to increase skills and knowledge in safety and health.

4. Suggest improvements. The committee will be making recommendations to correct unsafe practices and conditions. After examining an accident, or following a safety tour, the committee should develop a list of needed improvements and a timetable for fixing hazards. Specific work practices may be altered. Changes in company policy or in established safety programs and procedures may be suggested.

5. Anticipate problems. Sometimes a change in operations or even in the construction of a facility can produce unforeseen problems. Maybe a new chemical, or a new operation or process is introduced. The safety committee should check for any impact on safety or health before a new process is implemented or before changing the work environment.

The joint health and safety committee at the Mack Truck plant in Hagerstown, Maryland, includes both union and management. The committee chair rotates between management and the union. The union members come from each of the plant's operating shifts; management is represented by the safety supervisor, engineering department, maintenance department and plant supervisors. The plant has one of the lowest accident rates in the entire division. The number of lost time accidents dropped from 100 to 36 over a three-year period; lost days due to accidents dropped from 1200 to 950 during the same three years.

Make the Committee Work

Here are some hints about what can help make a safety committee successful:

- Management has ultimate authority for safety in the workplace. Top management must be involved and supportive.
- The committee must have access to relevant information and records.
- There must be clear procedures for running the committee and for resolving disagreements.
- The committee must have a clear method for handling complaints. When employees or supervisors distrust a safety committee, it usually is because the committee has not responded to an item brought to its attention.
- The committee should try to include members from all segments (and all shifts) of the workforce. Include maintenance, office, physical plant and grounds staff.
- Safety committees function best when there is a balance between employees and management. If the facility has a union, both sides should be represented equally. If there is no union, ask the employees to choose committee members from their ranks.
- Committee members should receive ample training to handle their tasks and responsibilities.



Activity 1A:

Rights and Responsibilities

The aim of this activity is to review various issues relating to OSHA. Using the manual as a resource, answer the following questions in your group:

1. Which is NOT a right guaranteed to employees under OSHA?
 - To see notices of OSHA citations posted.
 - To participate in an OSHA inspection.
 - To have the workplace inspected immediately by OSHA when a complaint is registered.
 - To file a complaint and remain anonymous.

2. A new chemical called Laq-Blu has been introduced into a spray operation at LOCK, Inc. Some individuals have had reactions including shortness of breath and hacking cough. Several operators have been to see the company nurse. One had to be taken to the emergency room.

How would OSHA rules help you get information about this chemical?

3. If OSHA fines an employer, does the employer have the right to make employees pay the fines?

4. Describe the types of OSHA enforcement powers.

In your experience are they effective?

5. MNO Electronics wants to have an in-house spill team. Briefly report on some of the crucial OSHA requirements that this will involve.

Activity 1B:**Skit - OSHA Rules and Regulations**

Your instructors will perform a short skit about spill response and OSHA rules and regulations. The situation is as follows:

A new chemical called Laq-Blu has been introduced into a spray operation to coat metal parts after they have been cleaned and degreased. In attaching the new spray applicator to a 30-gallon drum of Laq-Blu, the chemical was released into the air. As the operator pulled away, a small amount spilled.

Working in your small groups, please answer the following questions. Each group will present its points to the rest of the class. The rest of the class will record the actual points made and note the strengths of each point.

1. Which OSHA rules and regulations have an impact on this situation?

2. What would happen if a worker refuses to clean up the spill?



SUMMARY SHEET

CHAPTER 1 : OSHA REGULATIONS FOR EMERGENCIES

- ✓ OSHA will make an inspection according to the following criteria: imminent danger situations; fatal accidents or catastrophes; employee complaints; follow-up inspections; and programmed inspections.
- ✓ If you complain to OSHA, they will not reveal your name to your employer; but you must let OSHA know in writing who you are before they will respond to your complaint.
- ✓ You or your representative have the right to attend the closing conference of an OSHA inspection.
- ✓ Your most important rights under OSHA are the right to a workplace free from recognized hazards, the right to refuse unsafe or dangerous work, and the right not to be discriminated against for exercising health and safety rights. Know your rights.
- ✓ OSHA's Emergency Response standard (HAZWOPER) covers workers employed by an emergency response agency (such as fire and police) as well as private sector workers who deal with in-house chemical accidents and spills.
- ✓ OSHA mandates that the employer have an emergency plan that defines the chain of command, responsibilities and emergency procedures. It also requires the employer to train personnel enough to protect themselves against emergency hazards.
- ✓ Health and safety committees are one of the best ways to prevent work injuries because committees are always present and, if active, are the group putting the highest priority on safety.
- ✓ Make health and safety committees work by having clear procedures, fair representation from different parts the workforce, and an equal balance between workers and management.



OBJECTIVES

In this module we will discuss the importance of planning in preventing spills and emergencies and in preparing to respond to spills and emergencies. You will learn how to examine your facility through a technique called “risk mapping”. Finally, we will discuss how planning can help you to handle chemicals more safely.

The objectives of this chapter are to ensure that students:

- Understand the importance of planning.
- Utilize lessons of risk mapping in their own facility.
- Recognize the importance of how chemicals are used, stored, and transported.

On completion of this chapter, students will be able to:

- Describe the elements of a chemical spill review.
- Describe the four key parts of an effective spill plan.
- Develop a risk map of their facility and an inventory of chemicals at the site.
- Use a chemical release chart to learn about chemicals at their facility.

PREVENTING PROBLEMS

“It’s better to stay out of trouble than to get out of trouble.” This is our motto in training you about responding to spills or accidents where you work. The best way to protect your health and safety is to prevent chemical accidents from happening in the first place.

We are going to emphasize planning in this training. Like a sports team, you will need to have a game plan. Planning is a process in which you become aware of processes, procedures, and habits that can cause chemical accidents. Planning will help you identify changes in the work environment that can prevent an accident before it happens. Planning, then, will help you do two things. It will help you to prevent spills from happening. And it will help you get ready to deal with spills that may happen.



* Source of Graphic: Vermont SIRI website, <http://hazard.com/graphics>

ANTICIPATING WHERE EMERGENCIES MIGHT OCCUR: A Chemical Spill Review

A close review of chemical use, transportation, and storage is important in order to anticipate likely accidents and prevent spills.

A chemical spill review should help you develop a spill plan that shows what is stored, how much, and where. It should show how a chemical gets from one point to another, that is, how it moves through a facility. It should also show how the chemical is used in a work process, so that you do not simply address each chemical in isolation.

1. Storage

Large quantities of chemicals are usually kept in designated storage areas. Small quantities of chemicals may be stored in a work area or lab. Some chemicals, like ammonia, are stored in tanks outside the facility.

When looking at storage practices, keep in mind this principle: *flammables and oxidizers should be stored separately. Oxidizers can greatly increase the chance of a fire or explosion if they mix with flammable substances.*

Placement of Flammable and Incompatible Chemicals. Some chemicals, such as nitrates, dichromates, concentrated hydrogen peroxide, and concentrated nitric acid, are



powerful oxidizers which can ignite solvents. They should be stored separately from flammables.

There are strict fire code regulations involving the storage of all flammables. The Occupational Safety and Health Administration (OSHA) has a special standard governing flammables (1910.106):

- If possible, flammables are best located in a separate building. If that is not possible, they should be stored in a room that has a least one outside wall and interior walls made with fire-rated construction.
- Lighting and switches should be explosion-proof, and mechanical ventilation should be controlled by a switch outside the room.
- Flammable liquids, like acetone, should be stored in flammable liquid storage cabinets away from sources of ignition. These cabinets help protect the product from outside fire, prevent temperatures inside the cabinet from rising quickly, and contain spills inside the unit.
- Alkali metals such as sodium and potassium should be stored in such a way as to prevent their contact with water. If they come into contact with water, they produce highly flammable hydrogen gas. For this reason, sodium and potassium are normally stored under a layer of mineral oil to prevent contact with moist air.



Condition of chemical containers. Things can happen to containers that increase the chance of spills. Temperature or pressure inside a container may increase while the product sits. Containers age and rust. Rust or bulging are signs of potential container failure.

Glass containers of some substances (i.e. ether, picric acid) may form peroxide crystals around the opening. This indicates a very explosive situation.

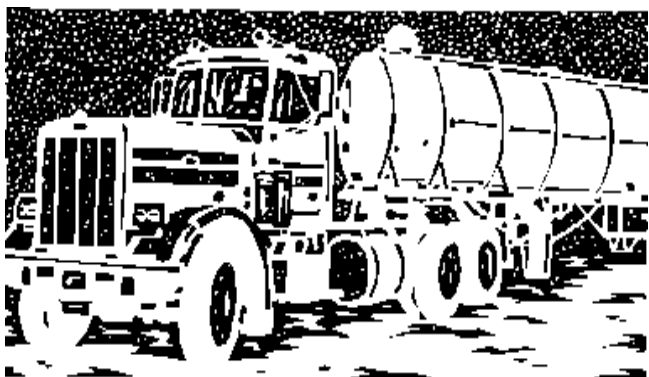
A product such as ammonia may be stored in large outside or underground tanks, and piped into and through the plant. The condition of pumps, piping, valves and packing — and the controls that run the system — should be reviewed critically. Frequent inspections and testing of the equipment should occur. Spare parts and maintenance records must be kept up-to-date. It is important to have written procedures for safe operations, from starting up the process, to operating it safely, to emergency shutdown.

Shelving. It is important to consider how containers are stored and handled:

- Shelving should be strong enough.
- Each shelf should carry no more weight than its rated capacity.
- All containers should be shelved at eye level or less, where a worker can see its label. Heavy containers should be shelved even lower (no more than 2 feet up).
- Corrosives should be kept at floor level.
- Shelves should have raised edges or rim guards to prevent containers from tipping off.
- Products stored on a metal shelf should be compatible with that metal.
- Gas cylinders should be secured to prevent falling, and stored away from ignition sources, flammable products, and corrosives.
- Cylinders of incompatible gases should be separated from each other.

2. Transport

Consider how chemicals arrive at the facility and how they are transported through the facility. Chemicals are transported in many different ways. Production workers may come into the storage area to get specified amounts. Containers may be moved from storage into a production area on handcarts. Chemicals may be piped from large storage containers to the production area.



Just as you might look at a route your child takes to school to determine where it might be unsafe, you will look at the journey that chemicals take in your facility. Consider where spills are most likely to happen. For example, you may find that it is safer to move chemical containers on a dolly than by handtruck. You might spot people moving gas cylinders that are not safely anchored and secured. You might notice people leaving flammables open in the

work area. You might spot maintenance workers using a product improperly.

3. Process/Use

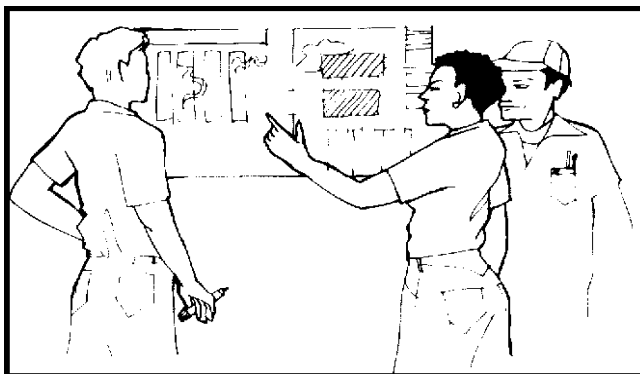
When you analyze how chemicals are used in a work process, be sure to review the production area with particular attention to pumps and valves, packing, equipment maintenance, and temperature and pressure controls. Interview operators and supervisors to gain a better understanding of specific work processes and how spills can be prevented.





Some chemicals are handled directly by operators. Other chemicals may be introduced into the work process directly and automatically - untouched by human hands. Therefore, mechanical fault lines or valves may lead to spills.

Chemicals may be heated or altered in a process, so you need to be aware of by-products that may result. Chemicals may affect the equipment in which they are used. You can probably think of other ways the work process can lead to spills.



BASIC POINTS IN LOOKING AT YOUR FACILITY

- Know your products. What's on site? An employer is required to have this information already as part of their OSHA HazCom Plan. (The Hazard Communication Plan is the method by which your employer informs his/her employees about the hazards of workplace chemicals.) Is your HazCom plan up to date?
- Develop a chemical release chart for each product as a way of organizing information about spills. (Chemical release charts are described on page 9 of this chapter). This will give you a quick reference to identify the products and recognize hazards.
- Look at how the chemical products arrive, are stored, used, and discarded.
- Investigate whether chemicals are stored safely, and in containers which are well labeled and in good condition.
- Examine operations and processes and consider the processes, equipment, and machinery that may contribute to an emergency situation. For example, you might have chemicals piped into an operation. What could happen if there was a leak at a valve or in the piping? Are there shutoffs and where are they? Can you shut off the electricity feeding that system? These are the types of questions you should try to answer.

- Work with production, maintenance, and custodial staff in your facility. They may be the first on the scene. Make sure these staff people know what kinds of information you, as a responder, will need from them in an emergency.
- Consider whether temperature, ignition sources, confined spaces or other environmental factors may complicate an incident.
- Consider the areas outside your facility. Not all accidents happen inside. What about the front gate or the road to your loading dock? How about an outside gas tank? How close are you to highways, railroads, navigable waterways, and air traffic? What about other commercial facilities, and residences?

This may seem overwhelming, so set priorities. Start with your bad actors: the products or processes that worry you the most. Tackle these first then move to less hazardous products and processes. It is important to have an ongoing relationship with your plant's safety person and the environmental and health and safety committees. In fact, members of the response team should be on all safety committees.

AN EFFECTIVE CHEMICAL SPILL PROGRAM

Any plan for spill response will be more effective if it is part of a larger program that addresses all facility safety and health issues. Such a health and safety program would include methods to identify general worksite hazards. It would also include procedures to control and eliminate hazards.

An effective program will have four key parts:

1. Management Commitment and Employee Involvement

Department and line supervisors will take their cues from management's commitment. If management takes health and safety seriously, then it will commit resources for a good emergency plan. Employee involvement is critical to the success of both general health and safety and an emergency response plan.

2. Worksite Analysis

This refers to looking at the workplace, conditions of operations, and work practices from the safety and health perspective. It includes the following

- Baseline worksite surveys.
- Review of processes, materials and equipment.
- Routine job hazard analysis.
- Site inspections.
- Communications, including methods to register complaints and make suggestions.



3. Hazard Prevention and Control

This includes the following:

- Review methods to control hazards.
- Maintain personal protective equipment and other equipment.
- Plan and prepare for emergencies.

4. Training

This includes the following:

- Training on health and safety responsibilities and roles of all personnel.
- Employee training on the nature of hazards and methods of control, and on the specifics of safety and health programs and policies.

The Ongoing Activity:

Chemical Release Chart

*This is a continuing exercise. As you finish each module you will be directed to complete a new section of the **Chemical Release Chart**. (Look on the next page for a sample Chemical Release Chart). This exercise has two tracks; the track you follow depends on whether or not this is a contract course or an open enrollment course.*

- If this is an open enrollment course you will be given a choice of two chemicals to chart. The first chemical is selected from the following list:

Ammonia (gas)
Nitric Acid (fuming)
Xylene
Caustic Soda
Chlorine

An accompanying MSDS will be provided for each chemical. The second chemical is one from your own work environment or one that you are concerned about.

- If this is a contract course, the course coordinator will determine which chemicals each group will work on.

When you complete the chemical release charts you should have a working knowledge of the information you need to make a responsible decision for responding to known chemicals. You should also understand why all releases of unknown chemicals require full protection. (We will discuss full protection in chapters 5 and 6.)

You will begin to complete chemical release charts in Activity 2. On the next page is an example of a chemical release chart for mercury.



Chemical Release Chart

Product: Mercury liquid metal		Date Prepared:	Reviewed:
Dense silver gray liquid; beads together and rolls quickly; odorless; colorless; evaporates quickly.			
Location(s)	Quantity:	Container Size(s)	
See map			
Hazards			
Flash Point: NA	LEL: NA	UEL: NA	
Vapor Density: 6.9	Vapor Pressure: 0.0012 mm	Specific Gravity: 13.6	
PEL: 0.1 mg/m3		IDLH: 10 mg/m3	
Reacts with: ammonia, chlorine dioxide, sodium carbide, acetylene			
Routes of entry into the body: can be absorbed through skin, or inhaled			
Corrosive: xx YES		NO	
Acute & chronic health effects: vapors harm brain, eyes, kidneys; may cause mood changes; loss of feeling in hands; breathing much vapor in a short time can poison, causing chest pain, coughing, breathing problems, and nausea.			
Protective Equipment			
Respirator:	SCBA above 1.25; half-face APR (with goggles) if under .25; full-face		
Type of filters (if needed)	APR if over .25 but below 1.25; use mercury/chlorine gas cartridge.		
Suit: level and material	eye, face and skin protection, 2-ply Tyvek/Saranex or Barricade		
Boots:	cover with overboots		
Eye/Face:	if not in full respirator, use safety goggles		
Gloves, outer material: Butyl Neoprene		Gloves, inner material: PVC Viton Neoprene	
Spill Response Equipment			
Air Monitoring:	mercury vapor lamp: vapors increase when mercury is disturbed; shift		
Personnel Monitoring:	from 64oF to 78oF doubles VP; reoccupy when air levels = .3ug/m3.		
Soil & Water Sampling:			
Absorbents:	sprinkle powdered zinc to keep mercury out of air, turns beads into paste		
Decontaminants:	no neutralizers		

Personnel Decontamination Procedures

Include drawing:

Response Procedures:

How many gallons or number of square feet covered is called a small spill?

Number of gallons 30 ml(on non porous surface) Number of square feet

Over this size spill is a large spill.

Small Spill Response

If spill on a nonporous surface (and less than 30 milliliters), sprinkle powdered zinc to keep mercury out of the air. Use a solution of 20% calcium sulfide or 20% sodium thiosulfate to make a paste; using damp sponges, work into paste while scrubbing surface.

For liquid beads, push together with squeegee. Collect in pans, then place into plastic bags. Use flashlight in corners to highlight silver beads. Decon with water and mild shampoo.

Sprinkle powdered sulphur; if it turns brown, mercury is still present.

What is the largest size spill you can handle?

Large Spill Response

Call for outside help? Yes No

If spill reaches porous surface (such as wood, carpeting), isolate and dike; of if spill is larger than 30 milliliters (1 pound), isolate and use outside contractor.



Activity 2:

Risk Mapping

The purpose of this activity is to develop a map showing where releases/spills of hazardous chemicals are most likely to occur. By anticipating where releases/spills can occur we think about what can be done to prevent them.

This activity should be done in groups. **Each group needs to select a recorder and a spokesperson to brief the class on your group's findings.** Each group should choose to do:

- a risk map of the “loading dock” site (see the next page);
OR
- a risk map of a site at which someone in the group works.

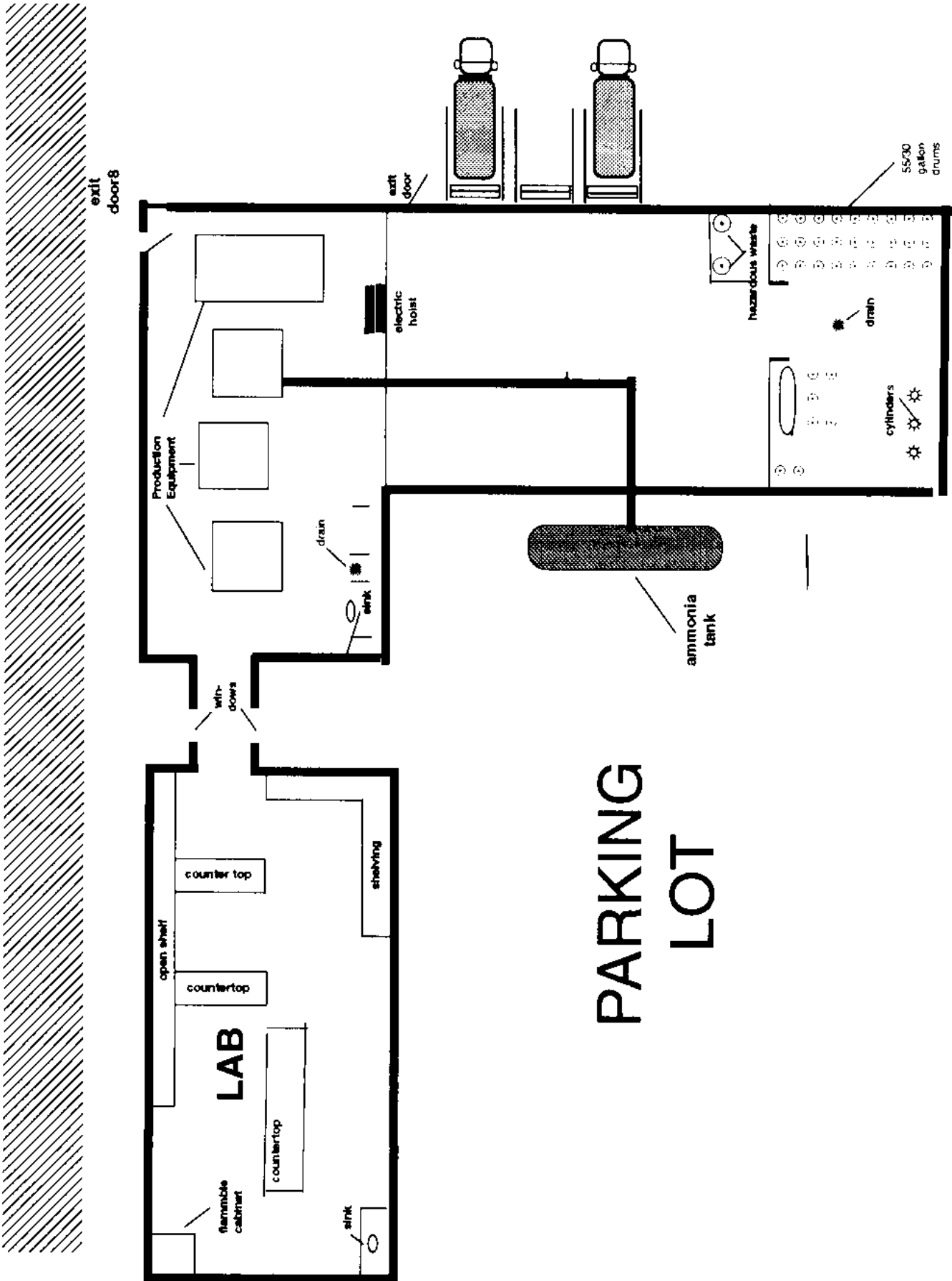
Once you have selected a site to map, complete the following tasks:

1. Draw a rough floor plan on large newsprint paper. Identify the hazard areas, focusing mainly on chemical hazards. Where are there potential hazards for chemical spills or releases? You may include other hazards - such as physical, biological, or radiological - if they are important. Use a color coding system to specify levels of hazard (such as high, medium, or low). Different colored highlighters should be on your tables. You will be asked to present your group's risk map to the rest of the class.

When you consider any possible incidents, address the following:

- **Type of release:** Gas, liquid, or solid. Released into air, soil, water.
- **Hazards:** Flammable, toxic, reactive, corrosive, physical hazards (entrapment, heat/cold, engulfment).
- **Source:** Temperature malfunction in chemical bath, valve leak, container rupture, pipe/hose leak, mixing of incompatible chemicals.

2. Now that you have decided what the different hazards are, make a list of chemicals at this site. Then place each chemical on a separate chemical release chart. (If you are in an open enrollment class, take one chemical from the list provided and one chemical of your choice.) Determine the type of container and the quantity stored at each location where the chemical is bulk stored and/or used. Please do not fill out any more information on the chemical release chart at this time.





SUMMARY SHEET

CHAPTER 2 :

PREVENTING PROBLEMS: PLANNING

- ✓ Planning will help you prepare for spills and help you prevent them from happening.
- ✓ OSHA requires the employer to anticipate and plan for any potential emergencies. The employer must decide either to handle emergencies in-house or to call in an outside team.
- ✓ An effective spill plan will have four key parts:
 - management commitment and employee involvement
 - worksite analysis
 - hazard prevention and control
 - training
- ✓ Know your products! Create a spill guide for each product. A spill guide should show where chemicals are stored, how they move through the facility, and how they are used in a work process.
- ✓ Develop a spill response plan for the most hazardous chemicals and processes first, then move to less hazardous products and processes.
- ✓ Do NOT store incompatible chemicals near each other.
- ✓ Frequently inspect and maintain chemical containers, piping, and system controls, and follow written procedures for safe operation.
- ✓ Involve facility production, maintenance, and custodial staff in your facility in the spill prevention process. Everyone can help to prepare for and prevent emergencies.
- ✓ Examine how emergencies can happen and be prevented outside your facility -- at the front gate, at an outside gas tank, or out on the highway.
- ✓ Your facility's health and safety committees should work closely with the emergency response team.
- ✓ Work closely with outside emergency organizations including Local Emergency Planning Committees (LEPCs), fire departments, and police departments in developing emergency response plans.



OBJECTIVES

Now that we have looked at the importance of emergency planning, we will look at how various sources of information can assist you in planning for routine and non-routine incidents. Before we discuss information sources, we will evaluate the toxic effects that various chemicals have on the body. You will learn to evaluate how dangerous a chemical is based on the amount of the chemical that is allowed in the air and how long you can safely be exposed to it. We will examine the purpose of medical surveillance and the relationship of medical tests to chemical exposure. We will learn how to use the NIOSH pocket guide. Finally, we will discuss Material Safety Data Sheets (MSDSs), the information they provide and their limitations as a tool for protecting health and safety of emergency responders.

The goals of this chapter are to ensure that students understand:

- The routes of entry of toxins and the overall effects (acute and chronic) of toxins on the body.
- The exposure guidelines (IDLH, TLVs, and PELs).
- The functions of medical surveillance programs.
- The terminology and interpretation of information in the NIOSH pocket guide and on a Material Safety Data Sheet.

On completion of this chapter, students will be able to:

- List four routes of entry of toxins into the body.
- State the difference between an acute and a chronic exposure.
- Describe the meaning of TLV, PEL, and IDLH.
- List two purposes/functions of medical surveillance.
- List two problems associated with MSDSs.
- Look up a chemical's properties in the NIOSH guide.

You want answers about particular products you have in your facility and you want them long before accidents happen. Is this product flammable? If it spills on my legs will it burn? If it is heated will it pose a breathing hazard? How can the substance get into my body? In this chapter we will become more familiar with gathering information about the toxic properties of chemicals, that is, the health hazards posed by toxic chemicals. We will refer to Material Safety Data Sheets (MSDSs) and the NIOSH pocket guide for health effects information. In the following chapter on **Chemical Hazards** you will use the NIOSH guide and MSDSs to learn more about the physical properties of chemicals.

A LOT OF CHEMICALS AROUND

Chemicals are used in almost every type of workplace. Each year in the United States we produce more than 100 million tons of about 80,000 different chemicals to create manufactured goods, pharmaceuticals, plastics, paints and many other useful items. Another 10,000 new chemicals are introduced each year.

Chemicals can cause explosion or fire or make a fire burn hotter and faster. Some will burn your skin or even blind you. Others can suffocate you. Some chemicals can damage organs like the liver and the brain and can affect your ability to have healthy children. A few cause cancer. When you respond to a chemical release, you will want to know what chemical hazards you may be exposed to.

TOXICITY

Chemical hazards can be broken down into several categories:

- Flammability
- Reactivity
- Corrosivity
- Toxicity

In this chapter we will explore the toxicity hazards of chemicals - the ways chemicals can harm your health.

The **toxicity** of a substance is the ability of that substance to cause harmful health effects. Even water can be harmful if you drink too much; therefore, the amount of the chemical that gets into the body is important. A chemical is considered to be relatively **non-toxic** if a large amount (dose) is needed to cause a harmful response. The chemical is considered to be **toxic** if a small amount causes a harmful response. Toxic chemicals can cause harm when they get into the body through the skin, by breathing, by swallowing, or through injection. They can immediately damage the body at the point of contact and/or they can effect internal organs over time.



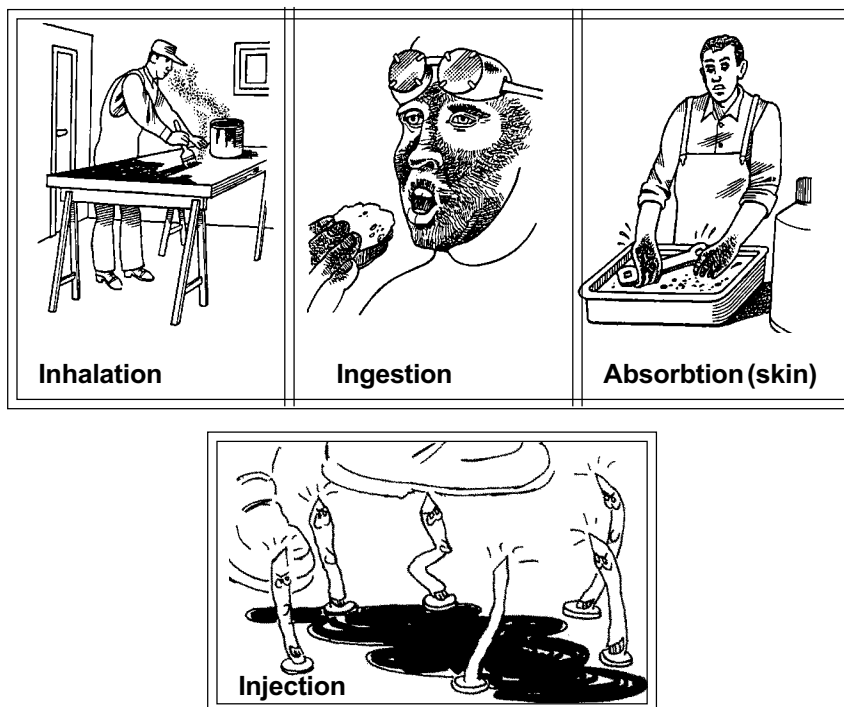
ROUTES OF ENTRY

Toxic chemicals have to get into or on your body to cause you harm. There are four main ways that chemicals can enter the body -- many substances get in by more than one route:

- 1) You can breathe them in (inhalation).
- 2) You can absorb them through the skin (absorption).
- 3) You can swallow them (ingestion).
- 4) They can enter through puncture wounds (injection).

Since choosing effective protection depends on knowing how a chemical can get into your body, it is important to understand these routes of exposure. Some chemicals will be more hazardous depending on how they enter the body. For example, trichloroethylene (a common solvent) has more immediate and serious effects when swallowed than when its vapor is inhaled.

The Four Major Routes Of Entry



*Source of graphic: *Safety, Health and Welfare on Construction Sites - A Training Manual*, International Labor Organization, 1995, pg. 69. Source of Injection graphic: *Emergency Response and Prevention Workbook*, OCAW/Labor Institute.

Inhalation

The most common type of exposure occurs when you breathe a substance into your lungs. The lungs consist of branching airways (called bronchi) that end in clusters of tiny sacs (called alveoli). The alveoli absorb oxygen and other chemicals into the bloodstream.

Dusts, fumes, vapors, mists and gases can all be inhaled. (See Chapter 4 for definitions of these terms.) Once inhaled, they may irritate the lung itself, or be absorbed into the blood stream where they can affect other organs. Some materials that dissolve in water, such as acid gases or mists, will cause irritation in the upper airways of the lungs. Less soluble materials, such as solvent vapors, get deep into the lungs, where they may impair lung function or be absorbed into the blood.

Particles, depending on their size, may be deposited in the bronchi and/or alveoli. Many of them may be coughed up, but others may stay in the lungs and may cause lung damage much later (such as silica and asbestos). Some particles may dissolve in the water in your lungs, be absorbed into the blood stream, and have effects elsewhere in your body.

Skin Absorption

The skin is a protective barrier that helps keep foreign chemicals out of your body. Some substances, such as acids, may attack the skin directly. Others irritate the skin (for example, certain cutting oils) and can cause dermatitis and, possibly, skin cancer after prolonged exposure. Some chemicals (such as phenol or nitrobenzene) easily penetrate the skin and enter the bloodstream. This can happen when you have direct contact with a liquid, or when you are exposed to a gas or vapor. Once in the blood, chemicals are carried throughout the body and can harm other organs. Some chemicals will damage the red blood cells in the blood itself. If the skin is cut or cracked, or very wet, chemicals can penetrate through the skin more easily. A concentrated chemical will also pass more easily through the skin.

Some caustic substances, like strong acids and alkalis, can chemically burn the skin. Others can irritate the skin. Many chemicals, particularly organic solvents, dissolve the oils in the skin, leaving it dry, cracked, and susceptible to infection and absorption of chemicals.



Ingestion

Many chemicals can enter the body through the mouth and digestive tract. This is a less common route of entry than the respiratory system or the skin. If a person's hands are covered with a toxic dust (like lead), when she/he eats, smokes, or applies cosmetics, she/he could mistakenly “eat” the dust as well.

Injection

Chemicals can also enter the body through a puncture wound to the skin or eye by a sharp object. Although less common than the other routes of entry, chemical contamination through injection is nevertheless a threat in many industrial workplaces and laboratories. For instance, sharp metal edges on machinery, containers, and scaffolding, as well as broken glass and nails, and medical sharps can puncture even thick chemical protective clothing, providing a pathway for chemicals directly into the bloodstream.

EXPOSURE LIMITS

Exposure limits are established to protect workers from airborne exposures, because these are the most common. Exposure limits help you determine which respirator to use. To assess toxic exposures we need to look at a chemical's exposure limits. There are several exposure limits which are important to know.

Threshold Limit Values

Threshold limit values (TLVs) are air concentrations of chemicals used by industrial hygienists in recommending controls for workplace exposures. TLVs are developed by the American Conference of Governmental Industrial Hygienists, which is not a government body but a professional association of industrial hygienists. The guidelines are mostly based on information from animal experiments, observation of symptoms in workers, or some guessing inspired by dose-response studies on animal populations. When possible, information comes from a combination of all three. TLVs are recommended guidelines and are not legally enforceable. The TLV list is updated yearly. There are three types of **TLVs**: the 8-hour **time weighted average (TWA)**; the **short term exposure limit (STEL)**; and the **ceiling limit (C)**.

Permissible Exposure Limits

The Occupational Safety and Health Administration (OSHA) has set **permissible exposure limits (PELs)**. These are legally enforceable standards for worker exposures to chemicals in their work. In 1971 OSHA used the 1968 list of recommended TLVs for its own legal standards, the PELs. These have been updated periodically, but this must be done through a rule-making process which can take years to complete. Since TLVs are just recommendations, they are updated more easily than legal PELs. Consequently, PELs are generally outdated and less stringent than current TLVs.

Recommended Exposure Limits

The National Institute for Occupational Safety and Health (NIOSH) conducts research which is the basis of the standards it recommends to OSHA. These include requirements for controlling exposures and preventing disease as well as **recommended exposure limits (RELs)**. They are based solely on health considerations. These recommendations are sometimes used by OSHA in developing its standards. PELs, since they are developed through a political process based on many considerations, are also generally less stringent than RELs.

Time Weighted Average

The **time weighted average (TWA)** is the upper limit of a toxic material to which an average person can be exposed for a normal 8-hour workday and a 40-hour work-week, day after day, without adverse health effects. It is permissible to be exposed to concentrations above the limit. However, any periods of higher exposure must be equaled by periods below the limit during the same work day. This means that it would be legally permissible for a worker to be exposed to a concentration of twice the PEL (TWA) for four hours as long as there was no exposure during the other four hours of the work day. **The important point is that a worker's average exposure over his/her 8-hour work day must not exceed the TWA.**



Short-Term Exposure Limit

The 8-hour TWA can be exceeded for part of the day provided the average daily dose doesn't go over the TWA. Some chemicals have limits for shorter exposures. These **short-term exposure limits (STELs)** are usually for an average of 15 minutes. They are meant to prevent acute effects that could occur as a result of high exposures over a short duration. Exposure at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL.

Ceiling

Some substances, usually those with fast-acting toxic effects, have been assigned **ceiling** limits in addition to, or instead of, 8-hour TWAs and/or STELs. This is a concentration that should never be exceeded. For example, if a worker is exposed to a carbon monoxide concentration of 300 parts per million (ppm) for just a couple of seconds, his exposure would have exceeded NIOSH's ceiling limit of 200 ppm.

Immediately Dangerous to Life and Health (IDLH)

IDLH values are the maximum concentration of a chemical from which one could escape within 30 minutes without irreversible health effects. This includes any severe eye or respiratory irritation which could prevent escape without permanent injury. The IDLH guideline is used in the decision-making process for respiratory selection developed by NIOSH and OSHA. Supplied air respirators are required when working in IDLH atmospheres. The IDLH is important for emergency responders, particularly when responding to a spill in a confined space or low-lying area where vapors may accumulate. A situation that has exposures above the IDLH requires maximum protective measures.

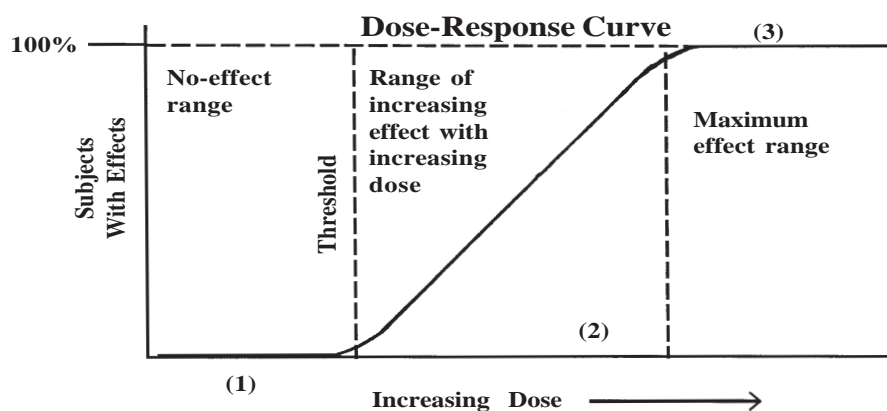
The PEL, STEL, ceiling, and IDLH are important in helping you determine which respirator to use. Unfortunately, MSDSs do not record the IDLH, but you can look that up – as well as the other exposure limits – in the NIOSH pocket guide.

HEALTH EFFECTS

Dose and Duration

When a person is exposed to a hazardous material, some of it may enter the body through the respiratory system, skin or digestive system. The amount of chemical that is in the air you breathe, or is on your skin or on the food that you eat is called the **exposure**. The amount of the substance that you actually absorb into your body is the **dose**.

In general, as the dose increases so do the number of people who experience symptoms. This is called a **dose/response relationship** (see graph below). Small doses may cause milder symptoms such as headaches or respiratory irritation, while higher doses may cause life-threatening damage to vital organs. With cancer-causing agents (carcinogens), however, this rule does not apply. **There is no known “safe” level of exposure to carcinogens.**



With most chemicals it is easier to measure how much is in the air (the exposure) than how much has entered your body (the dose). This is because many chemicals, such as solvents, pass through the body quickly, causing harm but leaving no sign that they were there. For some chemicals it is extremely difficult to see exactly what they do in the body.

However, for other materials that remain in the blood, bones or fat tissue, we can measure the amount of chemical in the body. Lead is a substance that can be measured in blood and bones, and PCBs can be measured in fat tissue.

The longer you are exposed to a chemical, the more likely you are to be affected. Chemical exposure which continues over a long period of time can be particularly hazardous because some chemicals accumulate in the body or because the body does not have a chance to repair the damage the chemicals cause.



How Toxic Substances Harm the Body

Chemicals can damage the body at the point where contact is first made - these are called **local effects**. The most common points at which substances first contact the body are the skin, eyes, nose, throat and lungs. Toxic substances can also enter the body and travel in the bloodstream to internal organs and cause **systemic effects**. The internal organs most commonly affected are the liver, kidneys, heart, nervous system (including the brain) and reproductive system. A toxic chemical may cause local effects, systemic effects or both.

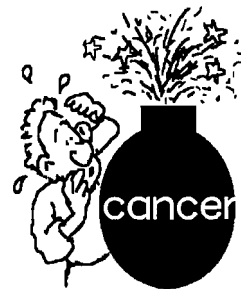
Health Effects - Now or Later?

The effects of toxic substances may appear immediately or soon after exposure (**acute effects**), or they may take many months or years to appear (**chronic effects**). Acute health effects are those that occur soon after a single exposure or a few exposures. Acute effects are visible and the cause can often be traced without difficulty.

Chronic effects are those which occur following repeated exposures (often low exposures) over months and years. Unlike an acute effect, a chronic effect may not be obvious. The onset of symptoms is gradual, and as a result the symptoms may go unnoticed, or may be explained away as the result of “being run down”, “getting old”, etc. It is much harder to trace the cause of a chronic effect and by the time the link between exposure and symptoms has been identified, permanent damage may have occurred. In some cases, this could be 20 or 30 years after exposure. Obviously, it could then be very hard for a doctor to diagnose such a disease as being “work-related.”

ACUTE AND CHRONIC EFFECTS OF SOME COMMON WORKPLACE HAZARDS		
	ACUTE EFFECTS	CHRONIC EFFECTS
ASBESTOS (a dust)	None	Asbestosis. Cancer of the lung, pleura, or G.I. tract.
TRICHLOROETHYLENE (a solvent)	Dizziness, nausea	Neurological changes. Liver and kidney damage, possibly cancer.
CARBON MONOXIDE (a gas)	Drowsiness, headache, confusion, death	Heart disease

A toxic chemical may cause acute effects, chronic effects or both. For example, if you inhale solvents on the job, you may experience acute effects such as headaches and dizziness which go away when you leave the work environment. Over months, you may begin to develop chronic effects such as liver and kidney damage. The delay between the beginning of exposure and the appearance of disease caused by that exposure is called the **latency period**. Some chronic effects caused by chemicals have very long latency periods. Cancer has been known to develop as long as 40 years after a worker's first exposure to a cancer-causing chemical.



The length of the latency period for chronic effects makes it difficult to establish the cause-and-effect relationship between the exposure and the illness. Since chronic diseases develop gradually, you may have the disease for some time before it is detected. It is therefore important for you and your physician to know what chronic effects might be caused by the substances you have been exposed to.

Types of Health Effects

There are certain key health effects that you should become familiar with, especially since they are the types of health effects emergency responders may suffer from.

Central Nervous System (CNS) Depression: This describes a range of symptoms that occur when a chemical attacks the nervous system and brain. Individuals experience nausea and loss of coordination; they may also feel high or drowsy. Solvents such as toluene, acetone, and trichloroethylene all affect the brain in this way, but at different doses.

Sensitization and allergies: Some substances do not cause harm initially, but become harmful after the body becomes sensitized to them. Once you are sensitized, you can develop allergic reactions which can range from skin irritation to breathing problems, such as asthma. For example, toluene diisocyanate (TDI) is a chemical used in making polyurethane products. Some workers have become sensitized to it and now suffer asthmatic attacks when exposed to very tiny amounts of TDI.

Irritation: Some substances cause immediate (or slightly delayed) pain or reddening of skin, eyes, and breathing passages where contact has occurred. PCBs, for example, cause irritations when they come into contact with the skin. Other irritants include turpentine, pine oil, zinc sulfate, and aluminum chloride. The major danger of irritants is that they can cause scar tissue formation which may be permanent. Dozens of solvent vapors cause mild irritation of the eyes, nose and throat.



Corrosion: Some substances rapidly destroy body tissue. Exposure may cause pain, burning, bleeding and fluid loss. Acids and bases (caustics) are common corrosives.

Asphyxiation: Some gases can replace the normal oxygen which is in the air. Even if an asphyxiant is not inherently dangerous, in high enough concentrations it can cause suffocation. Carbon dioxide, acetylene, and argon are examples of such gases. Asphyxiation may also be caused by substances which combine with the oxygen-carrying sites on red blood cells, thereby reducing the available oxygen in your blood. Carbon monoxide and hydrogen cyanide are examples of chemical asphyxiants.

Reproductive damage: Some substances can affect male and/or female fertility, sex drive or offspring by attacking the reproductive organs. Substances such as lead, pesticides, xylene, benzene, mercury and some solvents can damage the reproductive system.

Exposure to chemical substances may affect your ability to have children. Toxic reproductive effects include the inability to conceive children (infertility or sterility), lowered sex drive, menstrual disturbances, spontaneous abortions (miscarriages), stillbirths, and defects in children that are not apparent until after birth or later in the child's development.

There is not a great deal of information on the reproductive toxicity of most chemicals. Although there may be "safe" levels of exposure to chemicals that affect the reproductive system, trying to determine a "safe" level is very difficult, if not impossible. Pregnant women should be aware that extremely minute doses of chemicals may adversely affect the developing fetus.

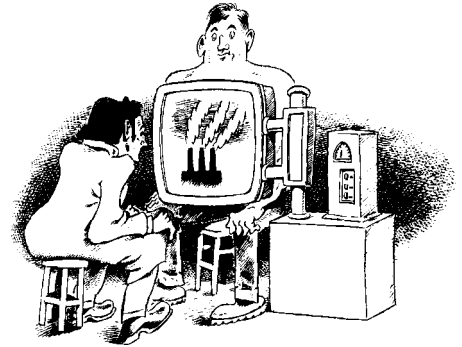
Cancer: Substances called carcinogens can cause cancer. Benzene, for example, can cause bone cancer and vinyl chloride can cause liver cancer. Cancer, which is the uncontrolled growth and spread of abnormal cells in the body, is not caused by all chemicals. It is not true that "everything causes cancer" when taken in large enough doses. Only a relatively small number of the many thousands of chemicals in use today cause cancer. There is no known minimum dose of a **carcinogen** (cancer-causing agent) which can be considered safe. Any exposure to a carcinogen increases the risk of developing cancer.

About 30 chemicals are known human carcinogens. Another 200 chemicals are known to cause cancer in laboratory animals and are, therefore, likely to be human carcinogens. Common sites for occupational cancer are the skin and lungs, but can also include the brain, stomach, blood, rectum, and other organs.

Additive and Synergistic Effects of Chemicals

Workers are rarely exposed to only one toxic substance on the job. Usually they work with several chemicals. Exposure to two or more chemicals can result in (1) an additive effect, or (2) a synergistic effect.

An **additive effect** is a process by which two or more chemicals produce a result no greater than the sum of their individual effects. A **synergistic effect** is a process by which two or more chemicals produce an effect that is greater than the sum of their individual effects. Smoking and asbestos are an example of this. Though both are known carcinogens, a person exposed to cigarette smoke and asbestos is at a much greater risk of contracting cancer than if just one substance were present.

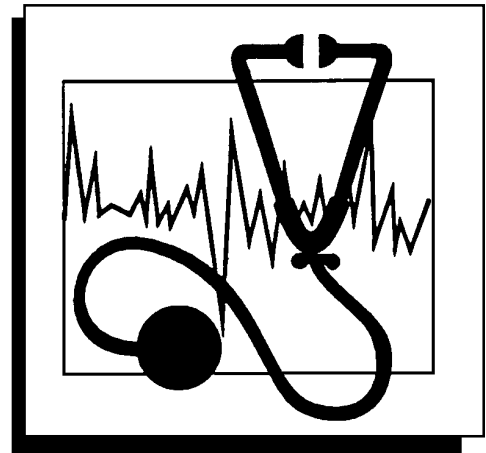


MEDICAL SURVEILLANCE

Medical surveillance is a program of medical examinations and tests designed to detect early warning signs of harmful exposure. A medical surveillance program may discover small changes in health before severe damage occurs.

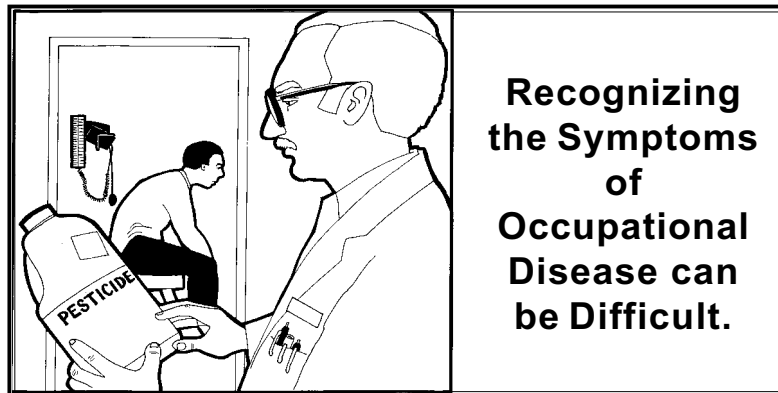
Medical and Biological Monitoring

Testing for health effects is called *medical monitoring*. The type of testing needed in a surveillance program depends upon the particular chemicals involved. Lung function tests, for example, can indicate the presence of a variety of lung diseases, such as asthma, caused by exposure to certain agents. Since normal test results vary from person to person, some tests require a baseline screening which could then be compared to later tests in order to see if any changes have occurred. These tests may not be able to pinpoint the causes of the problem and whether it is related to work conditions. Unfortunately, medical monitoring tests that accurately measure early health effects are available only for a small number of chemicals.





Biological monitoring is a component of a medical surveillance program that determines how much of a chemical is getting into your body as a result of exposure. This is done by measuring the amount of the actual chemical or the amount of its metabolite in your blood, urine, breath, or even in some cases, your hair, fingernails or fat tissue. Drug testing is a form of biological monitoring.



A complete occupational surveillance program should consist of industrial hygiene monitoring, medical monitoring, and biological monitoring when appropriate. Tests for health effects when you are already sick are not part of medical surveillance and must be selected by your physician on a case by case basis. Under the HAZWOPER Standard (29CFR 1910.120). Emergency responders are legally entitled to:

1. A baseline physical examination.
2. On-going medical surveillance, if they exhibit signs and symptoms resulting from exposures at an incident.

A medical surveillance program may include recording your work history (including job duties, previous exposures, personal protective equipment used, etc.), a physical examination, and medical laboratory tests. Medical surveillance is needed to determine your fitness to do a certain job, under certain conditions of exposure, and wear personal protective equipment.

In any case, as an emergency responder, you should be in tune with your body. You should recognize and record any changes in your body, whether they might be work related or not. This information can be extremely important in tracking the health effects from workplace exposures.

A Sample Occupational History Form

Work History

Name: _____

Birthdate: _____

Sex: M F

A. Occupational Profile

The following questions refer to your current or most recent job:

Job title: _____ Describe this job: _____

Type of industry: _____

Name of employer: _____

Date job began: _____

Are you still working in this job? Yes No

If No, when did this job end? _____

Fill in the table below listing all jobs you have worked including short-term, seasonal, part-time employment, and military service. Begin with your most recent job. Use additional paper, if necessary.

Dates of Employment	Job Title and Description of Work	Exposures*	Protective Equipment

* List the chemicals, dusts, fibers, fumes, radiation, biologic agents (i.e., molds, viruses) and physical agents (i.e., extreme heat, cold, vibration, noise) that you were exposed to at this job.

Have you ever worked at a job or hobby in which you came in contact with any of the following by breathing, touching, or ingesting (swallowing)? If yes, please check the box beside the name.

- | | | | | | |
|---------------------------------------------------|------------------------------------------------------|----------------------------------------------|------------------------------------------------|----------------------------------------|---------------------------------------------------|
| <input type="checkbox"/> Acids | <input type="checkbox"/> Cadmium | <input type="checkbox"/> Dichlorobenzene | <input type="checkbox"/> Mercury | <input type="checkbox"/> Phosgene | <input type="checkbox"/> Trichloroethylene |
| <input type="checkbox"/> Alcohols
(industrial) | <input type="checkbox"/> Carbon
tetrachloride | <input type="checkbox"/> Ethylene dibromide | <input type="checkbox"/> Methylene
chloride | <input type="checkbox"/> Radiation | <input type="checkbox"/> Trinitrotoluene |
| <input type="checkbox"/> Alkalies | <input type="checkbox"/> Chlorinated
naphthalenes | <input type="checkbox"/> Ethylene dichloride | <input type="checkbox"/> Nickel | <input type="checkbox"/> Rock dust | <input type="checkbox"/> Vinyl chloride |
| <input type="checkbox"/> Ammonia | <input type="checkbox"/> Chloroform | <input type="checkbox"/> Fiberglass | <input type="checkbox"/> PBBs | <input type="checkbox"/> Silica powder | <input type="checkbox"/> Welding fumes |
| <input type="checkbox"/> Arsenic | <input type="checkbox"/> Chloroprene | <input type="checkbox"/> Halothane | <input type="checkbox"/> PCBs | <input type="checkbox"/> Solvents | <input type="checkbox"/> X rays |
| <input type="checkbox"/> Asbestos | <input type="checkbox"/> Chromates | <input type="checkbox"/> Isocyanates | <input type="checkbox"/> Perchloroethylene | <input type="checkbox"/> Styrene | <input type="checkbox"/> Other (specify)
_____ |
| <input type="checkbox"/> Benzene | <input type="checkbox"/> Coal dust | <input type="checkbox"/> Ketones | <input type="checkbox"/> Lead | <input type="checkbox"/> Talc | _____ |
| <input type="checkbox"/> Beryllium | <input type="checkbox"/> Manganese | <input type="checkbox"/> Lead | <input type="checkbox"/> Phenol | <input type="checkbox"/> Toluene | _____ |
| | | <input type="checkbox"/> Manganese | <input type="checkbox"/> Phenol | <input type="checkbox"/> TDI or MDI | _____ |

Developed by ATSDR in cooperation with NIOSH, 1992.



A Sample Occupational History Form

B. Occupational Exposure Inventory *Please circle the appropriate answer.*

- | | |
|--------------------------------------------------------------------------------------------------------------|-----------|
| 1. Have you ever been off work for more than one day because of an illness related to work? | no yes |
| 2. Have you ever been advised to change jobs or work assignments because of any health problems or injuries? | no yes |
| 3. Has your work routine changed recently? | no yes |
| 4. Is there poor ventilation in your workplace? | no yes |

Environmental History

Please circle the appropriate answer.

1. Do you live next to or near an industrial plant, commercial business, dump site, or nonresidential property? no yes

2. Which of the following do you have in your home? *Please circle those that apply*

Air conditioner	Air purifier	Central heating (gas or oil)
Gas stove	Electric stove	Fireplace
Woodstove	Humidifier	

3. Have you recently acquired new furniture or carpet; refinished furniture; or remodeled your home? no yes

4. Have you weatherized your home recently? no yes

5. Are pesticides or herbicides (bug or weed killers; flea and tick sprays, collars, powders, or shampoos) used in your home or garden, or on pets? no yes

6. Do you (or any household member) have a hobby or craft? no yes

7. Do you work on your car? no yes

8. Have you ever changed your residence because of a health problem? no yes

9. Does your drinking water come from a private well, city water supply, or grocery store? no yes

Describe: _____

10. Approximately what year was your home built? _____

If you answered *yes* to any of the questions, please explain.

When a person who works with hazardous substances sees a doctor, he/she should make sure the doctor understands what is done on the job each day and what things are occasionally done at work. Understanding the patient's job will help the doctor be more effective. Regardless of the quality of your employer's medical surveillance program or the qualifications of your physician, you should try to keep track of your own exposures and health effects on the job. You can do this by filling out and regularly updating an occupational history form like the example on the previous page. This may be very useful for you and your doctor in the event you develop a potentially work-related illness in the future.

The Importance of Occupational Physicians

A general practitioner may diagnose a particular illness, but may not recognize that the illness is occupationally related. It may be an illness that can be caused by something other than work exposures. An occupational physician has training and experience looking at job exposures and their chronic effects on the body. She or he will be more likely than a general practitioner to recognize connections between your job and your health. Occupational physicians are trained to recognize connections between a worker's job and worker's health. Recognition of such a connection is important for prevention of further illness and for compensation. Qualified occupational physicians can be located through an organization called the Association of Occupational and Environmental Clinics (AOEC).

Summary of Medical Surveillance

Under the OSHA HAZWOPER standard (29 CFR 1910.120) you are entitled to your individual medical surveillance test results. Your union is also entitled to the results, with your permission.

Corporations have many programs such as alcoholism programs and drug testing. But these are not occupational health surveillance programs. An occupational health surveillance program is a program that tests for job exposures to toxic chemicals or conducts OSHA-mandated medical tests.

Medical surveillance for work-related hazards is only useful to the extent that the medical tests are the right ones to assess the possible health effects of the specific hazard that you face on your job. For example, if you are exposed to lead, you should have a blood test, not a chest x-ray.



You should ask questions about your medical surveillance program. You can ask of a test, “what is it supposed to tell?” You can refuse any invasive test. Consult a local COSH (Committee on Occupational Safety and Health) group, or if you belong to a union, a union health and safety department if you have questions in this area.

If your program reveals a pattern of health problems, it should not be assumed that the problems are caused by lifestyle factors like drinking or smoking. Similar health problems among a group of people who work together may be an indication of occupational illness, and may be due to some exposures at the worksite. This will need further analysis by a trained professional. If you do indeed discover such a pattern, contact any one of the recommended occupational health resources listed in Appendix A of this manual.

There always are potential conflicts of interest when a company controls a medical surveillance program. It would be far better if employees played a role in picking the medical provider.

COMMUNICATING HAZARDS: HOW IT IS DONE

How do we find the answers about physical and chemical hazards? The hazards you might encounter where you work should already be somewhat well known, because of the “**HazCom**” program. HazCom is designed to make sure that workers are informed about hazards of chemicals they work with.

The Hazard Communication Standard (29CFR1910.1200), or HazCom, is based on one of the most important rules OSHA ever made. HazCom is often called the “Federal **Right-to-Know**.” Most states have adopted HazCom regulations at least as thorough as the Federal version. HazCom requires your employer to obtain information about chemicals in use. Your employer must also inform and train workers about the chemical hazards. This means that if you work with a chemical product, you should already be aware of its potential hazards.

Hazard Communication Program

Employers are required to develop a written Hazard Communication (HazCom) program. It must cover key issues:

- How hazards are determined.
- A list of chemicals on site.
- Labels and labeling procedure.
- How to read material safety data sheets.
- Methods to inform and train employees.



Essentially, if you have a question about a chemical's hazards or about the type of protection you need when facing chemical hazards, you should be able to get this information from your employer. OSHA requires that one person be in charge of the HazCom program at your site.

There are a number of OSHA HazCom requirements that are critical to the success of a spill/response team. An important one is that information about a chemical's hazards must be obtained and made available to employees.

If you have a good HazCom program, you should have fewer accidents. Under HazCom, employees should know the hazards of using chemicals. If you do have a spill, the people who were either involved in the accident or sounded the alarm, should be able to give you a better picture of the hazards. Since your first question will be to ask someone "what happened?", it is best that people who are directly involved are fully aware of what they are dealing with. One way to build awareness about chemical hazards is through annual training on HazCom, even though OSHA does not require it. (OSHA does not say how often training must be provided but that employers must ensure that workers know the workplace chemicals they are or may be exposed to).



THE NIOSH POCKET GUIDE TO CHEMICAL HAZARDS

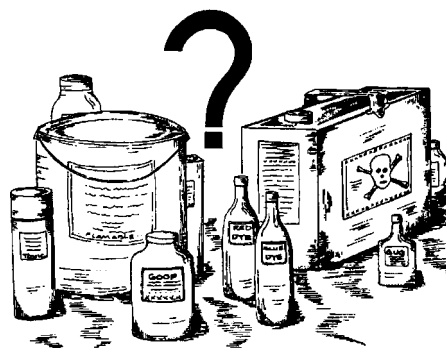
The June 1997 NIOSH Pocket Guide lists chemical-specific information for over 1200 chemicals that have OSHA Permissible Exposure Limits (PELs). It is a general reference guide to over 650 chemicals. It is a valuable source of information about some hazardous materials. The data in the Pocket Guide includes physical and chemical properties, exposure limits, health effects, and information about measuring and controlling exposures. The data comes from NIOSH criteria documents as well as other recognized documents in the fields of industrial hygiene, occupational medicine, toxicology, and analytical chemistry.

All of this information is abbreviated in an effort to reduce the size of the book. The abbreviations are defined in tables at the beginning of the Guide. Chemicals are listed alphabetically in the Guide, but are also cross-referenced by synonyms and Chemical Abstract Service numbers (CAS #) in the back of the book. The recommendations for respiratory and personal protection are NIOSH recommendations and are not legally enforceable, but they may be the most appropriate.

The following two pages show an example of a listing in the Guide with explanations for each column of information. More specific descriptions of each column are given in the section of the Pocket Guide entitled “How to Use This Pocket Guide”.

MATERIAL SAFETY DATA SHEETS (MSDS)

According to the HazCom Standard, manufacturers and importers of chemicals must determine the hazards of chemicals they use. Most will rely on the information they get from their chemical supplier, unless they make their own chemicals. The supplier provides the Material Safety Data Sheets (MSDS) and labels for the product. This information must be sent with the first shipment. Employers are responsible for making sure they get the HazCom package. Anytime there is a change or additional information about a product, then that change must be added to the MSDS and label and forwarded with the next shipment of the product. (continued on page 22)



USING THE NIOSH POCKET GUIDE (Pages 26 & 27)

Chemical name, structure/formula, CAS and RTECS Nos. and DOT ID and guide Nos.	Synonyms, trade names, and conversion factors	Exposure limits (TWA unless noted otherwise)	IDLH	Physical description	Chemical and physical properties MW, BP, SOL, VP, FRZ Fl.P, IP, Sp. Gr, flammability	Incompatibilities and reactivities	Measurement method (See Table 1)
Benzene C ₆ H ₆ 71-43-2 CY1400000	Benzol Phenyl hydride	NIOSH CA 0.1 ppm ST 1 ppm See Appendix A	Ca (500 ppm)	Colorless to light-yellow liquid with an aromatic odor. (Note: A solid below 42° F.)	MW: 78.1 BP: 176° F Sol: 0.07% Fl.P: 12° F IP: 9.24eV VP: 75mm FRZ: 42° F UEL: 7.8% LEL: 1.2%	Strong oxidizers, many fluorides & perchlorates, nitric acid	
1114 27		OSHA (1910.1028) 1 ppm ST 5 ppm See Appendix F			Sp.Gr: 0.88 Class IB Flammable Liquid	"UEL" = Upper Explosive Limit "LEL" = Lower Explosive Limit	

"CAS" = CHEMICAL ABSTRACTS SER-
VICE NUMBER. A UNIQUE ID NUMBER
FOR EACH CHEMICAL.

"TWA" = TIME-
WEIGHTED AVER-
AGE. AN AVERAGE
CONCENTRATION
OVER AN 8-HOUR
WORK SHIFT.

"IMMEDIATELY DANGEROUS TO LIFE AND
HEALTH."

"Ca" MEANS IT
CAUSES CANCER.

"IP" = IONIZATION POTENTIAL

"Fl.P" = FLASH POINT

"VP" = VAPOR
PRESSURE

RECOMMENDED EXPOSURE
LIMITS. OFTEN MORE PROTECTIVE
THAN OSHA'S LIMITS.

"SHORT-TERM" EXPOSURE
LIMIT. A 15-MINUTE AVERAGE THAT
CAN'T BE EXCEEDED

OSHA'S LEGAL LIMITS.
THE NUMBER IN BRACKETS MEANS
THERE IS A STANDARD FOR BENZENE.



TABLE 4 IS LONG AND COMPLICATED.

YOU NEED A MEDICAL DICTIONARY FOR TABLE 5

THIS SECTION CANNOT BE USED TO SELECT SPECIFIC CPC

Personal protection and sanitation (See table 3)		Recommendations for respirator selection - maximum concentration for use (MUC)		Health Hazards		
Personal protection and sanitation (See table 3)	Recommendations for respirator selection - maximum concentration for use (MUC)	Route	Symptoms (See table 5)	First Aid (See table 6)	Target organs (See table 5)	
Skin: Prevent Skin Contact Eyes: Prevent Eye Contact Wash skin: When contaminated Remove: When wet Change: N.R. Provide: Eyewash, quick drench	NIOSH V: SCBAF:PD,PP/SAF,PP:ASCBA Escape: GMFOV/SCBAE	Inh Irrit eyes, nose, resp Abs resp, sys;gidd;head; nau Ing staggered gait; ffg, anor Con lass;derm;bome marrow depres; [carc]	Eye: Irr immed Skin: Soap wash prompt Breath: Resp support Swallow: Medical attention immediately	Blood,CNS skin, bone marrow, eyes resp sys [leukemia]		

GIVES SPECIFIC TYPES OF CANCER CAUSED BY CHEMICAL

"INH" = INHALATION (BREATHING)
 "ABS" = SKIN ABSORPTION
 "ING" = INGESTION (EATING)
 "CON" = SKIN AND EYE CONTACT

From your perspective as responders, MSDSs will serve as the basic menu to help you plan for spills and releases. Every chemical should have an MSDS where you can easily get at it. But you don't want to have to refer to an MSDS while an incident is happening. Part of the planning process is to take an MSDS and break it down in such a way that it gives you information quickly and easily. Some responders use the MSDS and other sources to fill out a spill guide that they can refer to as they are getting ready to respond to an emergency.

QUESTIONS	WHAT TO LOOK FOR	* SECTIONS OF AN MSDS
Who makes it?	•Manufacturer's name	Section one
What is this stuff?	•Ingredients and •Who makes it	Hazardous ingredients Identity
Can this product hurt my health?	•Health effects •Symptom •Cancer hazard •First Aid	Health Hazard Data
Is the product dangerous?	•Fire and explosion hazard •Materials to avoid •Stable or unstable	Fire and Explosion Hazard Data Reactivity Data Special Precautions
How can I protect myself?	•Personal protective equipment to use •Control measures •Work/Hygiene practices	Control Measures Special Precautions Spill Procedures
How should the product be handled?	•Safe handling & storage •Fire & spill procedures •Waste disposal	Precautions for Safe Handling & Storage Spill Procedures
Where do I get more information?	•Name and telephone number	Section one

* Because MSDSs can be in any format, the names of the sections may be different from the OSHA recommended form.



How to Read An MSDS

A simple checklist can be used to go through each MSDS and guide you in filling out a spill chart.

What to look for on an MSDS:

Is the chemical dangerous?

- Fire and explosion hazard
- Materials and conditions to avoid

Is it a health hazard?

- Health effects

How should we be protected?

- PPE
- Respirators
- Control measures

How should we handle the situation?

- Fire and spill procedures
- Waste disposal



Where on the MSDS do I find this ?

Unfortunately, there is no single simple format for MSDSs. However, most MSDSs do follow the suggested format in OSHA Form 174, which segregates information into several sections. MSDSs usually have the following sections:

- Manufacturers information
- Identity of the chemical substance
- Physical hazards and health hazards
- Measures of exposure

What is this stuff ?

Most chemicals are not a single substance, but a mixture -- just as a cake is a mixture of eggs, milk, flour, butter. If the product has been tested as a mixture, the MSDS will say that. HazCom does not require manufactures to test mixtures. Since most mixtures have not been tested, you will have to plan ingredient by ingredient. The MSDS section on hazardous ingredients will help with this.

The MSDS must list the chemical name of each ingredient. Since a chemical can have more than one scientific name, there are unique numbers assigned to each chemical called "CAS" numbers (Chemical Abstract Service). These are like a social security number. Each chemical is uniquely identified by its number. It is often easier to write down the CAS number than a long chemical name. The CAS number is the way chemists identify a product. Most chemical reference books use these numbers too.

Is the chemical a health hazard?

Health Hazard Section

This section of the MSDS will give you information not only on what problems the product can cause but also how it gets into your body. It should also provide information on first aid.

Routes of Entry

This section should tell you if a chemical can enter your body by inhalation, skin absorption or ingestion.

Health Hazards

This part describes the harmful effects of the substance. MSDSs must tell you about both kinds of health effects - chronic (long-term) and acute (short-term). Many chemicals will attack a specific organ, such as the brain or the liver. This must be reported in the MSDS. (It should also appear on the container's label.) Since so little is known about the effects of continual, low-level exposures, most of what you will learn from an MSDS is on acute health effects.



Cause Cancer

This section will tell you if any chemicals in the product have been designated as a carcinogen. Many experts agree that there is no safe level of exposure to cancer-causing chemicals. Even so, reducing your exposure to carcinogens reduces your risk of developing cancer. Therefore, it is important to avoid exposure as much as possible. You should push your employer to use a less toxic material instead of a chemical that causes cancer. (See the section on Control Measures for ideas.)

The MSDS must also indicate what agency determined that the substance could cause cancer. The determination is based on reports by specific national and international agencies. Note that most chemicals have not been thoroughly tested to determine if they are carcinogens.

Signs and Symptoms of Exposure

There are two ways to detect exposure to hazardous chemicals. Symptoms (such as skin irritation) are changes in how you feel caused by exposure. Signs (such as blood changes) are what a doctor finds during an exam and from lab tests following a worker's exposure.

Medical Conditions Generally Aggravated by Exposure

People with a pre-existing medical condition may be affected by a chemical exposure more seriously than others.

Is the Chemical Dangerous?

The following sections of MSDSs tell you about safety hazards of a chemical -- it can explode, react and/or cause a fire.



Fire and Explosion Data Section

This section will tell you how explosive or flammable a product is by listing its flash point and LEL/UEL. (See Chapter 4).

Reactivity Section

This section will tell you whether the chemical is stable or not under normal conditions. It will also tell you which materials or conditions are incompatible with the product, causing it to react. It should tell you whether the chemical will decompose or otherwise turn into a hazardous product under normal conditions.

How Should We Handle the Substance?

We have looked at the MSDS purely from the perspective of what happens in an emergency. However, since we want to anticipate and avoid emergencies, we need to examine our MSDS still further. There are many important practices and procedures that you may want to know that will reduce the possibility of a spill, fire or explosion. These can be found on the MSDS in the sections usually titled **Special Precautions** and **Safe Handling and Storage**.



How Should We Handle the Situation?

Steps To Be Taken In Case A Material Is Released or Spilled

In this section, many MSDSs simply say “avoid breathing gases and vapors” or “avoid contact with liquids.” This is clearly insufficient. But look through the sections on **Reactivity, Waste Disposal, Fire and Spill Procedures** for more detailed information on what to do in the event of a spill or release.



Waste Disposal

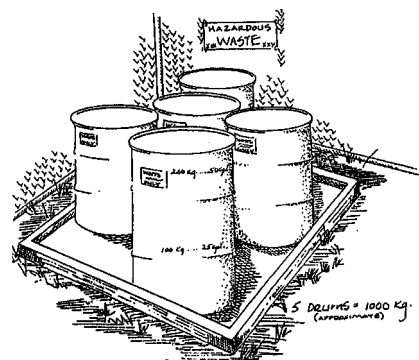
Any special procedures that should be used for disposing of hazardous workplace materials are noted in this section. If you have any questions about disposal methods, you can contact the Environmental Protection Agency’s special hotline number: 1-800-424-9346 or call the vendor’s designated information line as listed on the MSDS.

Precautions To Be Taken In Handling And Sorting

This section may advise, for example, not to store acids and bases together, not to keep organic chemicals around strong oxidizers or to keep some chemicals in temperature controlled areas.

Other Precautions

This section is a catch-all for any special precautions that may not have been discussed on the MSDS. Always check this section because sometimes information that should be listed somewhere else is listed here instead.



How Can I Protect Myself?

The best control measures for chemicals are those that reduce or eliminate the problem at the source, before anyone can have contact with it. Personal protective equipment (PPE) - respirators, clothing, goggles - should be the last resort in protecting workers. Unfortunately, during an emergency it is usually not possible to control hazardous exposures well enough and PPE must be used. The MSDS should list very specifically what kinds of respirators need to be used, the type of glove material that is protective, etc. Unfortunately, many MSDSs do not provide this information even though they should. You can get this information by contacting the manufacturer or local COSH group.

Most data on worker protection will refer to the type of exposures a production worker gets. There is less about emergencies; you may, however, find valuable information in sections on **Special Protection Information for Spills**. An MSDS rarely will give you any ideas about what to do if the spill is large or small, in a confined area or near other products or processes.

Where Do I Get More Information?

The name, address and phone number of the manufacturer or supplier must be on the MSDS. The person responsible for the information on the MSDS may well know more about the substance. Don't hesitate to call if you have a question.

An MSDS Is A Tool

An MSDS is like any tool; you need to be aware of its strengths and weaknesses. All MSDSs are not created equal: some are incomplete, others are inaccurate. As you get used to reading different MSDSs, you will begin to gain a sense of when you have a poor one. The Seattle Area Hospital Council conducted a study of 476 MSDSs to see how accurate they were. They found that only 70% of the 476 MSDSs reviewed were internally consistent (that is, did not contain contradictory information).

We recommend that you always check three sources. As you develop your plan and spill charts, check with at least two additional sources. Some agencies and references you can use are listed in Appendix A in the back of the manual.

You also can contact a local COSH group, OSHA consultation program, or poison control center. If you are in a union, many will have health and safety departments. No matter how bad the MSDS is, it usually will give you enough information to follow up with other sources.



LABELS

Containers of hazardous chemicals must be labeled, tagged or marked with the products' identities and hazard warnings. Most employers will rely on the labels sent by their supplier. The information that OSHA requires on a label is the product identity, hazard warnings and any physical or health hazards, including target organ effects. The label should enable you to find the appropriate MSDS for that product. Thus the label may say "Black Magic 2" but the name of the contained chemical is 1,1,1-trichloroethane. As long as it is clear that the label refers to the right MSDS, OSHA will allow for a label to say "Black Magic 2".

Standardized Labeling Systems

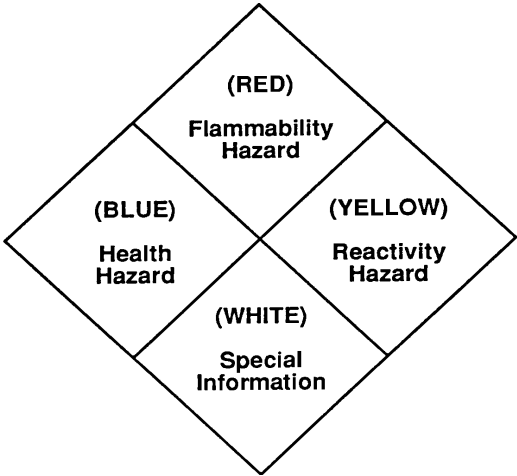

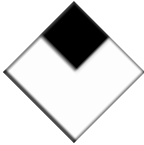

There are a few long-standing labeling systems. Most do not meet all OSHA labeling requirements, but OSHA allows them to be used if workers understand that they can always look at the correct MSDS. Two of the most common systems in use in facilities are the National Fire Protection Association (NFPA) and the Hazardous Materials Identification System (HMIS). In addition, the Department of Transportation (DOT) system is used on vehicles, tanks and shipping containers.

National Fire Protection Association (NFPA 704M) System

The **NFPA** labeling system was developed to warn fire fighters about the potential hazards of chemicals in a fire situation. It is usually found on fixed storage containers at a site. The NFPA label uses a color code — red, yellow and blue — for flammability, reactivity and health. The degree of hazard is ranked by a number, 0 - 4, arranged in a diamond layout. The higher the number the greater the hazard. The bottom white box is used to indicate special hazards. (See the figure on the next page.)

The NFPA label gives you a basic idea about the product's flammability or reactivity. But it is not terribly helpful when dealing with health effects because it only gives general information about **acute** effects. Also, the names of the chemical, the product and the manufacturer are not given on the label.

NFPA Labeling System

					
HEALTH - BLUE		FLAMMABILITY - RED		REACTIVITY - YELLOW	
Type of Possible Injury		Susceptibility of Materials to Burning		Susceptibility to Release of Energy	
Signal		Signal		Signal	
4	Materials that on very short exposure could cause death or major residual injury. (ACRYLONITRILE)	4	Materials that on rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or that are readily dispersed in air and that will burn readily. (PROPANE)	4	Materials that in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures. (NITROGLYCERINE)
3	Materials that on short exposure could cause serious temporary or residual injury. (SULFURIC ACID)	3	Liquids and solids that can be ignited under almost all ambient temperature conditions. (METHYL ETHYL KETONE)	3	Materials that in themselves are capable of detonation or explosive decomposition or reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water. (DIBORANE)
2	Materials that on intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury. (STYRENE)	2	Materials that must be moderately heated or exposed to relatively high ambient temperature before ignition can occur. (ACETIC ACID)	2	Materials that readily undergo violent chemical change at elevated temperatures and pressures or which react violently with water or which may form explosive mixtures with water. (SULFURIC ACID)
1	Materials that on exposure would cause irritation but only minor residual injury. (ACETONE)	1	Materials that must be preheated before ignition can occur. (DICHLOROMETHANE)	1	Materials that in themselves are normally stable, but which can become unstable at elevated temperatures and pressures. (VINYL CHLORINE)
0	Materials that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material. (ETHANOL)	0	Materials that will not burn. (SULFURIC ACID)	0	Materials that in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water. (ACETONE)



Hazardous Materials Identification System (HMIS)

The Hazardous Materials Identification System (HMIS) uses rectangular labels which may be found on bulk storage units or smaller containers at a site. The HMIS system addresses four topics. For health, flammability and reactivity, a number from 0 to 4 is assigned based on the severity of the hazards, just like NFPA. The higher the number the more severe the hazard. The fourth designation is for Personal Protective equipment. These PPE recommendations apply to normal use and may not be adequate for an emergency.

Although chronic health effects usually are not rated, they may be indicated after the health hazard rating or by written warnings in the upper white section of the label. HMIS labels also contain the name of the product and more specific hazard information including:

- Routes of Entry
- Health Hazards
- Target Organs and Effects
- Physical Hazards.

An example of these labels is given below.

NAME OF PRODUCT _____																																
<p style="text-align: center; font-weight: bold; font-size: small;">CHECK APPROPRIATE BOXES</p> <p style="text-align: center; font-weight: bold; font-size: x-small;">TARGET ORGANS & EFFECTS</p> <table style="width: 100%; font-size: x-small;"> <tr> <td><input checked="" type="checkbox"/> Lungs</td> <td><input type="checkbox"/> Liver</td> </tr> <tr> <td><input type="checkbox"/> Kidney</td> <td><input type="checkbox"/> Blood</td> </tr> <tr> <td><input type="checkbox"/> Skin, Eyes</td> <td><input type="checkbox"/> Heart</td> </tr> <tr> <td><input type="checkbox"/> Cardiovascular System</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Central Nervous System</td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> Respiratory System</td> <td></td> </tr> </table> <p style="text-align: center; font-weight: bold; font-size: x-small;">HEALTH HAZARDS</p> <table style="width: 100%; font-size: x-small;"> <tr> <td><input type="checkbox"/> Toxic</td> <td><input type="checkbox"/> Corrosive</td> </tr> <tr> <td><input checked="" type="checkbox"/> Highly Toxic</td> <td><input type="checkbox"/> Sensitizer</td> </tr> <tr> <td><input checked="" type="checkbox"/> Irritant</td> <td><input type="checkbox"/> Carcinogen</td> </tr> <tr> <td><input type="checkbox"/> Reproductive Toxin</td> <td><input type="checkbox"/> None</td> </tr> </table> <p style="text-align: center; font-weight: bold; font-size: x-small;">PHYSICAL HAZARDS</p> <table style="width: 100%; font-size: x-small;"> <tr> <td><input type="checkbox"/> Compressed Gas</td> <td><input type="checkbox"/> Explosive</td> </tr> <tr> <td><input type="checkbox"/> Combustible Liquid</td> <td><input type="checkbox"/> Organic Peroxide</td> </tr> <tr> <td><input type="checkbox"/> Oxidizer</td> <td><input type="checkbox"/> Reactive</td> </tr> <tr> <td><input checked="" type="checkbox"/> Flammable L. Liquid/Solid</td> <td><input type="checkbox"/> Flammable Gas</td> </tr> </table> <p style="text-align: center; font-weight: bold; font-size: x-small;">ROUTE OF ENTRY</p> <table style="width: 100%; font-size: x-small;"> <tr> <td><input checked="" type="checkbox"/> Inhalation</td> </tr> <tr> <td><input type="checkbox"/> Ingestion</td> </tr> <tr> <td><input checked="" type="checkbox"/> Absorption (skin or eye contact)</td> </tr> </table>	<input checked="" type="checkbox"/> Lungs	<input type="checkbox"/> Liver	<input type="checkbox"/> Kidney	<input type="checkbox"/> Blood	<input type="checkbox"/> Skin, Eyes	<input type="checkbox"/> Heart	<input type="checkbox"/> Cardiovascular System		<input type="checkbox"/> Central Nervous System		<input checked="" type="checkbox"/> Respiratory System		<input type="checkbox"/> Toxic	<input type="checkbox"/> Corrosive	<input checked="" type="checkbox"/> Highly Toxic	<input type="checkbox"/> Sensitizer	<input checked="" type="checkbox"/> Irritant	<input type="checkbox"/> Carcinogen	<input type="checkbox"/> Reproductive Toxin	<input type="checkbox"/> None	<input type="checkbox"/> Compressed Gas	<input type="checkbox"/> Explosive	<input type="checkbox"/> Combustible Liquid	<input type="checkbox"/> Organic Peroxide	<input type="checkbox"/> Oxidizer	<input type="checkbox"/> Reactive	<input checked="" type="checkbox"/> Flammable L. Liquid/Solid	<input type="checkbox"/> Flammable Gas	<input checked="" type="checkbox"/> Inhalation	<input type="checkbox"/> Ingestion	<input checked="" type="checkbox"/> Absorption (skin or eye contact)	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; font-size: 24px; font-weight: bold;">4 HEALTH</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; font-size: 24px; font-weight: bold;">3 FLAMMABILITY</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; font-size: 24px; font-weight: bold;">1 REACTIVITY</div> <div style="border: 1px solid black; padding: 5px; font-size: 24px; font-weight: bold;">K PROTECTIVE EQUIPMENT</div>
<input checked="" type="checkbox"/> Lungs	<input type="checkbox"/> Liver																															
<input type="checkbox"/> Kidney	<input type="checkbox"/> Blood																															
<input type="checkbox"/> Skin, Eyes	<input type="checkbox"/> Heart																															
<input type="checkbox"/> Cardiovascular System																																
<input type="checkbox"/> Central Nervous System																																
<input checked="" type="checkbox"/> Respiratory System																																
<input type="checkbox"/> Toxic	<input type="checkbox"/> Corrosive																															
<input checked="" type="checkbox"/> Highly Toxic	<input type="checkbox"/> Sensitizer																															
<input checked="" type="checkbox"/> Irritant	<input type="checkbox"/> Carcinogen																															
<input type="checkbox"/> Reproductive Toxin	<input type="checkbox"/> None																															
<input type="checkbox"/> Compressed Gas	<input type="checkbox"/> Explosive																															
<input type="checkbox"/> Combustible Liquid	<input type="checkbox"/> Organic Peroxide																															
<input type="checkbox"/> Oxidizer	<input type="checkbox"/> Reactive																															
<input checked="" type="checkbox"/> Flammable L. Liquid/Solid	<input type="checkbox"/> Flammable Gas																															
<input checked="" type="checkbox"/> Inhalation																																
<input type="checkbox"/> Ingestion																																
<input checked="" type="checkbox"/> Absorption (skin or eye contact)																																

Department of Transportation (DOT) System

Another major labeling system that you will often see on vehicles is the DOT system. The DOT regulates more than 1,400 hazardous materials. The regulations require labels on small containers and placards on tanks and trailers shipping hazardous materials across state lines. These labels and placards are required in addition to those required by OSHA. The DOT label uses a system of color, hazard identification number, hazard class number, and hazard symbol. The information is far more limited than that which you should get from your facility's internal labeling system. The color coded backgrounds and identifying numbers which represent the nature of the hazardous material are summarized below.

If bulk containers are used to deliver chemicals to your plant, they should be clearly marked with DOT placards. Like the labels, they give information by means of color, symbol, and identification and hazard class numbers. Sometimes placards will display a four-digit number. This is the UN/NA (United Nations/ North American) ID number. This number will usually allow you to identify the particular chemical by using the USDOT Emergency Response Guide Book. It is important to know that this number is not always unique to a particular chemical like the CAS numbers we talked about earlier. Sometimes the number will refer you to a particular class of compounds such as corrosives. Placards and 4 digit UN/NA numbers primarily are for the benefit of fire/ER personnel who may be at a distance from an incident.



DOT HAZARD IDENTIFICATION SYSTEM



UN HAZARD CLASS SYSTEM

United Nations Hazards Class Number	Description
1	Class A, B and C explosives
2	Nonflammable and flammable compressed gases
3	Flammable liquids
4	Flammable solids, spontaneously combustible substances and water-reactive substances
5	Oxidizing materials, including organic peroxides
6	Class A and B poisons, irritants, and etiologic (disease-causing) materials
7	Radioactive materials
8	Corrosive materials (acids, alkaline liquids and certain corrosive liquids and solids)
9	Miscellaneous hazardous materials not covered by any of the other classes

Activity 3:**Getting Information on Health Effects**

For the two chemicals that you are tracking (or for methylene chloride) examine the health effects information in the MSDSs, the NIOSH guide and this manual. Answer the following questions. Then enter this new information on health effects into the chemical release chart for each chemical.

How does your chemical (or methylene chloride) get into the body?

What symptoms may be associated with exposure to this chemical?

What target organs does the chemical attack?

List any health effects:

Hazards		
Flash Point:	LEL:	UEL:
Vapor Density:	Vapor Pressure:	Specific Gravity:
PEL:		IDLH:
Reacts with:		
Corrosive:	YES	NO
Routes of entry into the body:		
Acute & chronic health effects:		



SUMMARY SHEET

CHAPTER 3 : GETTING INFORMATION

- ✓ Substances can get into the body through inhalation, absorption, and ingestion.
- ✓ Employers must develop a written Hazard Communication program which must address:
 - how hazards are determined.
 - what chemicals are on site.
 - labeling procedure.
 - MSDSs.
 - ways to inform and train employees.
- ✓ A good HazCom program will require annual training, even though OSHA does not require it.
- ✓ Material Safety Data Sheets are useful for getting information on:
 - a chemical's properties and hazards, including health hazards.
 - recommended control measures, including personal protective equipment.
 - fire, spill and emergency procedures, including waste disposal.
- ✓ MSDSs are just a tool and are often incomplete and inaccurate. You should always check at least two additional sources, such as the NIOSH pocket guide or as an OSHA consultation program or local COSH group.
- ✓ Standardized labeling systems are a quick way of getting helpful information but have limited information on a product's flammability, reactivity, and health effects. When information on labels is confusing or insufficient, you should consult the correct MSDS to find out more about the product.



OBJECTIVES

Now that we have looked at sources of information, and examined the toxic properties of chemicals, we will examine the safety hazards chemicals pose. In this chapter you will learn about the physical properties of chemicals and how these properties may determine how hazardous a chemical is. Using sources of information such as MSDSs and the NIOSH guide, you will learn to recognize the particular hazards posed by a variety of chemicals encountered in emergency response work.

The objectives of this chapter are to ensure that students:

- Understand basic hazards like flammability, corrosivity, and reactivity.
- Understand the importance of other properties of chemicals, such as vapor pressure and vapor density.
- Understand how a chemical's physical properties can determine its hazards.

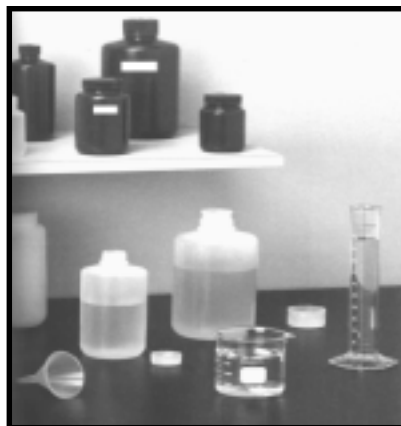
On completion of this chapter, students will be able to:

- Identify two physical hazards common in emergency response.
- Describe three hazardous properties of chemicals.
- Describe the fire triangle.
- Describe the different forms of chemicals and how those forms might change during an emergency.

PHYSICAL PROPERTIES

In the last chapter, we talked about the toxicity of chemicals. Now we will learn about the three other chemical hazards:

- flammability
- reactivity
- corrosivity



FLAMMABILITY

The Fire Tetrahedron

Flammability is the ability of a solid, liquid or gas to ignite and burn. Three elements are required for fire to occur: fuel, oxygen, and an ignition source. This relationship is illustrated by the fire triangle. A fire can be extinguished by taking away any one element of the fire triangle.

Fuel: Examples of flammable liquids are acetone, gasoline, methyl ethyl ketone (MEK), and xylene. They provide the fuel in the fire triangle. But none of these substances will burn unless there is enough heat or oxygen.

Oxygen: The oxygen that feeds a fire usually comes from the air. However, some chemicals that contain oxygen can supply that oxygen to a fire and are called “oxidizers”. Oxidizers can feed a fire even when oxygen is low. Fires or explosions are more likely to occur if any kinds of oxidizers are stored near flammables. Oxidizers should never be stored near flammables. A chemical that is both a flammable and an oxidizer is very dangerous.

Heat: Heat is provided by an ignition source. Typical ignition sources might include: static electricity; an open flame; two metal objects striking each other; and an excessively hot surface.

Chain reaction is the propagation of a chemical reaction between one or more chemicals.



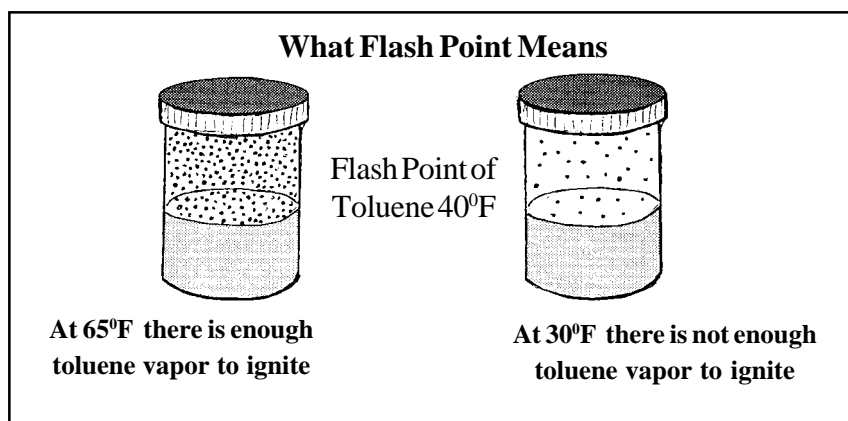


The most dangerous flammable substances:

- are easily ignited.
- require little oxygen to support combustion.
- are also oxidizers.
- are also toxic or corrosive (eg. acrylonitrile and acetic acid).

Flashpoint and Flammable Range

Flash point and flammable range are physical properties of a chemical that define how flammable the chemical is.



The **flashpoint** of a liquid is the minimum temperature to which the substance must be heated in order to create enough vapor for it to ignite. For example, toluene has a flashpoint of 40°F: This means that, with sufficient heat and oxygen, toluene could catch fire at room temperature (65°F). Liquids don't actually burn. It is their vapor that burns. The lower the flashpoint, the greater the fire hazard.

U.S Department of Transportation defines any substance with a:

- Flashpoint less than 100° F = High Risk (Flammable)
- Flashpoint between 100° F and 200° F = Moderate Risk (Combustible)
- Flashpoint greater than 200° F = Low Risk (Non-Combustible)

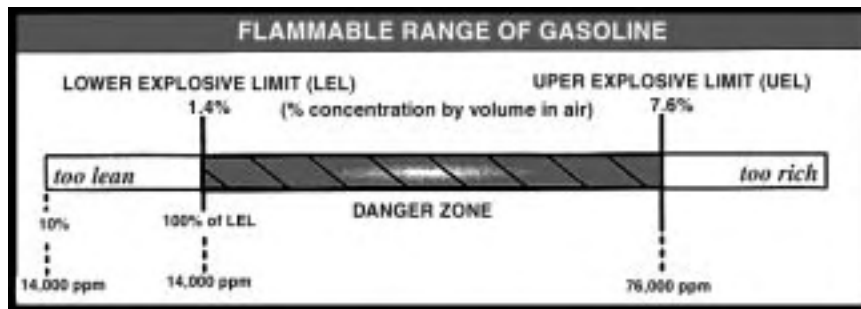
If you have a chemical substance with a flashpoint less than the surrounding temperature, you have reason to worry. However, even if the chemical has a flashpoint greater than the surrounding temperature it will catch on fire because most substances will burn if you put them in direct contact with fire.

Different Flashpoints, in degrees Fahrenheit ($^{\circ}$ F)	
Gasoline	-45
Acetone	0
Benzene	12
Methyl Ethyl Ketone	20
Toluene	40
Ethyl Alcohol	55
Xylene	84
Styrene	88
Cresol	187
Ethylene Glycol	232

An Example: The Flammable Range of Gasoline

When you start your car without enough gas, the engine will not run. The gas-to-air mixture is too lean - not enough gas. In order to burn, fuel and oxygen must be mixed in certain proportions. If the engine floods (too much gas), the mixture is too rich and you still can't start your car.

Ordinary gasoline will ignite when there is at least 1.4 % gas-to-air and at most 7.6% gas-to-air. The lower end (1.4%) is called the **Lower Explosive Limit** or **LEL**. The **Upper Explosive Limit (UEL)** is 7.6%. If you are above or below those limits, there will be no ignition. In between those percentages lies the **flammable range**.



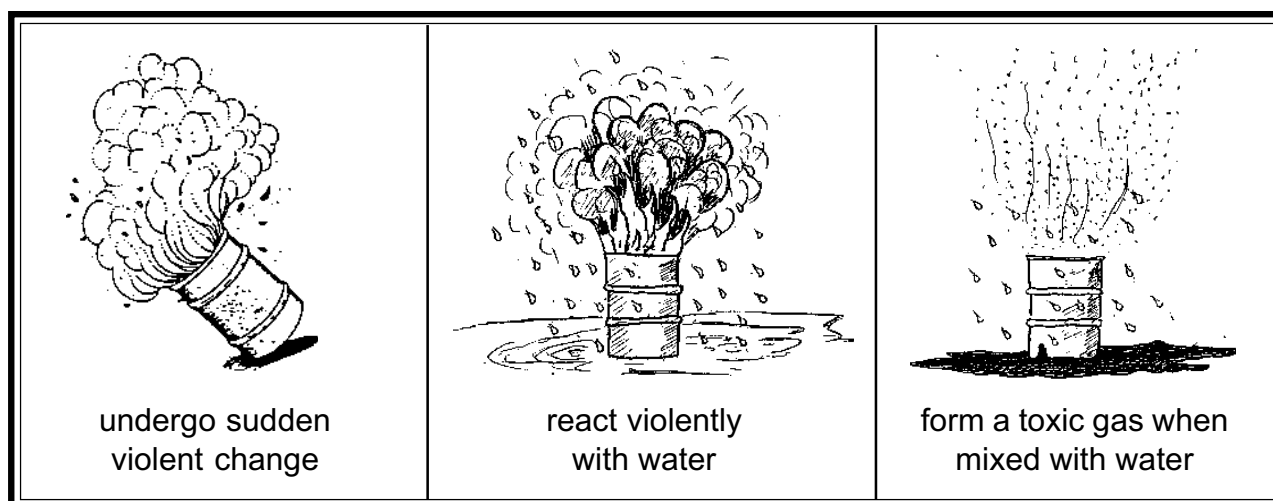
A substance having a low LEL and a wide Flammable Range can be particularly hazardous because there are many conditions under which it can ignite. For example, hydrogen has a LEL of 4% and a Flammable Range of (4-75%). Acetylene has a LEL of 2.5% and a Flammable Range of (2.5- 81%).



REACTIVITY

Reactive chemicals are substances that may be unstable under certain conditions. Examples of **reactivity** would include shock sensitivity, violent reactions with water or air under normal conditions, and reactions with other chemicals. Sodium metal can cause a hydrogen explosion if it contacts water. Magnesium acts similarly on contact with water.

Two or more chemicals that may be stable alone may react with each other. The **incompatibility** of two substances can be very important in an incident.



Some Common Hazards Caused by Chemical Incompatibility:

- Produce a lot of heat (acid and water).
- Cause a fire (nitric acid and acetone).
- Cause an explosion (picric acid and sodium hydroxide).
- Release a poisonous gas (acid and cyanide, or chlorine and ammonia).
- Produce a flammable gas (acid and metal).

Chemical incompatibility is not always hazardous. Bases and acids are incompatible; however, they can neutralize each other. Sometimes when an acid is spilled we add a base to neutralize it and make it easier to handle. Care must be taken when neutralizing chemicals. Sudden heat or other hazards may be generated.



The Fearsome Incompatibles

Keep These		Away From These	Or You May Get These
Acids	+	Bases	→ Heat Violent Reaction
Acids or Bases	+	Reactive Metals (Aluminum, Beryllium, Calcium, Lithium, Potassium, Magnesium, Sodium, Zinc Powder) Metal Hydrides	→ Fire Explosion Hydrogen Gas
Water or Alcohols	+	Concentrated Acids or Bases Calcium, Lithium, Potassium Metal Hydrides Other Water Reactive Waste	→ Heat Fire Explosion Flammable and Toxic Gases
Reactive Organic Compounds or Solvents (Alcohols, Aldehydes, Nitrated Hydrocarbons)	+	Concentrated Acids or Bases Reactive Metals and Metal Hydrides	→ Fire Explosion
Cyanide or Sulfide Solutions	+	Acids	→ Toxic Hydrogen Cyanide Sulfide Gas
Strong Oxidizers (Chlorates, Chlorine, Chlorites, Chromic Acid, Hypochlorites, Nitrates, Perchlorates, Permanganates, Peroxides)	+	Organic Acids Concentrated Mineral Acids Reactive Metals Metal Hydrides Reactive Organic Compounds or Solvents Flammable or Combustable Waste	→ Fire Explosion

*Source of graphic: Emergency Response and Prevention Workbook, Emergency Response and Prevention Workbook, OCAW/Labor Institute.



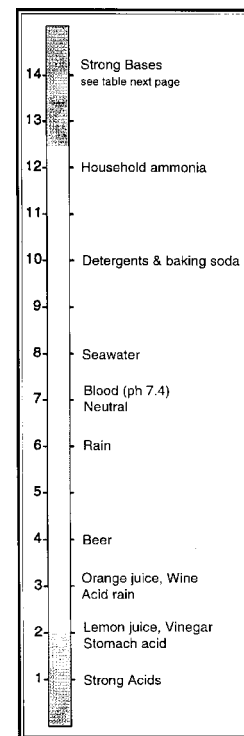
CORROSIVITY

Corrosive chemicals can irritate or burn the skin and mucous membranes. Corrosives will also eat away many metals. When controlling a spill or leak of a corrosive, you will need tools and equipment that are not affected by the corrosive. Corrosives are usually liquids but may also be gases or solids.

Acids and bases are the most common corrosives. The **pH (potential of Hydrogen) scale** is used to distinguish acids from bases and gives an indication of how corrosive a substance is. **Acids** have a pH less than 7. As the pH of an acid increases, the acid becomes weaker or less corrosive. The closer the pH is to 1, the stronger the acid.

Bases (also called **alkalis** or **caustics**) have a pH above 7. As the pH of a base increases, the base becomes stronger or more corrosive. Bases can cause more damage to skin and tissue, especially to the eyes, because bases rapidly penetrate tissue. Acids tend to sit on the skin surface and, if quickly removed, often will not result in permanent damage.

Liquids with a pH less than 2.0 or greater than 12.5 are corrosive and can cause serious chemical burns.

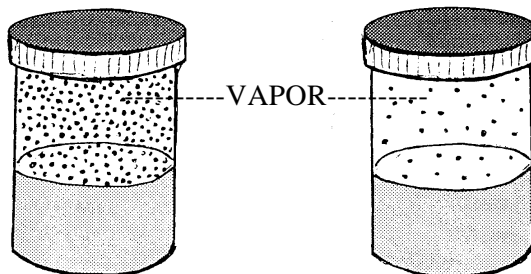


OTHER USEFUL PHYSICAL PROPERTIES OF CHEMICALS

Vapor Pressure

Low Vapor Pressure — less than 1mm Hg @ 68° F

Moderate vapor Pressure — between 1 and 10mm Hg @ 68° F



VP = 180 mm Hg @ 68° F
Acetone High Vapor Pressure

VP = 0.001 mm Hg @ 68° F
PCB Low Vapor Pressure

Remember: Vapor pressure depends on temperature.
Benzene vapor pressure = 15 mm Hg at 14° F, but increases to

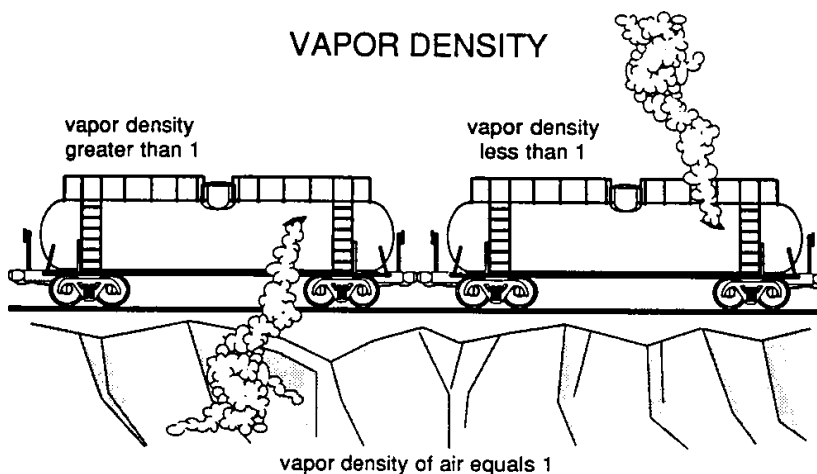
Vapor pressure (VP) is a measure of how much vapor is given off by a liquid or solid at a given temperature. The higher the vapor pressure, the more vapor will be found in the air above the liquid. As the temperature goes up, more vapor will be released. (Boil water and you produce steam, the vapor of water.)

Vapor pressure measures how hard the vapor of a material “pushes” against the sides of a closed container. The more heat that is applied to the container, the greater the vapor pressure will become inside that container. For example, it is vapor pressure that triggers the whistle when you boil water in a kettle. The higher the vapor pressure of a sealed chemical container, the more likely it will explode as the temperature rises (for example, during a fire). This is why we must be careful opening a drum or container with a high vapor pressure.

Vapor pressure is measured in millimeters of mercury (mm Hg). Normal atmospheric pressure is 760mm Hg. The vapor pressure listed for a chemical usually is its vapor pressure at room temperature. If a chemical has a vapor pressure of around 1 mm Hg, not much of it will get into the air. Generally, any chemical with a vapor pressure above 10mm Hg is thought to have a high vapor pressure.

Vapor Density

Vapor density tells us how a chemical’s vapors will behave in the air. Vapor density is measured in comparison with air, where the vapor density of air is 1. If a chemical has a vapor density **greater than 1**, it means that the vapor will sink to the floor and can collect in low-lying areas or confined spaces. A vapor density less than 1 means that the product’s vapor may collect overhead near a ceiling.





FORMS OF CHEMICALS

Just as the form of a chemical substance determines how it can get into your body and what harm it can cause, its form also affects whether a chemical can become flammable or reactive. A substance can change forms while you work with it. Here are three questions to ask when getting information about chemicals on a site:

1. What forms of the substance are present?
2. How can the substance get into my body?
3. Can the substance change form during an emergency?

The form of a chemical is important to consider when choosing protection for workers. We may provide splash protection against an acid not thinking that there may be mists from the acid that will call for respiratory protection as well.

A substance can change form because of an increase in temperature or pressure, or if it comes into contact with water. During an emergency a chemical can start in one form and end up in another. A solid could melt to a liquid form and run down a drain. A liquid may heat up and give off flammable vapors. As a liquid, there was little threat of a fire, but the vapors have created a hazard.

There are three forms that chemicals can take:

Solids: We all know what solids are - like a block of wood. But, solids aren't always big. **Dusts** are tiny particles of solids, often invisible. They may be created by cutting, grinding, sanding, etc. Some dusts can explode. **Fumes** are also solids. They are even tinier particles than dust. They are formed whenever a solid material is heated, volatilizes and then condenses in the air into extremely fine particles. Fumes are present in vehicle exhaust and welding smoke.

Liquids: Many hazardous substances are liquids at normal temperatures. Examples are acids and solvents. Many liquids give off vapors which can be both a fire and a health hazard. A liquid can be made into a mist. **Mists** are tiny droplets of liquid suspended in air. A mist can be created by splashing or spraying a liquid. They may be breathed in or land on the skin, be flammable, corrosive or toxic.

Gases: Some substances are gases at normal temperature; other liquids and solids can become gases when heated. Some gases are easy to detect because they smell or develop a certain coloration on contact with air. Other gases like carbon monoxide are odorless and colorless and can go undetected unless specific tests are carried out. Gases may also be flammable or explode and are often stored in compressed cylinders under pressure. Under certain circumstances, gases can be emitted by solids. Polyurethane foam is safe under normal conditions but when it burns it gives off a deadly gas. **Vapors** are gases that form above a liquid or solid material at room temperature.

Activity 4A:

Physical Properties of Chemicals

Since the physical properties of a chemical offer clues as to how it may behave, we want you to become familiar with looking up each chemical's properties. Working in groups and using the resources at your table fill out the chart below. Each group is to find the information requested for the chemical assigned to your group and a chemical of your choice. After you finish collecting the information please answer the questions on the next page.

Group A:

Chemical	State/Color Solid, Liquid, Gas	Vapor Density	Vapor Pressure	Flash Point	LEL/UEL
Ammonia (gas)					
Chemical of your choice					

Group B:

Chemical	State/Color Solid, Liquid, Gas	Vapor Density	Vapor Pressure	Flash Point	LEL/UEL
Nitric Acid (fuming)					
Chemical of your choice					

Group C:

Chemical	State/Color Solid, Liquid, Gas	Vapor Density	Vapor Pressure	Flash Point	LEL/UEL
Xylene					
Chemical of your choice					

Group D:

Chemical	State/Color Solid, Liquid, Gas	Vapor Density	Vapor Pressure	Flash Point	LEL/UEL
Caustic Soda					
Chemical of your choice					

Group E:

Chemical	State/Color Solid, Liquid, Gas	Vapor Density	Vapor Pressure	Flash Point	LEL/UEL
Chlorine					
Chemical of your choice					

Activity 4B:

Using the information provided in the manual, the video “Hazardous Properties of Chemicals”, the NIOSH guide, and the MSDSs, examine the physical properties of your two chemicals of choice. Enter all appropriate information on flammability, toxicity, corrosivity, and reactivity into the chemical release chart for each chemical.

Hazards		
Flash Point:	LEL:	UEL:
Vapor Density:	Vapor Pressure:	Specific Gravity:
PEL:	IDLH:	
Reacts with:		
Corrosive:	YES	NO
Routes of entry into the body:		
Acute & chronic health effects:		





SUMMARY SHEET

CHAPTER 4 : CHEMICAL HAZARDS

- ✓ The fire tetrahedron consists of the following:
 - Oxygen
 - Fuel
 - Heat
 - Chain Reaction
- ✓ The flash point of a liquid helps to determine if a fire hazard exists. Any liquid with a flash point less than 100° F poses a high risk.
- ✓ The most dangerous flammable substances are those that:
 - have a low Lower Explosive Limit (LEL) and a wide flammable range.
 - require little oxygen to support combustion.
 - are also toxic or corrosive.
- ✓ Some chemicals can react dangerously with air and water.
- ✓ Liquids with a pH less than 7 are acids. Chemicals with pH greater than 7 are bases.
- ✓ Liquids with a pH less than 2.5 or greater than 12.5 are corrosive. Corrosives can cause serious chemical burns.
- ✓ The form of a chemical – for instance, solid, liquid, or gas – determines how it can get into your body and cause damage. It is important to know the form of chemical and how it might change form during an emergency.
- ✓ The NIOSH Pocket Guide to Chemical Hazards is an important source of information about some hazardous materials.



OBJECTIVES

In this chapter you will learn the basics of respiratory protection. You will learn about the components of a respiratory protection program and the limitations of various respirators.

You will become familiar with wearing and maintaining respiratory equipment.

The objectives of this chapter are to ensure that students understand:

- The purpose of respiratory protection.
- The importance of effective respiratory protection programs.
- The limitations of various types of respirators.
- The selection and use of appropriate respiratory equipment.

On completion of this chapter, students will be able to:

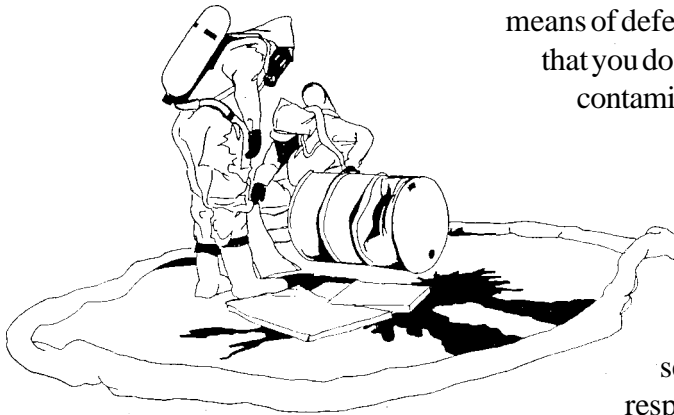
- List the two main types of respirators and explain how they work.
- Give the assigned protection factor for the most common types of respirators.
- Describe how to select a respirator for IDLH atmospheres and emergency response, as well as for non-IDLH atmospheres.
- Describe how to qualitatively fit test a full facepiece air-purifying respirator.
- Name two reasons for poor respirator fit.
- Demonstrate how to check out and wear an air-purifying respirator and an SCBA.
- Describe how to maintain respirators.
- List five components of a respiratory protection program required by OSHA.

As a member of an emergency response or spill team you are likely to come in close contact with hazardous chemicals. In many cases, dangerous amounts of these chemicals will contaminate the air in the vicinity of the release.

Chemicals in the air can harm you in two ways:

- (1) they may have harmful effects if you breathe them in.
- (2) they may displace oxygen from the air.

In such situations respirators are often your most important means of defense. Respirators are designed to ensure that you do not breathe harmful air while working in contaminated atmospheres.



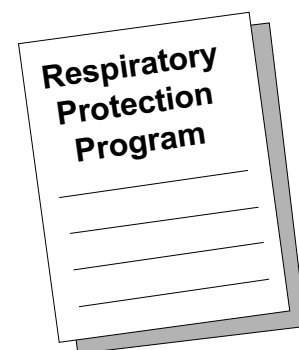
Using respirators in an effective manner is a complicated business. Not all respirators protect you from all airborne contaminants. There are many types to choose from and they must be carefully selected for each situation. Also,

respirators do not always provide enough protection. To protect you, they must be used correctly and carefully maintained. OSHA has published a specific standard – 29 CFR 1910.134 Respiratory Protection – that requires employers to take all the necessary steps to ensure that respirators will effectively protect their employees.

OSHA REQUIREMENTS: A WRITTEN RESPIRATORY PROTECTION PROGRAM

OSHA requires that your employer have a written Respiratory Protection Program at any site where respirators are required for worker protection. The program should include written operating procedures for:

- Selecting appropriate respirators.
- Medically evaluating potential respirator users.
- Fit testing all tight-fitting respirators.
- Using respirators in routine and foreseeable emergency situations.
- Maintaining respirators (cleaning, disinfecting, storing, inspecting and testing, repairing, discarding).
- Evaluating the program.





If you are required to wear respirators on the job, your employer must have these written procedures. He or she must train you on what the procedures are. Your employer must also train you on the specific respiratory hazards at your work place.

TYPES OF RESPIRATORS

There are many different types of respirators. A respirator must be carefully selected to ensure that it protects against the hazard that you are exposed to. To understand the selection process you need to be familiar with some of the basic types of respirators that are available. There are 3 characteristics that differ between respirators: facepieces, negative and positive pressure, and air supply.

Facepieces

A feature that is common to all types of respirators is a facepiece. A facepiece covers your nose and mouth, where you breath air. The facepiece may be loose-fitting or tight-fitting. In this training we only consider tight-fitting facepieces because they are commonly used in emergency response.

Respirators may have **full facepieces** or **half facepieces**. **Full facepieces** seal across the forehead, down along the side of the face, and under the chin.



Half Facepiece



Full Facepiece

Because these parts of the face are relatively smooth, full facepieces tend to form a better seal with the face than other designs. They also protect the eyes from irritant chemicals or flying particles.

The **half facepiece** fits over the bridge of the nose and tucks under the chin. The shape of the bridge of the nose is not smooth and is different for each person. For these reasons, it is difficult to design a half facepiece respirator that maintains a good seal for many different users. Because of this problem, half facepieces do not offer as much protection as full facepieces.

When using respirators for emergency response and spill cleanup you will most likely be wearing some type of full facepiece. However, half facepieces may be used for some routine cleanup procedures when exposures are low, because they are cooler and they do not limit vision.

Negative and Positive Pressure

A respirator can also be classified as either a **negative pressure** or **positive pressure** respirator. A **negative pressure** respirator has a lower (or “negative”) pressure inside the facepiece than outside during inhalation. If the facepiece does not fit tightly or there is a leak, contaminated air will be sucked into the facepiece when you inhale. On the other hand, a **positive pressure** respirator maintains a higher (or “positive”) pressure inside the facepiece than outside throughout the breathing cycle. The higher pressure inside the facepiece forces air out and reduces the chance of outside contaminated air getting in. For this reason positive pressure respirators are more protective. In order to determine if a positive or negative pressure respirator is appropriate, you need to learn more about how they work and what their limitations are.

The Air Supply

The last important characteristic of respirators is where they get air from. There are two basic ways that respirators can supply air: **Atmosphere-Supplying Respirators** and **Air Purifying Respirators (APRs)**. **Atmosphere-supplying** respirators provide a supply of air from a source (such as a tank) completely separate from the air in the work area. In contrast, **air purifying** respirators work by removing the contaminant (dust, fume, mist or vapor) from the air in your work area before you breathe it in. Below, we take a look at these two types of respirators in more detail.

Atmosphere-Supplying Respirators

Atmosphere-supplying respirators give you an independent source of air to breathe. There are two basic types of atmosphere-supplying respirators: the **supplied air or airline respirator (SAR)**, and the **self-contained breathing apparatus (SCBA)**. **SARs** provide you with air through an airline--a long tube that pumps air into the respirator from outside of your work area. **SARs** are not commonly used during emergencies, but they are sometimes used for emergencies in confined spaces.

Self-contained breathing apparatus (SCBAs), the other type of atmosphere-supplying respirator, provide you with air from a tank which you carry on your back. Firefighters and other emergency responders often wear SCBAs. The air tank, or cylinder, is pressurized and comes in different sizes. The size of the cylinder and its operating pressure determine how much air is in the cylinder. NIOSH assigns each cylinder a “service life”--this is an estimate of how long the air in the cylinder will last. OSHA requires that SCBAs used in emergency response have a rated service life of at least 30 minutes. Cylinders rated at 45 or 60 minutes may also be used, but cylinders rated for less than 30 minutes cannot be used for emergency response. It is important to remember that the actual amount of time the air in your cylinder lasts depends on how much oxygen your body needs, how hard you are breathing, and if the bottle was filled correctly.



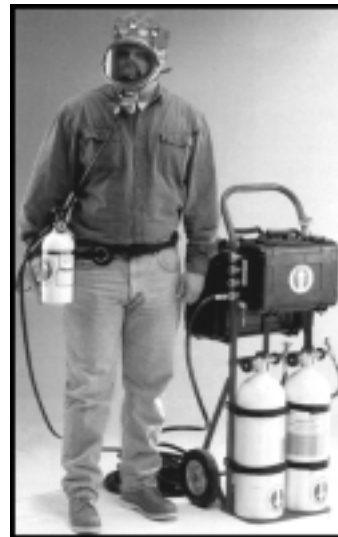
Auxiliary SCBAs are also available. These are very small cylinders usually certified for 3, 5 or 10 minutes. Auxiliary SCBA respirators should only be used to exit a hazardous work environment during an emergency.

Atmosphere-supplying (or air supplying) respirators are now only available in **positive pressure** modes. Positive pressure air-supplying respirators, (also referred to as “**continuous flow**” or “**pressure demand**” respirators) constantly blow air into the facepiece. However there are still some **negative** pressure units in circulation. (These are sometimes referred to as “demand” respirators since they only supply air when you inhale.) OSHA requires that only positive pressure air-supplying respirators can be used in emergency situations.

ATMOSPHERE-SUPPLYING RESPIRATORS



Self-contained breathing apparatus

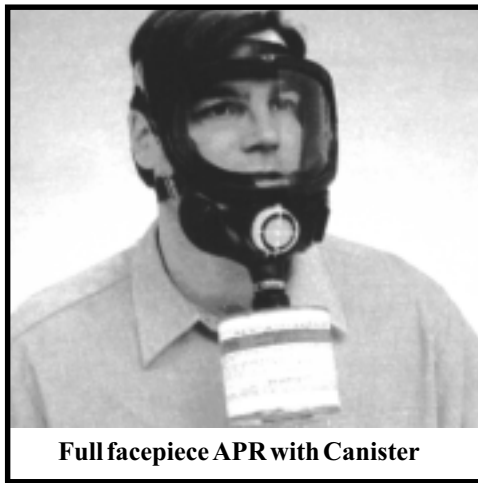


Supplied-Air Respirator

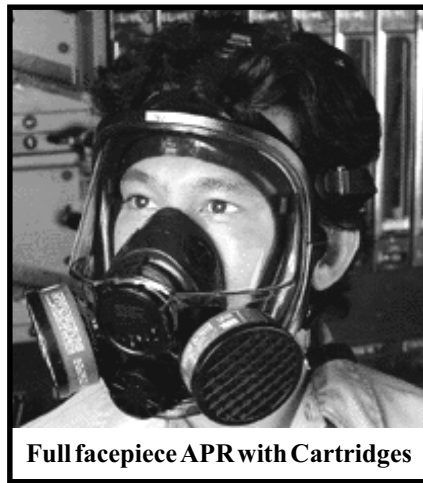
AIR PURIFYING RESPIRATORS

Unlike atmosphere-supplying respirators, APRs do not provide you with a separate source of air. Instead, they protect you by filtering out or absorbing contaminants from the surrounding air before you breathe them in.

COMMON AIR-PURIFYING RESPIRATORS



Full facepiece APR with Canister



Full facepiece APR with Cartridges

While there are many types of APRs, they all have a few things in common. They all use specially designed materials to capture contaminants. These materials are usually found inside a cartridge or canister. (In the case of a dust mask, the mask itself is the material that collects the contaminant.) They all have either full or half-face facepieces. And, all non-powered APRs are negative pressure respirators--they only supply air when you inhale.

The most common APRs use two cartridges mounted on each side of the facepiece. Some have a canister instead of cartridges. A canister is a big cartridge that holds more material to capture a given contaminant. It lets the user work in the hazardous environment for a longer time than the cartridge respirator. Canisters may be mounted directly on the front of the facepiece or attached by means of a hose. APRs that use a canister are often referred to as gas masks, and are sometimes used as escape-only respirators to exit a hazardous atmosphere during an emergency.



How well an APR protects you depends on both the facepiece and the cartridge or canister. Different chemicals require different cartridges/canisters to remove them from your breathing air. If you use the wrong cartridge, you may not be getting any protection at all. For example, particulate filter cartridges collect aerosols (dusts, mists, and fumes) as they strike the filter. Some filters are designed to trap very fine and toxic dusts, such as lead and asbestos. But even the best filters offer no protection from gases and vapors. Cartridges for gases and vapors are filled with special sorbent materials that collect the gases by means of chemical reactions. These materials must be matched to the particular gas or vapor you want to remove from the air. Some cartridges include both a filter and sorbent materials.

Identifying Cartridges and Canisters

Because you must use specific cartridges for specific contaminants, a standard color code has been developed to help identify cartridges and canisters. This color code is given in the table below.

COLOR	TYPE	EXAMPLE OF USE
Black	Organic Vapor	Xylene, Toluene, Ethyl Ether
Yellow	Organic Vapor & Acid Gas	Toluene, Ethyl Ether, Chlorine, Hydrochloride, Sulfur Dioxide, Chlorine dioxide, Hydrogen flouride
White	Acid Gas	Chlorine, Hydrogen Chloride, Sulfur dioxide, Formakdehyde
Green	Ammonia & Methyl Amine	Ammonia/Methylene
Magenta	P100 Dust (HEPA filter for toxic particles)	Asbestos & Lead
Orange	Mercury Vapor/Chlorine	Mercury Vapor/Chlorine
Olive	Various other gases & vapors	Multi-Chemical Cartridges

NOTE: NIOSH and ANSI are in the process of updating these color codes. Therefore some changes may occur in the near future.

The service life of air-purifying cartridges or canisters is limited. Cartridges that protect against gases and vapors will lose their effectiveness over time as the sorbent material becomes loaded with contaminant. If the cartridges are not replaced soon enough large amounts of the gas or vapor will begin to pass directly into the facepiece. This is called **breakthrough**. The amount of time for breakthrough to occur depends on the amount of chemical in the air, your breathing rate, and environmental conditions such as temperature and humidity.

OSHA requires the employer to ensure that breakthrough does not occur. Your employer can do this by taking one of the following measures:

1. Your employer can provide NIOSH approved “end of service life indicators” (ESLIs) when appropriate and available. End of service life indicators are a device on the cartridge which responds to high levels of contamination. A sensitive material in a little window changes color when breakthrough is about to occur. Your employer should explain to the workers whether ESLIs are being used or not.
2. If there is no end of service life indicator appropriate for the job, then your employer should schedule cartridge changes based on the job duties and contaminant levels experienced. This is done to make sure cartridges are replaced before breakthrough happens. When your employer determines the cartridge change schedule, they should plan for the worst case scenario and use the respirator manufacturer’s and/or chemical manufacturer’s breakthrough time data. If no information about breakthrough times is available, do not use an air-purifying respirator--use an atmosphere-supplying respirator instead.

CARTRIDGE CHANGE SCHEDULES FOR APR’S SHOULD BE INCLUDED IN THE RESPIRATORY PROTECTION PROGRAM.

When the cartridge is designed to remove aerolols (dusts, mists, and/or fumes) reach the end of their service life, it will become difficult to breath through the respirator. This happens because the filter becomes clogged. Unlike the gas cartridges, once the particulate filter cartridges are clogged no more dust will get through. But no air will get through either. So, cartridges should be changed before it becomes noticeably difficult to breath through the respirator.

Powered Air-Purifying Respirators

Powered air purifying respirators are often used in lead and asbestos abatement work. These respirators use an electric pump to blow air through the cartridges. This allows the wearer to breathe easier. The air pumped into the facepiece remains cooler and helps reduce fogging too.



Powered Air-Purifying Respirator



SELECTING A RESPIRATOR

Your employer is responsible for selecting an appropriate respirator based upon the hazards in your work area. The respirator must be certified by NIOSH. Respirators and their containers must carry certification labels. An example of a certification label is on the next page. (Detailed requirements regarding what information the labels should contain and where the labels should be placed can be found in 42CFR84.)

In order to select an appropriate respirator you need to know what chemical or chemicals are present in the air. You also must have a reasonable estimation of the concentration of those chemicals. This means that your employer must test the air! If this information is not available, then your employer *must* assume the atmosphere is **IDLH (Immediately Dangerous to Life and Health)**.

Respirator Selection in IDLH Atmospheres and Emergency Response

OSHA defines an IDLH atmosphere as one that poses an immediate threat to life, would cause irreversible damage, or would impair a person's ability to escape (29 CFR 1910.134). In emergency situations, oxygen levels below 19.5% are considered IDLH. IDLH levels for specific chemicals are listed in the NIOSH pocket guide. All atmospheres should be considered IDLH during uncontrolled chemical releases until tests have determined that they are not.


**USE A FULL-FACEPIECE, PRESSURE DEMAND SCBA OR SAR*
WHEN RESPONDING TO CHEMICAL EMERGENCIES.**

* Use an escape-only SCBA when using a supplied-air respirator


For IDLH situations OSHA requires:

- a full facepiece pressure demand (positive pressure) SCBA with a service life of at least 30 minutes; or
- a full facepiece pressure demand SAR with self-contained auxiliary air supply.

Do not wear an air-purifying respirator in IDLH conditions, or if you don't know what chemicals or how much of a chemical is in the air.



**PART 84 MATRIX APPROVAL LABEL
FOR P100 FILTER**



DEF MANUFACTURING COMPANY
ANYWHERE, USA
1-800-555-1234

THESE RESPIRATORS ARE APPROVED ONLY IN THE FOLLOWING CONFIGURATIONS:			
TC-	PROTECTION ¹	RESPIRATOR	CAUTIONS AND LIMITATIONS ²
84A-00X	P100	HALO 2000	ABCJMNO

1. PROTECTION

P100-Particulate Filter (99.97% filter efficiency level) is effective against all particulate aerosols.

2. CAUTIONS AND LIMITATIONS

- A—Not for use in atmospheres containing less than 19.5% oxygen.
- B—Not for use in atmospheres immediately dangerous to life or health.
- C—Do not exceed maximum use concentrations established by regulatory standards.
- J— Failure to use and maintain this product properly could result in injury or death.
- M—All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.
- N—Never substitute, modify, add, or omit parts. Use only exact replacement parts in the configuration specified by the manufacturer .
- O—Refer to user instructions and/or maintenance manuals for information about use and maintenance of these respirators.

NOTE: Part 11 labels are still in use, but are being phased out.



Respirator Selection in Atmospheres that are not IDLH

An atmosphere-supply respirator can be used in concentrations below the IDLH. While these respirators are always safe to use, they are often uncomfortable.

Air Purifying Respirators may also be used in non-IDLH atmospheres. To use APRs, however, you have to check for two things. First, select the right respirator and cartridge. The respirator must be selected so that it is appropriate for the chemical state and physical form of the contaminant. All cartridges and canisters used in the workplace must be marked with an abbreviation of the cartridge type. They must also be color-coded (see chart on page 7) and be marked with “NIOSH”, and the manufacturer’s name and part number. (Additional information about the cartridge is on the label that came with the shipping box.)

AIRBORNE CONCENTRATION OF BENZENE OR CONDITION OF USE	RESPIRATOR TYPE
(A) LESS THAN OR EQUAL TO 10 PPM	(1) HALF-MASK AIR-PURIFYING RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE.
(B) LESS THAN OR EQUAL TO 50 PPM	(1) FULL FACEPIECE RESPIRATOR WITH ORGANIC VAPOR CARTRIDGES. (2) FULL FACEPIECE GAS MASK WITH CHIN STYLE CANISTER.
(C) LESS THAN OR EQUAL TO 100 PPM	(1) FULL FACEPIECE POWERED AIR-PURIFYING RESPIRATOR WITH ORGANIC VAPOR CANISTER.
(D) LESS THAN OR EQUAL TO 1,000 PPM	(1) SUPPLIED AIR RESPIRATOR WITH FULL FACEPIECE IN POSITIVE-PRESSURE
(E) GREATER THAN 1,000 PPM OR UNKNOWN CONCENTRATION	(1) SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE IN POSITIVE PRESSURE MODE. (2) FULL FACEPIECE POSITIVE-PRESSURE SUPPLIED-AIR RESPIRATOR WITH AUXILIARY SELF-CONTAINED AIR SUPPLY.
(F) ESCAPE	(1) ANY ORGANIC VAPOR GAS MASK; OR (2) ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE.
(G) FIREFIGHTING	(1) FULL FACEPIECE SELF-CONTAINED BREATHING APPARATUS IN POSITIVE PRESSURE MODE.

Second, check the “**maximum use**” concentration for the cartridge. In some specific chemical standards OSHA indicates a “maximum use” concentration for cartridges. You should never use a respirator when the concentration of the contaminant in the air is higher than the cartridge’s maximum use concentration.

Footnote(1) Canisters must have a minimum service life of four (4) hours when tested at 150 ppm benzene, at a flow rate of 64 LPM, 25 deg. C, and 85% relative humidity for non-powered air purifying respirators. The flow rate shall be 115 LPM and 170 LPM, respectively, for tight fitting and loose fitting powered air-purifying respirators.

If the chemical has a specific OSHA standard, respiratory protection requirements will be included as part of the standard. A table, like the one below, is usually supplied which gives the highest concentration at which each type of respirator can be used.

For chemicals that do not have a specific standard, **Protection Factors (PF)** can be used. The Protection Factor is a number assigned by NIOSH that indicates how effective a respirator is at reducing contaminants you breathe. The larger the PF, the more effective the respirator.

$$\text{Protection Factor (PF)} = \frac{\text{Concentration outside}}{\text{Concentration inside}}$$

The PF can be used as a guide in selecting respirators. The highest level of contaminant to which a person should be exposed when using a particular respirator can be determined by using the PF. This is like the “maximum concentrations” set in OSHA standards. You can calculate the maximum concentration by multiplying the respirator’s PF by the OSHA Permissible Exposure Limit (PEL) of the chemical you’re being exposed to:

$$\text{Maximum Concentration} = \text{PF} \times \text{PEL}.$$

Suppose you wanted to use a half facepiece APR with a PF of 10 (see chart on next page) while working with a nitrotoluene, which has an OSHA PEL of 5 ppm. The calculation to determine the maximum concentration at which it is safe to use a half facepiece for this chemical is:

$$\text{Maximum Concentration Half Facepiece APR} = 10 \times 5 \text{ ppm} = 50 \text{ ppm}.$$

So, you could use this half facepiece APR in any work situation where the concentration was below 50 ppm. For concentrations greater than 50 ppm you would need a respirator with a higher protection factor. A full facepiece APR could be used up to a concentration of 250 ppm nitrotoluene:

$$\text{Maximum Concentration Full Facepiece APR} = 50 \times 5 \text{ ppm} = 250 \text{ ppm}.$$







But, the IDLH level for nitrotoluene is 200 ppm. You must know the IDLH concentrations of a chemical before doing these calculations. Remember, neither an APR nor a negative pressure atmosphere-supplying respirator can ever be used in an IDLH atmosphere. Since the IDLH of nitrotoluene is 200 ppm, a full facepiece APR could not be worn above this concentration. If the IDLH had been 300 ppm, the full facepiece APR could have been used at 250 ppm.

The chart on the next page gives the PF for the different types of respirators.

A flowchart for selecting the correct type of respirator is provided on page 14.

RESPIRATORS

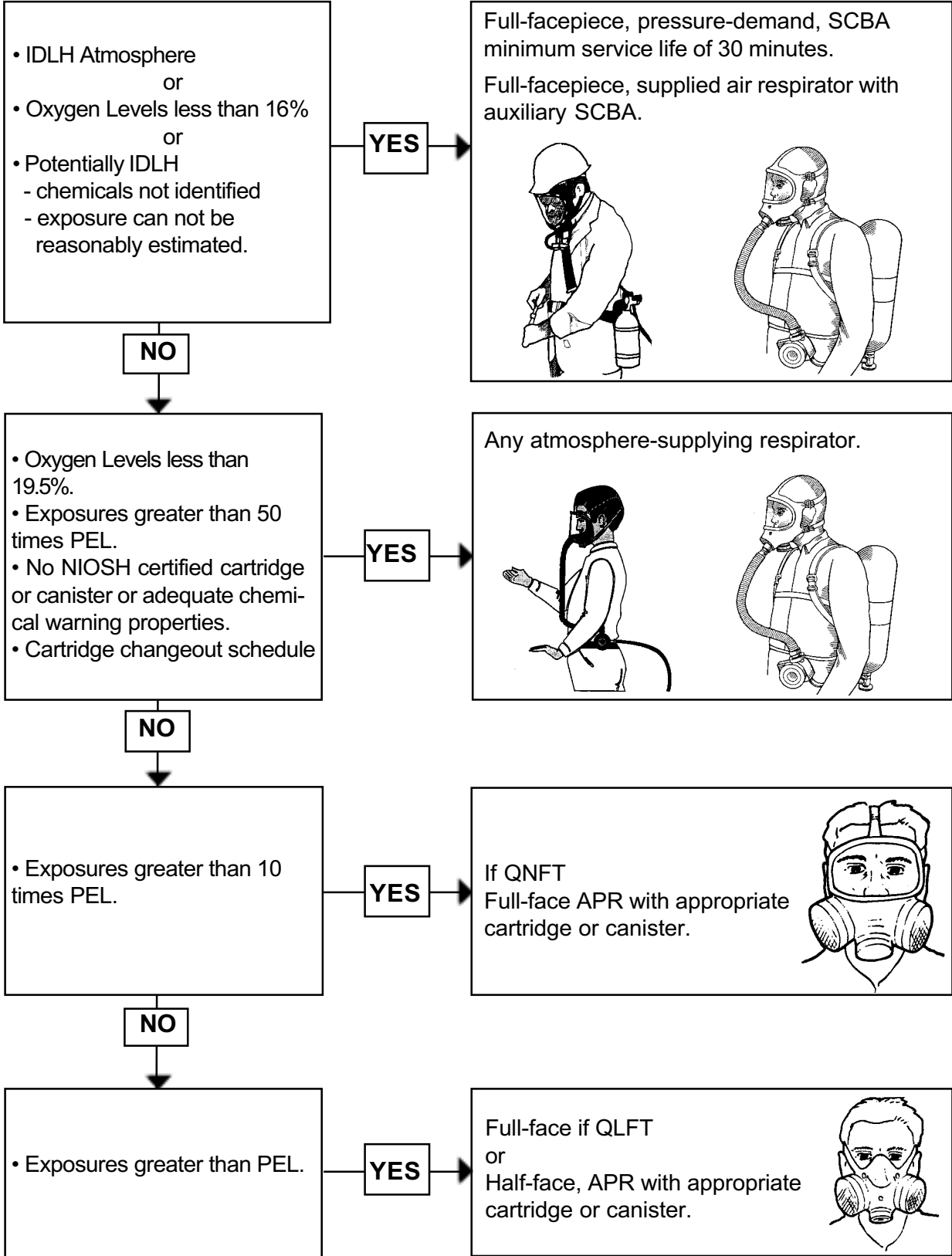


RESPIRATOR		POSITIVE OR NEGATIVE PRESSURE	NIOSH Protection Factor	Use at IDLH	Use at Low O ₂
			(PF)		
 Full Facepiece SCBA	Pressure-Demand	POSITIVE	10,000	YES	YES
	Demand	NEGATIVE	50	NO	YES*
 Full Facepiece Air-line Respirator	Pressure-Demand with Auxillary SCBA	POSITIVE	10,000	YES	YES
	Pressure-Demand	POSITIVE	2,000	NO	YES*
	Demand	NEGATIVE	50	NO	YES*
 PAPR Tight fitting Full-face		POSITIVE	50	NO	NO
 Full - face Cartridge or Canister APR		NEGATIVE	QNFT 50 QLFT 10	NO	NO
 Half -Face APR		NEGATIVE	10	NO	NO

* Only for O₂ levels between 16-19.5% (at sea level)

RESPIRATOR SELECTION GUIDE

ANY OF THESE CONDITIONS? → THEN WEAR





MEDICAL EVALUATIONS

Before any employee is fit tested or required to wear a respirator they must be medically evaluated. This evaluation is done to make sure that there is no medical condition that would make wearing a respirator dangerous for the user. **OSHA's requirements for medical evaluations are as follows:**

- Potential respirator users must fill out a medical questionnaire, including medical and work histories and information about specific work conditions. (OSHA provides a questionnaire in Appendix C of the Respiratory Protection Standard.)



- A licensed health care professional (PLHCP) must review these questionnaires to determine which, if any, workers need to have an examination before wearing a respirator. Employers may choose to have all prospective wearers examined and to obtain any required information during the examination.
- Additional medical evaluations must occur if:
 - an employee exhibits signs and symptoms of chemical exposure,
 - requested by a PLHCP, supervisor or program administrator,
 - the initial evaluation suggests the need for one, or
 - any change occurs in workplace conditions that may increase the physical demands on the respirator user.

FIT TESTS

The effectiveness of any respirator critically depends on having a good seal around the face. You don't want any leakage around your face seal due to a poor fit. OSHA requires fit testing for all tight fitting facepieces, including both atmosphere-supplying and air-purifying types.

The purpose of fit tests is to determine which facepiece fits your face the best. Your employer is required to have a selection of different makes and models available to ensure you can find one with a proper fit. Several sizes for each model should also be available.

During the testing you are asked to perform tasks that mimic work activities. A fit test must be passed before you use any respirator in a hazardous environment. The tests must be repeated at least annually. Also a test must be done if there is some important change in the way a respirator fits -- for example, if you lose a lot of weight and your face gets thinner.



There are two types of fit tests. The **quantitative fit test (QNFT)** is the preferred method because it is the most accurate. Measuring devices are placed inside and outside the facepiece in order to compare the concentrations of contaminants. A **fit factor** is assigned to each facepiece based on these measurements. The fit factor is the ratio of the concentration outside the facepiece to the concentration inside the facepiece. So, the higher the fit factor, the better protection the respirator is providing.

A QNFT is passed if a fit factor of 100 or better is achieved for a half-face facepiece, and a fit factor of 500 or greater is reached for a full-face facepiece.

(Note: These limits are the protection factors multiplied by a safety factor of 10.)



QUALITATIVE FIT TEST

The **qualitative fit test (QLFT)** is less accurate. This test requires you to stand in an enclosed space while wearing a respirator. A contaminant (banana oil, saccharin, bitrex or irritant smoke) is introduced into the space. The test is passed if you do not detect the chemical by smell or irritation at any time while performing certain required activities. OSHA only permits QLFT for respirators that will be used in atmospheres that do not exceed 10 times the PEL of the chemical(s) involved. The

detailed procedures for fit testing can be found in mandatory Appendix A of the Respiratory Protection Standard [1910.134]



USING RESPIRATORS

General Requirements

Even after selecting an appropriate respirator that fits properly, a respirator can only protect you if it is used properly.

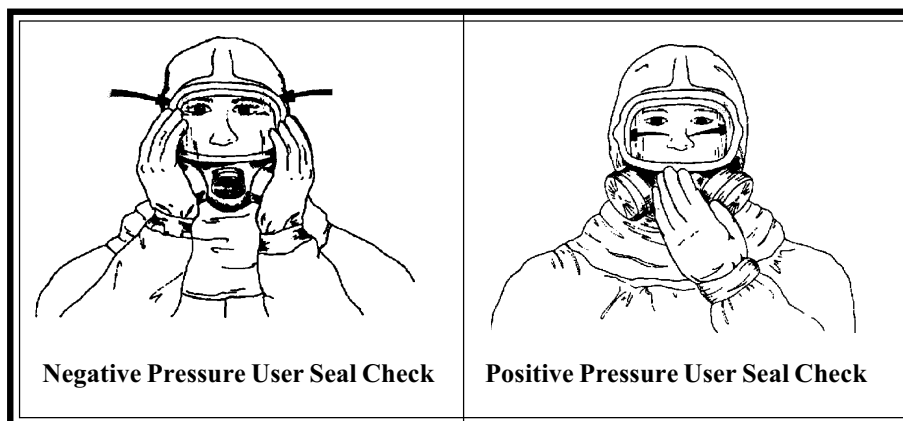
When wearing a tight-fitting facepiece nothing should interfere with the face seal. This includes facial hair, glasses, or any other personal protective equipment. If facial hair interferes with the seal you must shave, unless an appropriate loose fitting hood or facepiece can be found. Glasses must be replaced with contact lenses or special lenses that do not have sidebars.

OSHA places no restrictions on the use of contact lenses with respirators. However, OSHA does say that you should first practice wearing contact lenses with a respirator before doing an actual job. Some employers do not allow contact lenses to be worn if certain chemicals, such as ammonia, are present.



**Clip-On
Eyeglasses**

OSHA requires that you perform a **user seal check** each time you put on a tight-fitting respirator. This is to ensure that the facepiece has sealed against your face properly. The procedure for a seal check is given in mandatory Appendix B-1 of the Respiratory Protection Standard, and it is reprinted on the next page.



* Source of Graphics: Lead Abatement Manual, Massachusetts Respiratory Hospital. 1991.

Appendix B-1 to § 1910.134: User Seal Check Procedures (Mandatory)

The individual who uses a tight-fitting respirator is to perform a user seal check to ensure that an adequate seal is achieved each time the respirator is put on. Either the positive and negative pressure checks listed in this appendix, or the respirator manufacturer's recommended user seal check method shall be used. User seal checks are not substitutes for qualitative or quantitative fit tests.

I. Facepiece Positive and/or Negative Pressure Checks

A. Positive pressure check: Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

B. Negative pressure check: Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s), inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. The design of the inlet opening of some cartridges cannot be effectively covered with the palm of the hand. The test can be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

II. Manufacturer's Recommended User Seal Check Procedures

The respirator manufacturer's recommended procedures for performing a user seal check may be used instead of the positive and/or negative pressure check procedures provided that the employer demonstrates that the manufacturer's procedures are equally effective.

Using respirators can create additional safety hazards by limiting vision and mobility, or affecting your balance. For example, fogging of a full facepiece may occur, particularly in cold weather. This can be controlled by using a facepiece with a nose-cup, or by using coating and attachments designed to prevent this problem. Wearing a respirator also produces physical and mental stress that may increase your risk of heat stress.



You should leave the respirator use area if:

- you need to wash your face or facepiece to prevent skin or eye irritation due to respirator use;
- you detect gas or vapor breakthrough, changes in breathing resistance or facepiece leakage; or
- you need to replace a respirator, cartridge or canister.

Structural Fire-Fighting and Chemical Emergencies

When respirators are used for structural fire-fighting or chemical emergencies, the **buddy system** must be used. A buddy must accompany each person that enters the hazardous area. Buddies should remain in eye or voice contact while in the hazardous area. This means that no person can enter the potentially IDLH atmosphere alone. In addition, two equipped and trained backup personnel must be available for rescue.

Working in IDLH Atmospheres (Non-Emergencies)

When respirators are being used in IDLH atmospheres under non-emergency conditions additional precautions must be taken. There must be a person outside the hazardous atmosphere in regular contact with those working in the IDLH environment. In some cases more than one person may be required to monitor workers. These people must be trained and equipped to assist those workers in the IDLH environment.

CARING FOR YOUR RESPIRATOR

Cleaning and Disinfecting

Respirators should be regularly cleaned and disinfected regularly after each use.

The manufacturer's cleaning procedures or those given by OSHA in mandatory Appendix B-2 of the Respiratory Protection Standard must be used for cleaning respirators. (Appendix B-2 is reprinted on the next page.)



Appendix B-2 to § 1910.134: Respirator Cleaning Procedures (Mandatory)

These procedures are provided for employer use when cleaning respirators. They are general in nature. The employer, as an alternative, may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees, provided such procedures are as effective as those listed here in Appendix B-2. Equivalent effectiveness simply means that the procedures used must accomplish the objectives set forth in Appendix B-2. This means that the procedures must ensure that the respirator is properly cleaned and disinfected in a manner that prevents damage to the respirator and does not cause harm to the user.

I. Procedures for Cleaning Respirators

A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.

B. Wash components in warm (43° C = 110° F maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.

C. Rinse components thoroughly in clean, warm (43° C = 110° F maximum), preferably running water. Drain.

D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:

1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43° C (110° F maximum); or,
2. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45% alcohol) to one liter of water at 43° C (110° F maximum)
3. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.

E. Rinse components thoroughly in clean, warm (43° C = 110° F maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

F. Components should be hand-dried with a clean lint-free cloth or air-dried.

G. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.

H. Test the respirator to ensure that all components work properly.



Storage

Respirators should be protected from damage, contamination, dust, extreme temperature, excessive moisture, and damaging chemicals. They should also be stored to avoid deformation of the face seal or inhalation valve. Emergency respirators must be clearly marked, and must be accessible to the work area.

Inspections

All respirators maintained for emergency use should be inspected monthly. The inspection must be certified with the date of the inspection, name of the person conducting the inspection, findings, remedial actions if required, and some form of identifying the respirator. This information must be kept until the next certification. All respirators should also be checked for proper functioning before and after each use. Respirators that are used routinely should be inspected prior to use and during cleaning.



Inspections should include check of respirator function and condition of parts such as facepiece, head straps, valves, connecting hoses, cartridges, and/or canisters or filters. Facepiece straps, and other elastic parts should also be tested for pliability. The inspection of SCBAs should also ensure that cylinders are fully charged (>90%) and that the regulator and warning devices are functioning.

Repairs

Pressure and flow rates must be checked to make sure that the unit is delivering the right amount of air at the right pressure. Cylinders must be checked to ensure that they are not defective. The regulator must be checked to ensure that it is not defective. Hoses and couplings must be checked for cracks or leakage.

The manufacturer or someone trained by the manufacturer must perform any repairs to reducing and admission valves, regulators and alarms. Appropriately trained personnel must perform any other repairs. Only NIOSH-approved parts should be used. These parts must be designed for the respirator according to the manufacturer's specifications and recommendations.

Breathing Air Quality

Precautions must be taken to ensure that Type 1-Grade D or better breathing air is used in all atmosphere-supplying respirators. ANSI/Compressed Gas Association publishes specifications for oxygen content, hydrocarbons, carbon monoxide, carbon dioxide and odor. There are also specifications for moisture content for cylinders with compressed air, and for compressors used to produce breathing air.

TRAINING

Workers must be effectively trained in the following areas:

- Why a respirator is necessary and how improper fit, use or maintenance can effect performance.
- Limitations and capabilities of the respirator.
- Use of respirators in emergency situations.
- How to put on, remove, and use the respirator.
- How to inspect and check seals on the respirator.
- Procedures for maintenance and storage.
- Recognition of medical signs and symptoms that may limit or prevent effective or safe use of the respirator.
- General requirements of the Respiratory Protection Standard.

Training is required annually. Additional training must also be supplied if correct procedures are not being followed or changes occur in the workplace that effect how respirators should be used.

PROGRAM EVALUATION

Employers must evaluate the workplace as necessary to ensure the Respiratory Protection Program is being effectively implemented. Workers should be consulted regularly to obtain their views concerning how successful the program is and what problems need to be addressed.





Activity 5:

Thinking About Respirators

The aim of this activity is to have you think about respirators, how they work, and their limitations. You may refer to the manual and other materials to answer the following questions. After answering the questions, please fill in the section on respirators on the chemical release chart, shown on the last page of this chapter.

List any differences between a positive pressure respirator and a negative pressure respirator.

Describe some of the limitations of:

- a full-face Air Purifying Respirator (APR)
- an SCBA

What circumstances would prohibit you from using an Air Purifying Respirator?

What is a fit test?

Describe some key factors that should be used in choosing a respirator?

SUMMARY SHEET

CHAPTER 5 : RESPIRATORS

- ✓ It is always possible to encounter IDLH and oxygen-deficient conditions during emergency response.
- ✓ A positive pressure respirator gives a higher level of protection than a negative pressure type and should be used whenever possible.
- ✓ A respirator's protection factor is defined as the ratio of the concentration of air contaminant outside the mask to that inside the mask.
- ✓ An airline respirator with air supplied from a compressor must be supplemented with an escape respirator at all times when working in unknown atmospheres or concentrations above the IDLH.
- ✓ An air-purifying respirator must never be used in an oxygen-deficient atmosphere.
- ✓ People with beards cannot use respiratory protection masks.
- ✓ There are no respirator cartridges which will protect against all types of air contaminants. You should always use the correct cartridges for the model of respirator you are using and for the contaminant that you want to be protected against.
- ✓ You must perform a user seal check (positive pressure and/or negative pressure) every time you put on a tight-fitting respirator.
- ✓ Respirators must be properly cleaned, stored and inspected so as to prevent damage and not cause harm to the user.
- ✓ All the parts of a Respiratory Protection Plan must be carefully followed to ensure your protection.



Using the Chemical Release Chart

Based on estimated air concentrations (see page 13), please enter the appropriate respirator information on your chemical in the following section of your Chemical Release Chart.

Chemical Release Chart

Product:		Date Prepared:		Reviewed:	
Location(s)		Quantity:		Container Size(s)	
Hazards					
Flash Point:		LEL:		UEL:	
Vapor Density:		Vapor Pressure:		Specific Gravity:	
PEL:			IDLH:		
Reacts with:					
Corrosive:		YES		NO	
Routes of entry into the body:					
Acute & chronic health effects:					
Protective Equipment					
Respirator:					
Type of filters (if needed)					
Suit: level and material					
Boots:					
Eye/Face:					
Gloves, outer: material:			Gloves, inter material:		
Spill Response Equipment					
Air Monitoring:					
Personnel Monitoring:					
Soil & Water Sampling:					
Absorbents:					
Decontaminates:					
Other Equipment:					



OBJECTIVES

In this module you will learn why chemical protective clothing (CPC) is important as a method of protecting yourself from potential exposures during emergency response. You will practice wearing chemical protective clothing. You will learn about the limitations of CPC and the way to evaluate and select CPC.

The goals of this chapter are to ensure that students understand:

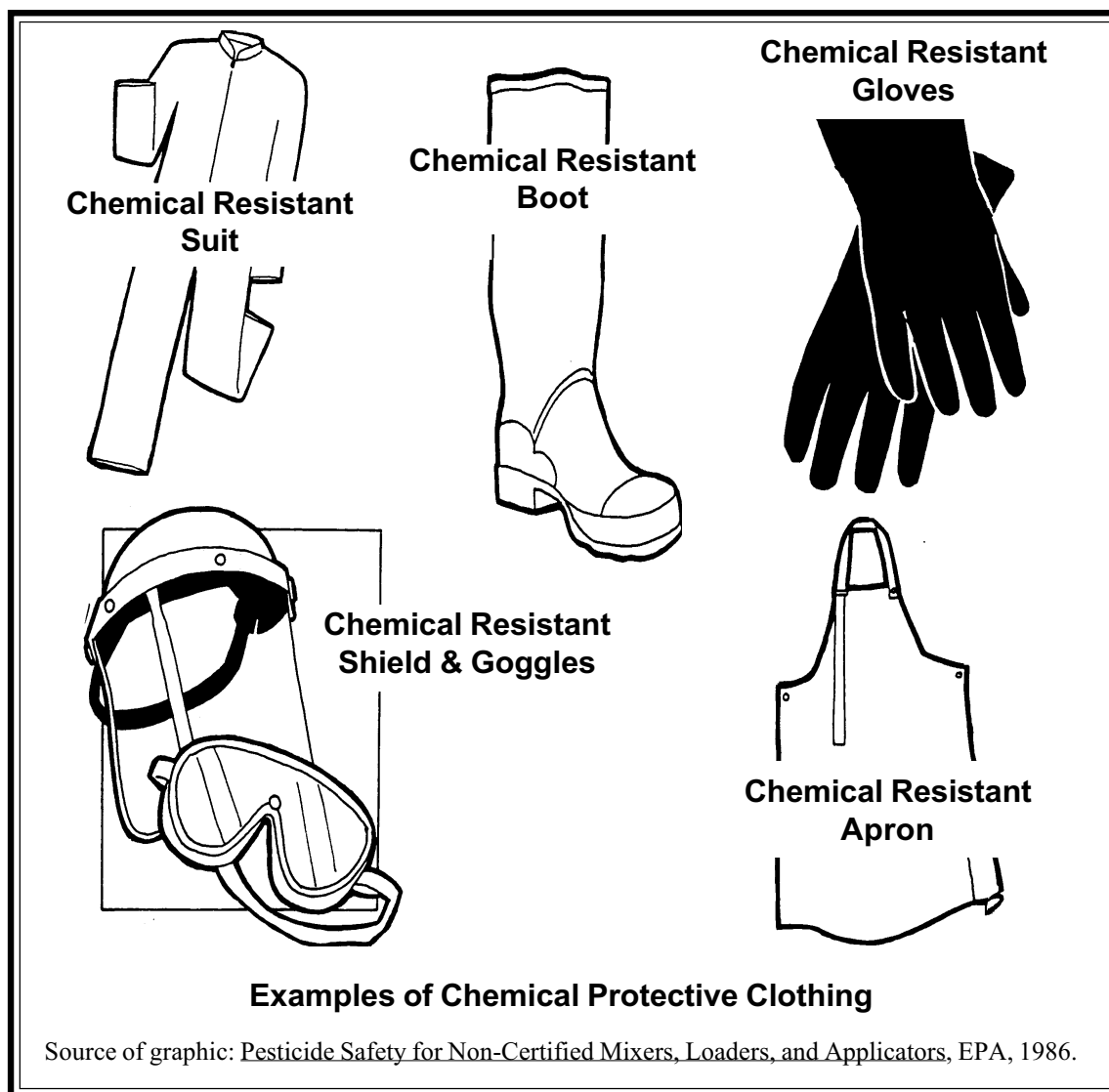
- The purpose of chemical protective clothing.
- The limitations of chemical protective clothing.
- How to wear and maintain CPC.
- The varieties of available CPC and how to select the most appropriate type.

On completion of this chapter, students will be able to:

- Identify the difference between levels of protection.
- Identify one physical and one psychological effect of wearing CPC.
- Name one limitation which affects the degree of protection afforded by a chemical protective suit.
- Identify one criterion for the selection and use of CPC.
- Identify the importance of using hazard recognition and health hazard evaluation in the selection of CPC.
- Identify two components of a personal protective equipment program.

OVERVIEW OF CHEMICAL PROTECTIVE CLOTHING (CPC)

Most workers wear some type of personal protective equipment (PPE) every day at work. Common PPE include hard hats, insulated boots, goggles used while welding or heat shields used during hot work. Personal protective equipment is designed to protect you against hazards such as abrasions, heat, water, cold, electricity and falling objects. Generally, this clothing is not designed to protect workers from hazardous chemicals. Chemical protective clothing (CPC) is a special category of PPE which is designed to isolate or shield workers from chemical hazards. CPC may include goggles, face shields, aprons, gloves, sleeve protectors, boots, leggings and suits.

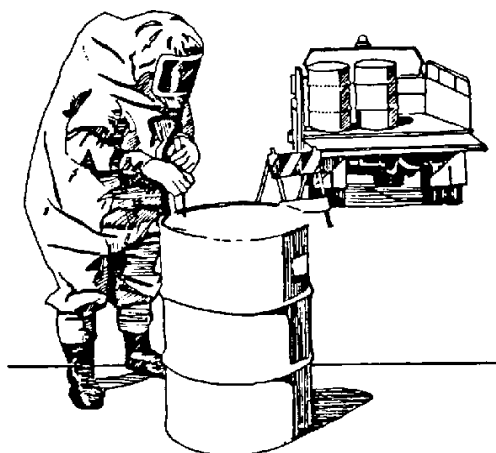




Protective equipment and clothing are not the best protection against hazards. CPC and PPE, when used in combination with other controls and good work practices, do help to protect workers from hazardous materials. While PPE is important, it should not be the focus of any safety and health program. However, because of the nature of emergencies, CPC is often the only protection responders have access to.

Chemical Resistant Suits

Chemical suits play a major role in emergency response. Chemical protective suits may be divided into two groups according to the protection they offer. (You will find that other CPC may be added to these suits to give more protection.)



Source of graphic: *Entrenamiento Sobre Salud y Seguridad Para Los Trabajadores de Desperdicios Peligrosos*, Occupational Health Program, University of California, Berkeley, 1991.

Gas-Tight Fully Encapsulating Suit

A fully encapsulating suit is a one-piece garment that completely encloses the worker. These suits are gas-tight and, therefore, the best available protection from toxic vapors, gases and mist that present a serious skin hazard. The worker must wear an air-supplying respirator under the suit.

Splash Suit

Splash suits may be two-piece pants-and-coat ensembles, or one-piece coveralls. They protect against splashes of hazardous liquids. They can be taped up with chemical protective tape to give more protection. But they are not gas-tight and so do not protect you against harmful gases/vapors. Newer splash suits will cover an SCBA and protect your air supply.

SELECTING CPC: WHAT TO WEAR?

It would be great if there were an all-purpose CPC suit that you could slip into for every chemical emergency. But there isn't. No single CPC item will protect against all chemicals in every circumstance. Therefore, there are four important steps to take when selecting chemical protecting clothing:

- 1. IDENTIFY THE CHEMICAL HAZARD**
- 2. EVALUATE CHEMICAL EXPOSURE**
- 3. EVALUATE CHEMICAL RESISTANCE OF CPC**
- 4. EVALUATE PHYSICAL RESISTANCE OF CPC**

Lets say we want to select a pair of gloves. We must first ask: Are we worried about acids or organics, peroxides, or alcohols? Depending on what we are working against we might need a butyl rubber, neoprene, PVA or PVC glove. Be sure to choose a glove that protects against the specific chemical involved.

Once we have selected the gloves, we must ask, How much do we wear? Is it enough to have gloves? Do we need an apron and overalls? Do we need a splash suit? Do we need a fully encapsulating suit? (And, do we need a respirator?)

Step 1: Identify the Chemical Hazards

We discussed the AREC model in the manual's Introduction. In Chapter 4 (Chemical Hazards) we talked about how to recognize hazards. You've learned how to:

- Identify the chemical or chemical family;
- Identify the physical form of the threat: vapor, liquid, solid;
- Identify the harmful action upon the body: e.g., an irritant to the lungs, a corrosive to the skin, toxic to the body, or a known or suspected carcinogen. You must gather all this information about the hazards before going on to Step 2.



Step 2: Evaluate the Chemical Exposure

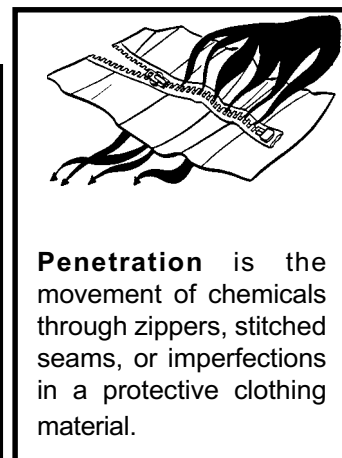
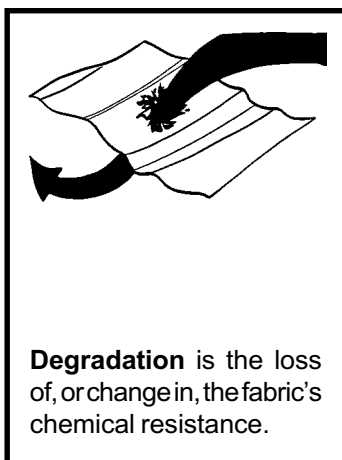
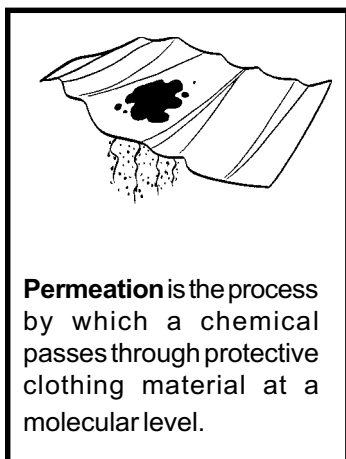
- Evaluate how toxic the chemical is by looking at the IDLH, TLV, or PEL.
- Evaluate the level to which you could potentially be exposed while doing a particular job. This means both the quantity and the frequency of the exposure. It is important to get a sense of how great a risk you face. This helps in deciding what level and type of CPC to use, as well as how to decontaminate after the exposure. This is often hard to do, but making an "educated estimate" is better than just guessing.

You should consult the NIOSH pocket guide, MSDSs, your health and safety officer or industrial hygienist, and other sources to determine the exposure limits for the chemical. In addition, readings should be taken from fixed or remote air monitoring instruments, if your facility has them, in order to better determine your potential exposure at a given job.

Step 3: Evaluating Chemical Resistance of CPC

The CPC you use should be matched to the chemical to which you are exposed. No CPC material protects against every chemical and you may be exposed to more than one chemical at a time. Even if you have the right CPC for the chemical, no material is completely successful in protecting you from exposure.

Chemicals pass through CPC in three ways: **permeation, degradation, and penetration.**



**THERE IS NO SUCH THING
AS A 100% PROTECTIVE SUIT.**

Chemical resistance is the concept we use to rate a particular CPC item. It defines the ability of the clothing to maintain a barrier to chemicals. Different clothing types have different chemical resistance.

The time it takes a chemical to permeate a material is called the **breakthrough** time. Breakthrough time depends on the material and the chemical. It may be immediate or take more than 24 hours. You want the CPC material to have a breakthrough time greater than the time it takes you to get the job done. OSHA likes to see CPC materials withstand breakthrough for at least an hour.

One way to overcome the limitation of any one CPC material is to layer different materials over each other. Many CPC suits are in fact made of several thin layers of different CPC materials. This strategy allows for lightweight suits with good permeation characteristics for a wide range of chemicals.

Three workers were removing roughly 650 55-gallon drums at a landfill in Pennsylvania. Most of the drums were leaking materials. The workers wore polyvinyl chloride (PVC) clothing and new SCBAs. The workers noticed a sweet smell; they then complained of dizziness, nausea and headaches. One worker was hospitalized. After the incident, their SCBAs were checked and found to be functioning properly. The PVC materials were checked. Swab samples of the clothing found a solvent, methyl isobutyl ketone (MIBK), both inside and on the outside of the garments. PVC is very permeable to most solvents.

Performance Testing

In order to determine if a particular CPC item is good enough to use against a chemical, you need to look at how well the item performs. This means you need information about its chemical resistance: how fast the chemical breaks through the material. (Liquid permeation data are usually quantified for each chemical listed.) This data comes from the manufacturer in the form of a chart that lists different chemicals and then compares it to different CPC. This data may be accurate and it may not. You may have to do some homework.



CPC is usually tested against a number of chemicals. If you work with a chemical and it is not on the list, then ask the manufacturer if they have any testing data on that chemical. Most CPC will have an instruction manual. Get it. It may cite limitations of the materials and discuss how to don and doff the material, how to inspect and store it, how to decontaminate it and how to use it. Always try to get samples before purchase so your team can evaluate them more practically -- for example, how easy (or hard) is it to do the job with the CPC on?

Other Informational Sources for CPC

The National Fire Protection Association (NFPA) has published three performance standards for CPC:

- **NFPA 1991: Vapor-Protective Suits for Hazardous Chemical Emergencies.**
- **NFPA 1992: Splash-Protective Suits for Hazardous Chemical Emergencies.**
- **NFPA 1993: Support Function Protective Clothing for Hazardous Chemical Operations.**

In Appendix B of HAZWOPER, OSHA recommends that selected CPC meet the requirements of these NFPA standards. When you are selecting CPC, ask the manufacturer if their clothing meets these standards. Manufacturers should supply you with this information. If they don't meet the standards or don't know, don't use their products.

If this seems like a lot to worry about, remember that there are people to help you. For example, you can contact a local COSH group, your health and safety officer, an industrial hygienist, or the local OSHA office, or a hazmat unit in your local fire department and ask for their help. In addition, there are special OSHA consultation programs in each state, usually run out of the state's Health Department. Look in **Appendix A** for government agencies and non-governmental organizations.

Step 4: Evaluating the Physical Characteristics of CPC

In addition to a CPC item's effectiveness as a barrier to chemicals, you also want to look at how sturdy the item is. CPC is of little value if it easily rips or tears. It also is of limited value if things like folding the material or leaving it in hot environments reduces its chemical resistance. Performance tests have been developed to evaluate the physical strength of different types of CPC. Below are some of the tests conducted on CPC:

- abrasion resistance
- cut resistance
- flexibility
- heat resistance
- puncture resistance
- tear resistance
- ozone resistance
- burst resistance

PHYSICAL CHARACTERISTICS OF SOME CPC MATERIALS*							
Material	Abrasion Resist.	Cut Resist.	Flex	Heat Resist.	Ozone Resist.	Punct Resist.	Tear Resist.
Butyl Rubber (Butyl)	F	G	G	E	E	G	G
Natural Rubber (Nat. Rub.)	E	E	E	F	P	E	E
Neoprene (Neop.)	E	E	G	G	E	G	G
Neoprene/Styrene-butadiene Rubber (Neop./SBR)	G	G	G	G	G	G	G
Neoprene/Natural Rubber (Neop./Nat. Rub.)	E	E	E	G	G	G	G
Nitrile Rubber (Nitrile)	E	E	E	G	F	E	G
Nitrile Rubber/Polyvinyl Chloride (Nitrile/PVC)	G	G	G	F	E	G	G
Polyethylene (PE)	F	F	G	F	F	P	F
Chlorinated Polyethylene (CPE)	E	G	G	G	E	G	G
Polyurethane (PU)	E	G	E	G	G	G	G
Polyvinyl Alcohol (PVA)	F	F	P	G	E	F	G
Polyvinyl Chloride (PVC)	G	P	G	P	E	G	G
Styrene-butadiene Rubber (SBR)	E	G	G	G	F	F	F
Viton	G	G	F	G	E	G	G

* Ratings are subject to variation depending on formulation, thickness, and whether the material is supported by fabric. **E = Excellent; G = Good; F = Fair; P = Poor**
 *Source: Martin, W. F, Lippitt J., M., Prothero, T. G. (1987). Hazardous Waste Handbook for Safety and Health, Butterworths, Boston. (Check with manufacture's technical manual for your CPC)



Think about how the CPC will be used, stored and handled at your job. Be sure that the type you choose will hold up.

An Example: Choosing Gloves and Limited-Use Clothing

Let's use an example of choosing gloves to illustrate selecting CPC. **Table 1, Glove Permeation Data** (from North), lists different chemicals, and gives their data on how long it takes for a chemical -- in a lab setting -- to break through for different types of gloves they make. As you go down the list, pick chemicals you work with and see which glove seems best.



GUIDE TO THE TABLES

- The first number given is the breakthrough time, in minutes.
- The second number, in parentheses, is the steady-state permeation rate; the higher the number the faster the chemical passes through the material.

nd = not detected

nt = not tested

ID = insufficient data

NR = not recommended

T = good for total immersion

I = good for intermittent contact

TABLE 1: Glove Permeation Data

Hazardous Chemical	North Silver Shield (4 mil)	North Viton (9 mil)	North Butyl (17 mil)	North Nitrile (11 mil)
Acetaldehyde	>360 (nd) T	0 (281.9) NR	576 (0.066) T	4 (161) NR
Acetone	>360 (nd) T	(ID) NR	>1020 (nd) T	5 (172) NR
Acetonitrile	>480 (nd) T	(ID) NR	>480 (nd) T	(ID) NR
Aniline	>480 (nd) T	10 (18.7) NR	>480 (nd) T	66 (45.0) NR
Benzene	>480 (nd) T	360 (0.012) I	31 (32.3) NR	(ID) NR
Butyl Acetate	>360 (nd) T	(ID) NR	114 (7.61) I	29 (54.4) NR
p-tert-Butyltoluene	>480 (nd) T	>480 (nd) T	102 (8.0) I	(ID) NR
Carbon Disulfide	>480 (nd) T	>480 (nd) T	7 (98.4) NR	13 (51) NR
Carbon Tetrachloride	>360 (nd) T	>780 (nd) T	(ID) NR	204 (5) I
Chloroform	10 (0.009) NR	570 (0.46) T	(ID) NR	4 (352) NR
Chloronaphthalene	>480 (nd) T	>960 (nd) T	(ID) NR	174 (>1.32) NR
Cyclohexane	>360 (nd) T	>420 (nd) T	66 (20.3) NR	(ID) NR
Cyclohexanol	>360 (nd) T	>480 (nd) T	>660 (nd) T	>960 (nd) T
Cyclohexanone	>360 (nd) T	29 (86.3) NR	>960 (nd) T	(ID) NR
Dibutyl Phthalate	>360 (nd) T	>480 (nd) T	>960 (nd) T	>960 (nd) T
1,2 Dichloroethane	>360 (nd) T	>480 (nd) T	120 (53) I	8 (311) NR
Diisobutyl Ketone (80%)	>360 (nd) T	72 (90.6) I	198 (41.2) I	180 (48.9) I
Dimethyl Formamide	>480 (nd) T	8 (6.5) NR	>480 (nd) T	13 (>15) NR
Dioxane	>480 (nd) T	23 (26.8) NR	>1200 (nd) T	28 (77.1) NR
Divinyl Benzene	>480 (nd) T	>1020 (nd) T	132 (238) I	(ID) NR
Ethyl Acetate	>360 (nd) T	(ID) NR	456 (3.4) I	8 (145) NR
Ethylamine (70% in Water)	47 (7.64) NR	(ID) NR	>720 (nd) T	66 (30.1) I
Ethyl Ether	>360 (nd) T	12 (21.5) NR	8 (92.2) NR	14 (21.8) NR
Formaldehyde (37% in Water)	>360 (nd) T	>960 (nd) T	>960 (nd) T	>1260 (nd) T
n-Hexane	>360 (nd) T	>660 (nd) T	(ID) NR	(ID) T
Hydrazine (70% in Water)	>360 (nd) T	(ID) NR	>480 (nd) T	>480 (nd) T
Hydrochloric Acid (37%)	>360 (nd) T	(ID) T	(ID) T	(ID) NR
Hydrofluoric Acid (50%)	>360 (nd) T	(ID) I	(ID) I	(ID) NR
Methylamine (40% in Water)	114 (2.0) I	>960 (nd) T	>900 (nd) T	>480 (nd) T
Methylene Chloride	>480 (nd) T	60 (7.32) I	24 (133) NR	4 (766) NR
MEK	>1440 (nd) T	(ID) NR	>480 (nd) T	(ID) NR
Morpholine	>480 (nd) T	114 (97) I	>960 (nd) T	48 (206) NR
Nitrobenzene	>480 (nd) T	>480 (nd) T	>1380 (nd) T	33 (1.7) NR
1-Nitropropane	>480 (nd) T	21 (26.1) NR	>480 (nd) T	16 (29.5) NR
Pentachlorophenol (1% in Kerosene)	>480 (nd) T	>780 (nd) T	(ID) NR	>780 (nd) T
Phenol (85% in Water)	>360 (nd) T	>900 (nd) T	>1200 (nd) T	39 (>1500) NR
Propyl Acetate	>360 (nd) T	(ID) NR	162 (2.86) I	17 (72.5) NR
Sodium Hydroxide (50%)	>360 (nd) T	(ID) I	(ID) T	>360 (ID) I
Sulfuric Acid (25%)	>360 (nd) T	(ID) T	(ID) I	(ID) NR
Tetrachloroethylene	>360 (nd) T	>1020 (nd) T	(ID) NR	78 (5.5) I
Toluene	>360 (nd) T	>960 (nd) T	21 (22.1) NR	11 (68.1) NR
Toluene Diisocyanate	>480 (nd) T	>960 (nd) T	>480 (nd) T	222 (1.8) I
1,1,1-Trichloroethane	>360 (nd) T	>900 (nd) T	(ID) NR	41 (76.4) NR
Trichloroethylene	>360 (nd) T	444 (0.24) I	18 (550) NR	8 (283) NR
Vinyl Chloride	>480 (nd) T	264 (0.098) I	(ID) NR	342 (0.14) I
Xylene	>1440 (nd) T	>480 (nd) T	(ID) NR	(ID) NR



Reusable vs Disposable CPC

CPC can be used over and over again or just once and then thrown out. Reusable CPC can be worn throughout many incidents as long as it is decontaminated and tested for re-certification. Disposable (also called limited use) garments are thrown out when the incident is over (in a hazardous waste barrel!). Reusable CPC -- made from materials such as viton, neoprene and butyl -- tends to be more rugged and costly. Limited-use materials are lighter in weight and withstand a broader range of chemicals. They also can be used as an outer covering over a reusable suit in a highly hazardous emergency.

Table 2 (Limited-Use Clothing Permeation Data) gives permeation test results (ASTM 739) for some limited-use materials made by Dupont. The table does not address all the safety issues. Differences in material strength and garment construction, and environmental and physical conditions can affect the degree of protection they provide. For instance, the zipper may be a weak point or the fit of the visor to the material not gas tight. These factors should be considered when selecting chemical protective clothing.

TABLE 2: Limited-Use Clothing Permeation Data

Hazardous Chemical	TYVEK® QC1.25-mil Polycoated	CHEMREL	RESPONDER®
Acetic acid, glacial	7 (3.0)	>180 (nd)	>240 (nd)
Acetone	immediate (7.8)	>480 (nd)	>480 (nd)
Acetonitrile	1 (13)	>480 (nd)	>480 (nd)
Acrylonitrile	5 (<0.01)	>240 (nd)	>180 (nd)
Ammonia, anhydrous	11 (0.12)	>60 (nd)	>480 (nd)
Ammonium hydroxide	immediate (62)	>480 (nd)	nt
Benzene	nt	17 (1.2)	>480 (nd)
1,3 Butadiene	immediate (high)	nt	>480 (nd)
n-Butyl alcohol (1-Butanol)	3 (1.6)	>480 (nd)	>480 (nd)
Carbon disulfide	immediate (high)	5 (360)	>480 (nd)
Carbon tetrachloride	nt	>4 (nd)	>480 (nd)
Chlorine, gas	1 (18)	>480 (nd)	>480 (nd)
Chloroform	immediate (350)	>4 (180)	>480 (nd)
Cresol	37 (0.4)	>120 (nd)	nt
Cyclohexane	nt	>480 (nd)	nt
Dichloromethane	immediate (600)	5 (300)	>480 (nd)
Diethylamine	1 (141)	110 (1200)	>480 (nd)
N, N-Dimethylformamide	45 (1.2)	>480 (nd)	>480 (nd)
1,4 Dioxane	nt	>480 (nd)	nt
Ethyl acetate	immediate (13)	55 (0.12)	>480 (nd)
Ethylene glycol	>480 (nd)	>480 (nd)	>240 (nd)
Ethylene oxide, gas	0.3 (18)	>480 (nd)	>480 (nd)
Formaldehyde, 37%	immediate (0.31)	>480 (nd)	>240 (nd)
n-Hexane	immediate (410)	>480 (nd)	>480 (nd)
Hydrazine	nt	>480 (nd)	>480 (nd)
Hydrochloric acid, 37%	81 (2.8)	>480 (nd)	>240 (nd)
Hydrofluoric acid, 48%	180 (0.08)	>480 (nd)	>180 (nd)

continued on next page

TABLE 2: Limited-Use Clothing Permeation Data (Cont.)

Hazardous Chemical	TYVEK® QC1.25-mil Polycoated	CHEMREL	RESPONDER®
Hydrogen chloride	immediate (high)	>60 (nd)	>480 (nd)
Methanol	1 (2.2)	136 (54)	>480 (nd)
Methyl bromide	nt	>780 (nd)	nt
Methyl chloride	immediate (0.3)	60 (nd)	>480 (nd)
Methyl ethyl ketone	nt	>480 (nd)	>240 (nd)
Mineral spirits	immediate (7.0)	60 (nd)	>480 (nd)
Nitric acid, 90%	nt	>360 (nd)	>180 (nd)
Nitric acid, 70%	345 (1.9)	>480 (nd)	>180 (nd)
Nitrobenzene	immediate (2.4)	>480 (nd)	>480 (nd)
Oleum, 40%	398 (0.2)	>60 (nd)	>480 (nd)
Phosphoric acid, 85%	nt	>480 (nd)	nt
50% PCB 1254, 50% Mineral Oil	nt	>480 (nd)	nt
Sodium hydroxide, 50%	>480 (nd)	>480 (nd)	>480 (nd)
Sulfuric acid, 95%	>480 (nd)	>480 (nd)	>480 (nd)
Sulfuric acid, 16%	>480 (nd)	>480 (nd)	nt
Tetrachlorethylene	1 (410)	26 (60)	>480 (nd)
Tetrahydrofuran	immediate (162)	7 (1200)	>480 (nd)
Toluene	immediate (500)	142 (1.8)	>480 (nd)
1,1,1 Trichloroethane	nt	>360 (nd)	>480 (nd)
Trichloroethylene	nt	>20 (nd)	>240 (nd)
1,2,4-Trichlorobenzene	immediate (8.0)	nt	nt
Xylene	nt	nt	>180 (nd)

LEVELS OF PROTECTION

Now that you have looked at selecting the right materials for the chemicals in question, you have to think about how much protection you will need. Will you need only leggings, boots and gloves or will you wear an enclosed gas tight suit? Will you need a respirator? In general, we break down these issues by ranking four basic levels of protection. Each level corresponds to a CPC ensemble: a collection of respiratory, personal and chemical protective clothing.

LEVEL A	Should be worn where the highest level of respiratory, skin and eye protection is needed.
LEVEL B	Should be worn where the highest level of respiratory, but a lesser degree of skin protection is needed.
LEVEL C	Should be worn when the criteria for air-purifying respirators are met, and some skin protection is needed.
LEVEL D	Should be worn as basic work uniform where there are no skin or respiratory hazards. It provides no respiratory protection and minimal skin protection.



Choosing which level to dress out in is based on the size and nature of the spill and the hazard of the product spilled. Is there much potential for splashes of liquid? Will the work require direct contact with the material? Are the chemicals readily absorbed by the skin? It is a case by case call. If the spill involves a highly corrosive gas, then you would probably opt for Level A. If it was a spill of a corrosive solid that was unlikely to become airborne, then you might be in Level D.

It is important to remember that these levels are guidelines. Other factors must be taken into consideration, such as:

- **Will a chosen level of protection hinder the workers' dexterity and ability to get the job done?**
- **What is the physical environment?**
- **Could safety hazards be created that are greater than the chemical hazard if the preferred level of protection is used?**
- **Each set of CPC should be tailored to the specific situation.**
- **As always, think of environmental/engineering controls to limit potential exposure, before deciding on using and selecting CPC.**

As a situation unfolds, you may find yourself moving up or down a level of protection. The decision to upgrade or downgrade must be made by a qualified person. In general, it is best to start with a higher level of protection and downgrade once conditions allow for that.

Level A Protection

Description

Level A consists of a gas/vapor tight suit with a supplied air respirator. It provides the maximum level of skin and respiratory protection against chemicals. It is designed to prevent contact of skin and body parts with hazardous vapors, liquids and solids.

Conditions that Warrant Level A include:

- High potential for splash or immersion, or potential exposure to gases or vapors that can harm or be absorbed through the skin.
- Potential exposure to unknown vapors, gases, particulates.
- Potential for direct skin and eye contact.
- Potential for exposures above IDLH.
- Effects of substance on skin are unknown.

Level A



Level A is considered necessary for work when little is known about the nature or amount of hazardous material. It is the highest level of CPC and respirator protection against hazardous chemicals. But, it is not without its own hazards: It is difficult to see, maneuver and communicate when wearing this level of protection. Heat stress is also a concern because the suits are air-tight. Therefore, we recommend that only highly trained responders should use this level in the most extreme of circumstances.

Personal Protective Components of Level A

- Light, cotton clothing under CPC
- Positive pressure SCBA
- Hard hat*
- Fully Encapsulating Suit (including boots and gloves)
- 3 sets of Gloves:
 - Inner glove
 - Chemical-resistant glove attached to suit
 - Chemical-resistant outer glove*
(worn over glove attached to suit)
- Chemical-resistant boots with steel toe and shank
(over or under fully encapsulating suit,
depending on suit type and construction)
- Disposable boot covers*
- Disposable Tyvek outer suit*

* *optional, depending on the situation*



Level B Protection

Description

Protective clothing worn with maximum respiratory protection. Level B is designed to minimize or prevent contact of skin and body parts with hazardous substances. It will not prevent skin absorption of gases or vapors nor protect against extensive contact with hazardous materials.

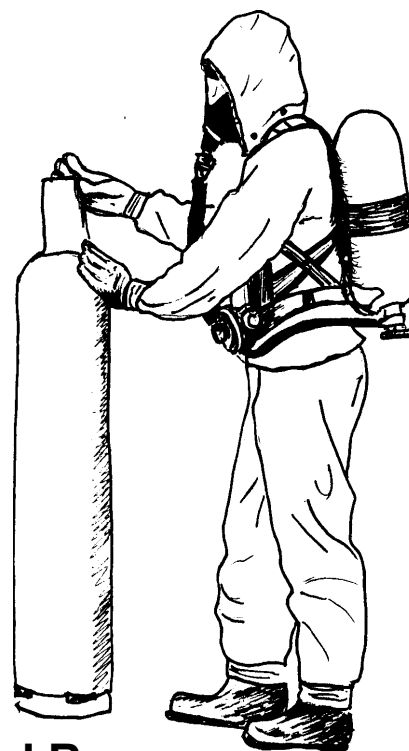
Conditions that Warrant Level B include:

- Limited direct skin and eye contact with hazardous chemicals or air contaminants which will not result in severe damage or irreversible effects.
- Work function involving the potential for only minor splashes.
- Potential exposure to IDLH or oxygen-deficient atmospheres.

Personal Protective Components of Level B

- Light cotton clothing under protective clothing
- Chemical splash suit, may include covering for SCBA. **We strongly recommend that SCBAs be protected and worn inside the ensemble.**
- Positive pressure SCBA
- Hard hat*
- 2 sets of Gloves
 - Inner glove
 - Chemical-resistant outer glove
- Boots, chemical-resistant, steel toe and shank
- Disposable boot covers*
- Chemical-resistant apron*
- Face shield*
- Disposable Tyvek outer suit*

** optional, depending on the situation*



Level B

Level C Protection

Description

This is the same protective clothing as Level B, but is worn with air purifying respirators. It is designed to minimize contact with many hazardous substances.

Conditions that Warrant Level C include:

- Limited direct skin and eye contact with hazardous compounds or air contaminants that will not result in severe damage or irreversible effects.
- Work function involves potential for only minor splashes.
- Conditions appropriate for air-purifying respirator (see Chapter 5).

Personal Protective Components of Level C

- Light cotton clothing under protective clothing
- Chemical splash suit
- Air-purifying respirator
- Hard hat*
- 2 sets of Gloves
 - Inner glove
 - Chemical-resistant outer glove
- Boots, chemical-resistant, steel toe and shank
- Disposable boot covers*
- Chemical-resistant apron*
- Face shield and or splash goggles (if respirator has a half-facepiece)*

* optional, depending on the situation



Level C

Level D Protection

is your basic work uniform.

Since it is not a specific chemical protective ensemble we will not refer to it in any detail.



CPC ITSELF MAY BE HAZARDOUS

There are many problems wearing CPC. These include:

- Hard to communicate
- Hard to see, especially to the sides
- Limited agility and dexterity
- Psychological effects:
 - * claustrophobia
 - * isolation
- Heat stress

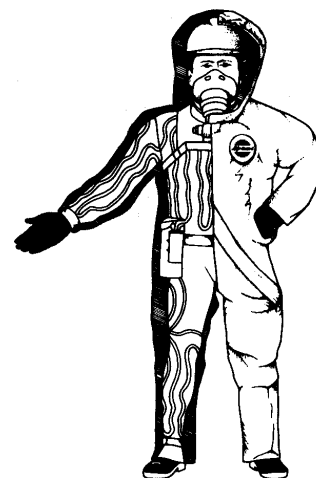
These factors combine to increase the likelihood of slips, trips, and falls which may cause tears in CPC. Responders should do drills wearing CPC to practice working in their ensembles.

These safety problems are made worse when CPC does not fit properly. Oversized or undersized CPC can create serious safety hazards. A range of different sizes should be available for all types of CPC at your workplace. If it doesn't fit, get one that does!

Heat Stress

Since CPC is a barrier to moisture as well as to chemicals, your body's ability to cool down through sweating is severely hampered. This is especially the case when wearing vapor tight suits. Not being able to cool down increases your risk of heat stress. When wearing these suits your vital signs (pulse, blood pressure, temperature) should be checked before and after you don a chemical suit. Adequate rest breaks and fluid replacement (drinking) must be built into the response.

Several ways to cool fully encapsulating suits have been developed including air cooling and ice water cooling. While these cooling suits do exist and are used, they are no substitute for other ways of preventing heat stress. For instance, limiting a worker's time wearing Level A or Level B protection -- by using engineering controls together with the practice of rotating the entry teams in and out more frequently -- may work better than cooling suits in preventing heat stress.



Iced Water
Cooling System

Source of graphic: Cool Guard, by Life Guard, Product Description Brochure, 1996.

PEOPLE WORKING IN CPC SHOULD ALWAYS WORK WITH A BUDDY.

How Heat Affects the Body

The body's internal core temperature must be maintained within a fairly rigid range of 98.6° Fahrenheit \pm 1.5°F. (36.5° Celsius to 38.5° C). To maintain that core temperature, the body strives to strike a balance between the amount of heat produced internally and the amount of heat lost to (or gained from) the outside environment. This is done largely through sweat. As sweat evaporates, it takes heat with it. Work harder and the body will sweat more. The internal core temperature stays within safe ranges as long as this heat/cooling mechanism functions properly.



Your heat exchange mechanism can be altered dramatically if it is very hot or humid, or if you work near a furnace, or wear chemical protective clothing. When that happens you can get very sick.

There are several types of heat disorders. Most are not life-threatening, but one — heat stroke — is very dangerous and occurs when the body's core temperature rises. Although there is no precise information on the incidence of occupational heat disorders, some records have been kept. In California in 1973 there were 422 cases of lost work time illness because of "heat and humidity." Of these, 47 workers were hospitalized and 3 died.

Heat Fatigue is marked by decreased alertness, lack of coordination and slower reactions. The condition itself does not pose a serious health threat but it can cause accidents. To prevent heat fatigue, schedule frequent work breaks and drink plenty of water.

Heat Cramps are painful cramps in the legs, arms or stomach muscles. It is the same problem that athletes suffer from during a game. Cramps occur because salt is lost during hard physical work in high heat. Cramps may occur later, after work. The key is to replace the salt lost through sweating. Once it was common to take salt tablets, but that practice now is discouraged. Usually a normally salted diet will help. If not, lightly salted fluids can help.

Heat Exhaustion occurs when more fluid is lost than is taken in. A person working hard in a hot environment can easily lose a quart of sweat in an hour. The signs of heat exhaustion are heavy sweating, weakness, nausea, headache and skin which is moist, pale and clammy. Remove the person to a cool place, give fluids, and rest. During hot heavy work, it is also important to keep taking fluids periodically, even if you do not feel thirsty.



Heat Syncope (fainting from heat) is characterized by dizziness or even fainting while standing in a hot environment. It is not a serious disorder though it can be scary. Remove the person to a cooler place and have them rest.

Heat Stroke is a major medical emergency. It results from the breakdown of the body's heat/cooling mechanism: the body can no longer rid itself of excess heat. Sweating stops completely. Skin will be hot, dry and spotted red; the person will be confused, may go into convulsions and lose consciousness. Core temperatures will climb dangerously above safe levels (a temperature above 42° C, or 108°F, for more than a few hours is usually fatal). If not fatal, heat stroke can damage the brain, liver and kidneys, and immediate hospitalization is called for. Remove outer clothing, sponge with cool water and fan vigorously until ambulance arrives.

Preventing these problems before they occur is the main treatment for heat disorders.

Controlling Heat on the Job

There is no OSHA standard for heat. However, there are some voluntary standards recommended by agencies like the National Institute for Occupational Safety and Health and the American Conference of Governmental Industrial Hygienists. Some unions have won contract language setting work loads and limits and some agencies like the U. S. Navy adhere to certain standards.

The key recommendations are:

- Cool drinking water or electrolyte drink such as gatorade should be available.
- Additional heat breaks should be provided to anyone showing signs of heat related strain or fatigue. This is especially important for new employees or workers just back from a vacation, illness or layoff, who are not yet used to the hot environment.
- Workers should have time to acclimatize themselves to heavy, hot work.
- Dedicated first aid training on heat disorders should be a priority in every hot work area or for every work crew.
- Excess heat from machinery should be shielded from the worker; the machinery should be isolated, enclosed or insulated.
- General ventilation and spot cooling through local exhaust ventilation at points of high heat can be useful.

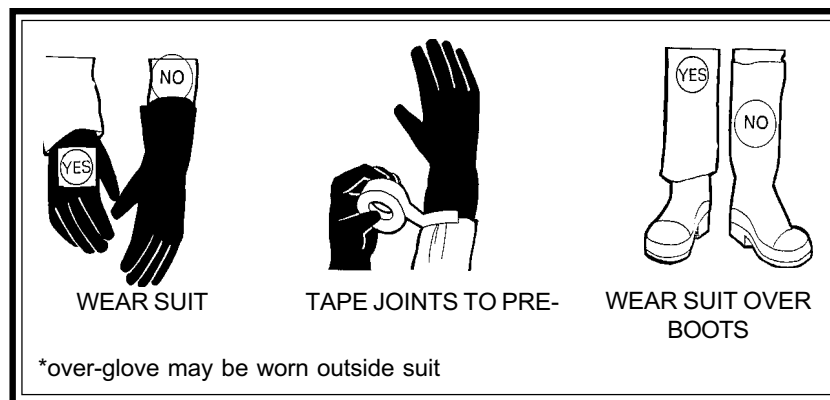
WEARING CPC

Inspect It First

Chemical protective suits should be inspected before each use to ensure that they are in good working condition. Check for defective or damaged seams and zippers. Inspect the suit material to ensure that it was not damaged in storage or during shipment. A garment should not be worn if it has any rips or tears, discoloration, cracking or blistering of protective layers. Imperfections in gloves and outer boots (chicken boots) can be detected by trapping air inside and searching for leaks. Vapor-protective suits should be pressure tested according to the manufacturer's recommendations. If the CPC has a shelf life, make sure it has not gone beyond it. Check the technical manual that comes with the suit.

Wear It Right !

Make sure that you wear your CPC correctly. You also should make sure that all the components of your ensemble are compatible with each other and fit properly. Whether the gloves gauntlet is worn under or over the chemical protective suit sleeves depends on whether the wearer is working with their hands overhead or below the shoulders.



Source of graphic: Pesticide Safety for Non-certified Mixers, Loaders, and Applicators, EPA, 1986.

What about Tape?

Many workers tape the openings in splash suits, including the collar, sleeves, waist, and pant cuffs, as well as at zippers and openings between gloves and boots and their suit. **Duct tape, though, is permeable to some chemicals. No amount of duct tape around these openings will stop these chemicals from penetrating that particular area.** At best, taping may slow down entry of toxins into the suit by holding the two parts of the suit together. If you feel tape is needed, then call the suit manufacturer for their directions as to what tape to use and how it is to be applied. Get the information in writing. Your life or others' lives could depend on it.

TNEC, as well as many other health and safety organizations recommends the use of non-latex gloves due to the allergenic properties of latex.



!! REMEMBER !!

- CPC performs differently for different chemicals.
- Combine work practices and other controls; don't rely just on CPC.
- Check permeation data for all CPC materials and for all chemicals.
- Check the physical performance of CPC. Poorly designed seams and zippers may allow significant exposures even if the material resists permeation. CPC that easily rips or tears may be of limited value.
- Avoid exposure if possible even when wearing CPC. No CPC provides absolute protection.
- **MAKE SURE IT FITS!** Poorly fitted CPC is a safety hazard.
- Match the CPC to the job. Too much or too little CPC may put you at risk.

PERSONAL PROTECTIVE EQUIPMENT (PPE) PROGRAM

OSHA requires employers to have written standard operating procedures for the use of any PPE, including CPC. This written program should include procedures for:

- Training in wearing CPC.
- Explaining the use and limitations of CPC.
- Selection of CPC according to hazards.
- Work duration in CPC.
- Donning and doffing procedures.
- Decontamination and disposal procedures.
- Inspection prior to, during and after use.
- Evaluation of the effectiveness of the CPC program.
- Medical considerations such as heat stress.
- Review of program annually or after an incident.



* Source of graphic: [Entrenamiento Sobre Salud y Seguridad Para Los Trabajadores de Desperdicos Peligrosos](#), Occupational Health Program, University of California, Berkeley, 1991.



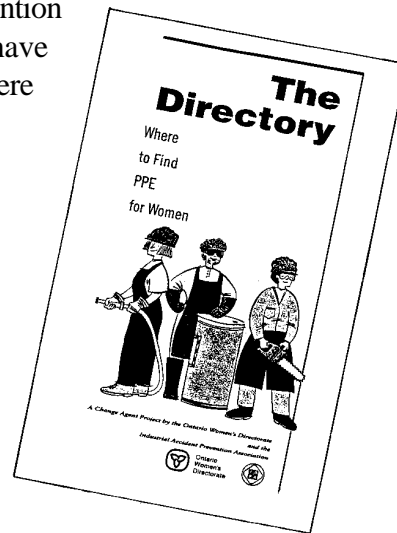
WHERE TO FIND PPE FOR WOMEN

The limited availability of personal protective equipment (PPE) for women is a critical workplace health and safety issue. It undermines efforts to protect worker health and safety and presents a barrier to equality of employment opportunity for women. Ill-fitting protective clothing and equipment can also mean that women entering certain 'nontraditional' fields will be unable to efficiently and safely perform the tasks of the job.

To address these issues, the Industrial Accident Prevention Association and the Ontario Women's Directorate have jointly developed a publication, "The Directory: Where to Find PPE for Women." The document is divided into two main sections.

The first part looks at PPE from a variety of angles:

- How women have been coping with the lack of adequate PPE;
- What they and others have to say about possible improvements;
- What is being done;
- Who is responsible for protection; and
- What motivates manufacturers and suppliers.



The second part is a directory that lists some manufacturers and suppliers who are able to meet the PPE needs of women workers.

Who is this publication for? Not only users, but also employers, unions, workplace health and safety organizations, and manufacturers and suppliers are part of the diverse audience this publication aims to reach.

Available FREE from:

**Consultive Services Branch
Ontario Women's Directorate
2 Carlton Street - 12th Floor
Toronto, Ontario M5B2M9 Canada
Tel: 416-314-0300**

Activity 6:

Evaluating CPC

Purpose: The aim of this activity is to have you look at the selection and use of CPC. Each group will work on the chemicals you have already reviewed.

Task: You have already filled out some sections of a spill chart. Now you will need to ask what types of CPC are appropriate for the chemicals you have. Please fill in the appropriate section on the chemical release chart, shown on the last page of this chapter.

1. Using the clothing and glove permeation tables, decide which type of CPC is best suited for your chemicals.

2. What are the physical characteristics of these materials? Do you think they will hold up?

3. Next to each chemical listed below are readings found by using the correct air monitoring equipment. What level of protection do you need - A, B, or C? Keep in mind that these readings must be compared to each chemical's exposure limit(s).

Ammonia gas, 35 ppm

Sulfuric acid, 6 mg/m³

Styrene, 600 ppm

Nickel, 5 mg/m³

Methylene chloride, 750 ppm



Activity 6: (continued)

4. An ER PLAN requires the following PPE for a liquid ammonia spill of 2 gallons:
- a full-faced air purifying respirator with an organic vapor cartridge.
 - a one piece polycoated tyvek splash suit.
 - chemical resistant boots.
 - a silver shield inner glove.
 - 11 mil nitrile outer gloves.

Do you agree with this?

Using the chemical release chart

"Please enter the appropriate CPC information on your chemical in the following section of your chemical release chart"

Protective Equipment	
Respirator:	
Type of filters (if needed)	
Suit: level and material	
Boots:	
Eye/Face:	
Gloves, outer: material:	Gloves, inner material:



SUMMARY SHEET

CHAPTER 4 : CHEMICAL PROTECTING CLOTHING

- ✓ CPC is chemical-resistant at best, not impermeable.
- ✓ No amount of duct tape will provide the seal necessary for protection from certain substances.
- ✓ Many different types of CPC are available, but they may not be available to you because of lack of resources to get the equipment. Don't let this stop you from requesting it and documenting that request.
- ✓ Heat stress may be a problem in Levels A, B, and C. Be aware of the signs and symptoms. Take rest breaks and record any health problems on the occupational work history form.
- ✓ The wearing of CPC can be mentally and physically exhausting. Psychological effects of stress, claustrophobia or isolation may occur. Know your limits.
- ✓ Use the buddy system; you should not go it alone when wearing CPC.

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OBJECTIVES

In this chapter students will learn about the role of testing the air during a response and the health and safety issues surrounding air monitoring techniques. They also will be introduced to a number of monitoring instruments. Students will learn how to use the equipment and limitations of the equipment will also be discussed.

The goals of this chapter are to ensure that students understand:

- The role testing plays in emergencies.
- The various types of air-monitoring equipment.
- The use and limitations of air monitoring equipment.
- The need for proper training in selection, use and care of air monitoring equipment.
- The importance of having a clear air monitoring plan in ER situations.

On completion of this chapter students will be able to:

- List two reasons why testing is important.
- List three things that could interfere with testing.
- List three units used for measuring air contaminant concentrations.
- Identify two instruments commonly used for detecting organic vapors during an emergency response.
- Identify whether or not an instrument is "intrinsically safe".
- Give two reasons why testing is a key component of an emergency response action plan.

TESTING THE AIR

In any emergency it is crucial to know the condition of the atmosphere. You will want to know if there is a danger of fire or explosion. You will also want to know whether there are toxic levels of gases or vapors in the air as a result of the spill/leak. You may want to make sure that there is sufficient oxygen or check if there is too much. And certainly you will be concerned about the concentrations of a spill/leak reaching levels that may injure anyone.

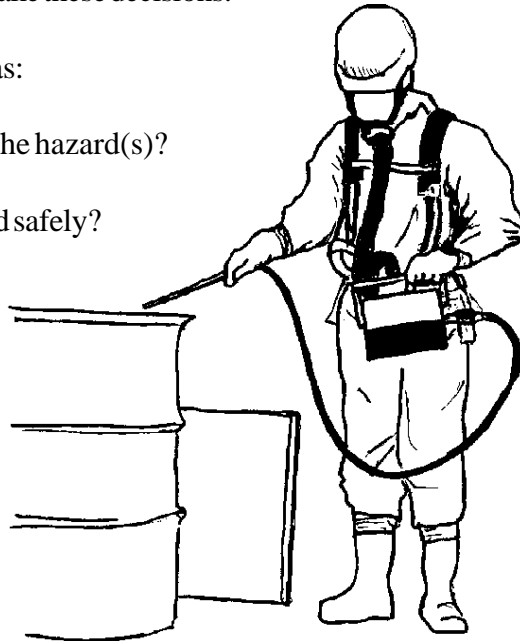
Air monitoring instruments help you determine the extent of the hazard and the risks involved. It is important to know the strengths and weaknesses of these tools.

Testing as Part of an Emergency Response Plan

You need to know how much spilled material is in the environment to make important decisions. The most important decision is whether you are capable of responding in the first place. Other issues -- which we have already covered -- are what type of respirator and how much protective clothing you will use. You will also want to know when you have succeeded in controlling the situation. Testing the atmosphere with air monitoring equipment will help you to make these decisions.

The ER plan must deal with issues such as:

- How do we measure the extent of the hazard(s)?
- What instruments do we use?
- How do we use them effectively and safely?
- What do the results mean?





MEASURING AIR CONCENTRATIONS

The units below are the common units of measurement used to describe air contaminant concentrations.

Parts per million (ppm) is a measure of the volume of gas or vapor contaminant in a volume of air: 50 ppm xylene means that there are 50 molecules of xylene in every million molecules of air. (This is like mixing 1 quart of juice into a swimming pool 5 feet deep, 10 feet wide, and 13 feet long filled with 14,000 gallons of water!)

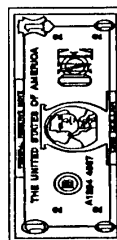
Percent is the same concept as parts per million. It means parts per hundred: a concentration of 5% xylene means that there are 5 molecules of xylene in every 100 molecules of air (5 out of 100 are xylene).

1 percent = 10,000 parts per million

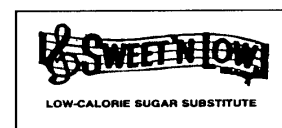
Milligrams per cubic meter (mg/m³) is a measure of the weight of a contaminant in a volume of air: 0.05 mg/m³ of lead means that there is 0.05 mg of lead for every cubic meter of air. This unit of measure commonly is used for solids and particulates, but can be used for gases and vapors.

MEASURING WEIGHT

1 gram (g) =



Weight of a
dollar bill

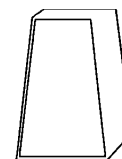


Weight of 1 packet
of Sweet & Low®

1 thousand milligrams (mg) = 1 gram

1 million micrograms (µg) = 1 gram

454 grams =



1 pound

What Do You Want to Know?

In the great majority of cases you will have a reasonably clear idea of the chemical(s) with which you are dealing. Reports from witnesses, labels and markings, knowledge from personnel in the immediate area and information from prior planning and drills will usually give you a good handle on the identity of a spilled product.

What you need to know, then, is-- How much has spilled and under what circumstances?

First, you'll need to answer these questions:

- **Is it a flammable\explosive situation?**
- **Is it an oxygen-deficient atmosphere?**
- **Are there high concentrations of toxic chemicals?**
- **Could the conditions change during the response?**
- **What are the chemicals present?**

You'll need some testing instruments to answer these questions.

During the response, you will want to continue asking questions to determine if the situation is under control. Say you have decided to allow a leaking solvent drum to sit and evaporate. How will you know when the solvent has disappeared so people can get back to work?

Or perhaps you have shut off valves to stop a gas leak. How will you know when the gas has dispersed sufficiently in the air?

Or you have suited up and are wearing the usual respirator that production workers in the area wear. How do you know that the respirator is the right one for an emergency?

In each case you will use monitoring equipment to get the answers you need.





WHAT INSTRUMENTS SHOULD I USE?

Two big problems often arise with air monitoring equipment. One is that people buy an instrument that looks great on paper but is not very good in the field because it is hard to use or very fragile. It is important to buy instruments that are reasonably easy to use and can take a beating.

Another major problem is that firms buy equipment but neither practice using nor maintaining it. Then when it comes time to use it in an emergency, the battery is dead or a sensor is defunct or no one remembers how it works!

Any instrument needs to be maintained and tested. ER personnel must practice using the equipment.

We will not go into all facets of selecting air monitoring equipment. But it is important when choosing equipment to get items that are relevant to the hazards in your work place, reasonably easy to use, and reliable. This, unfortunately, is not easy. Choosing equipment will require some technical aid. Each state has a local OSHA consultation program. Some areas have a COSH group, local occupational health programs, or a local OSHA office. If you are in a union, many have health and safety departments. Don't be bashful in taking your case to them and asking for input.

Let's return to the three big questions about environmental conditions in an emergency:

1. Is there a flammable/explosive situation?
2. Is there an oxygen hazard (too little or too much)?
3. Are there high concentrations of toxic chemicals?



1. Detecting Flammable/Explosive Atmospheres

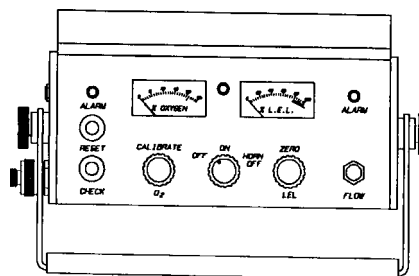
Combustible Gas Indicators

Combustible gas indicators (CGIs) are used to detect flammable atmospheres. They will detect any flammable substance and give readings in percent of the Lower Explosive Limit (LEL). When concentrations reach the LEL, it will read 100%. At concentrations lower than the LEL it may read 10%, 20%, 30%. The meter may give readings on a needle scale (analog) or read out as numbers (digital). Most CGIs have an audio and/or a visual alarm that can be set by the operator. It is important to set the alarm rate at an action level at 10% or less.

Action levels are set well below the LEL to compensate for any margin of error.

Flammable vapors may read low in one location but may be much higher in nearby areas which haven't yet been tested.

Moreover, most CGIs respond differently to different flammables. They are most accurate when used to test for the gas for which they have been calibrated. Some don't operate very well if oxygen levels are below 10%. As a result, the actual percent of the LEL may be more than two times higher than what the instrument says.



Source of graphic: PhotoVac International, product information.

Because the meter is not foolproof and because the atmosphere may change we usually choose an action level of 10% for flammables. That is, 10% of the LEL. For example, for ammonia we set the meter to alarm at 10% of ammonia's LEL. Ammonia's LEL is 15% in air. So, the action level would be 1.5%, or $10\% \times 15\% = 1.5\%$. OSHA sets an action level of 10% of the LEL.

CGIs have the following advantages and disadvantages:

Advantages:

- General purpose detector for most combustible hydrocarbons.
- Accurate over most of its range.
- Indicates **total** combustibles present (and is not specific to one chemical).
- Relatively unaffected by temperature and humidity changes.

**Disadvantages:**

- Nonspecific.
- Requires oxygen (air) for operation.
- Not recommended for chlorinated hydrocarbons or tetraethyl lead containing compounds.





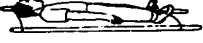
When concentrations are between the LEL and the UEL you are within the flammable range. When the concentration is **above the UEL**, a CGI will either lock at 100% or quickly return to zero. Both situations are dangerous, and if you haven't been paying close attention to the meter you could be in trouble. Even if it says zero but the operator hasn't been watching, it may mean that it has gone over the upper limit, pegged. If you move above the UEL you can quickly drop right back down into the flammable range, especially if any ventilation of the space involved is attempted. This is why it is important to listen for the alarms and watch the meters.

Other gases can affect the instrument. Some solvents or acid gases at high concentrations can make the meter misread combustibles. An operator must be aware of these possibilities. In short, individuals operating these instruments must be thoroughly familiar with their instrument's use, calibration and limitations.

2. Detecting Oxygen Levels

An **oxygen meter** is used to measure the concentration of oxygen in the air. Most read in percent. The range is from 1-25%. Oxygen meters are usually combined with a CGI in a combination meter or in a multigas model. This allows the user to measure oxygen levels and LEL simultaneously, and to determine whether there is enough oxygen for the CGI to operate.

Any atmosphere with oxygen levels below 19.5% should be considered **oxygen deficient**. Your oxygen meter should be set to alarm at this value. An **oxygen-enriched** atmosphere means that things will burn more completely. In such a situation the excess oxygen will tend to cling to your hair and clothing. If a fire were to occur, your hair and clothing would burn violently. Your oxygen meter should be set to alarm at a concentration of 23.5% oxygen. When an alarm sounds, leave the work area immediately. Oxygen meters use a sensor which can be affected by temperature and pressure, and even some common chemicals like carbon dioxide.

Effects of Reduced Oxygen		
Amount of Oxygen		Results
21%	→ 	You breathe this normally
19.5%	→ 	Minimum for safe entry
16%	→ 	Dizzy and confused
14%	→ 	Difficult breathing May lose consciousness
6%	→ 	Breathing Stops

Source of Graphic: Confined Spaces, AFSCME, 1995.

3. Surveying for Gases and Vapors

If you are concerned about one gas - such as chlorine, carbon monoxide, or hydrogen sulfide - then you can use a gas monitor that is calibrated to, and measures only that one chemical.

Photoionization Detectors

Photoionization Detectors (PID) are commonly used on hazardous waste sites to survey for gases and vapors. They can also be used in emergency response situations to quickly assess general levels of toxic gases and vapors. PIDs will not determine the identity or concentration of specific chemicals. By using an ultraviolet light to ionize the sample, the PID can be used to determine the total concentration of detectable contaminants. This information will help determine appropriate controls and action levels. The PID will detect many, but not all, gases and vapors. It will detect any chemical that has an ionization potential less than the energy produced by the light in the probe. The meter usually reads in the 0-3,000 ppm range, but some models will saturate at about 500 ppm. Some newer PID's read up to 10,000 ppm.

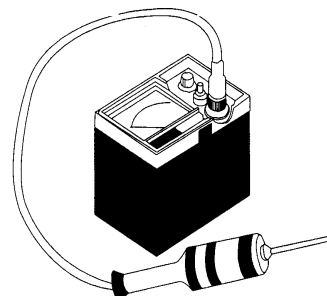


Advantages of Photoionization Detectors:

- Good general purpose detector.
- Durable and reliable.
- Wide common use.

Disadvantages of Photoionization Detectors:

- Nonspecific.
- Response varies with contaminant.
- Affected by humidity and temperature.
- Does not detect methane.



*Source of graphic: Entrenamiento Sobre Salud y Seguridad Para Los Trabajadores Desperdicios Peligrosos, Unversidad de California en Berkeley, December, 1991.

Flame Ionization Detector

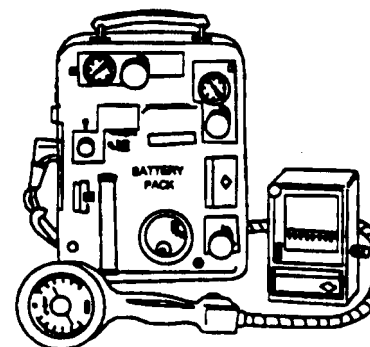
The **flame ionization detector (FID)** can also be used for surveying purposes. This instrument uses a hydrogen flame to ionize the sample. It will detect any flammable organic compound. The FID has a similar range as the PID but will not detect any inorganic gases or vapors. The FID will detect most hydrocarbons such as methane that a PID will not.

Advantages of Flame Ionization Detectors:

- General purpose detector for most combustible hydrocarbons;
- Accurate over entire range;
- Indicates total combustibles present; and
- Relatively unaffected by temperature and humidity.

Disadvantages of Flame Ionization Detectors:

- Nonspecific;
- Requires oxygen for operation; and
- Not recommended for chlorinated solvents.



Colorimetric or Detector Tubes

Colorimetric or detector tubes are commonly used to measure specific chemicals in the air. To use a detector tube, you must know what chemical is in the air. You need to match the tube to the chemical. If you want to test for carbon monoxide, you must use the carbon monoxide tube. A new tube is inserted into a pump. The pump pulls a specific amount of air through the tube and the amount of chemical is indicated on the tube. A color change or a stain in the detector tube is caused by a reaction between the sampled chemical and special chemicals in the tube. The length of the stain is read on a scale which is etched on the tube. An instruction sheet comes in the tube box. This will explain how to operate the device: how many pumps, for how long. You can't interchange tubes from one manufacturer's device to another. The tubes, the pump, and the instruction sheet all have to be for the same device.

Advantages:

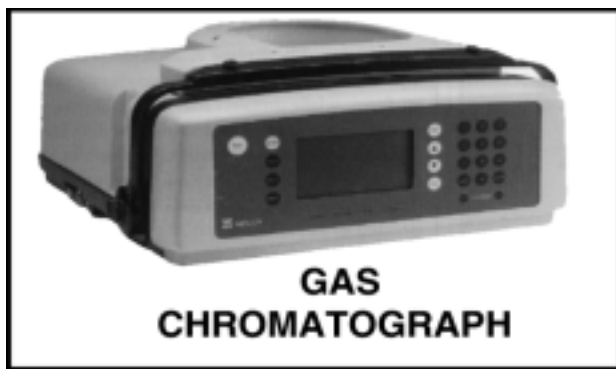
- Immediate results.
- Inexpensive.
- Easy to use.

Disadvantages:

- Accuracy off by 25-35% or more
- Interference by other chemicals
- Need to have appropriate tube
- Tubes expire after a certain amount of time
- Accuracy compromised by extreme heat/cold

Portable Gas Chromatograph

A fairly recent development in air testing equipment is the **portable gas chromatograph**. Like the detector tubes, this instrument measures concentrations of



* Source of graphic: GasTech , GT Series Gas Monitor, Operations Manual.



specific chemicals. The portable GC has the advantage that it sometimes can be used to determine the identity of some chemicals. A sample of air is fed into the instrument. Each chemical passes through the instrument at a different speed so that each will reach the detector at a different time. The instrument prints out a chart which can be used to determine what chemicals are present and their concentrations. This instrument is more accurate than colorimetric tubes but requires very extensive and specialized training. It is also very expensive.

Other Gas Monitors

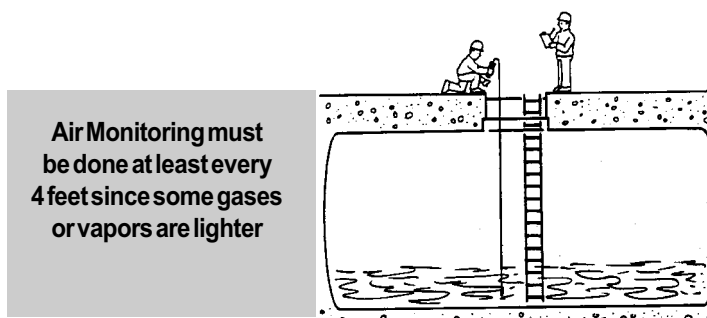
There are also **multigas monitors**. They read oxygen levels, flammables and one or more toxics. A common type will read oxygen, carbon monoxide, hydrogen sulfide and %LEL. It combines an oxygen meter with a combustible gas meter and a gas monitor. Some require you to select a gas by using a switch or a pad: Others permit you to read all four gases at the same time with the data stored and printed out.



Four- Gas Monitor

HOW DO I TEST?

To use any detection instruments effectively you need to know something about how the chemical may behave. Think about the chemical's physical characteristics. Does it have a high or low vapor pressure? If high, then expect lots of product to be in the air of the space. Is it heavier or lighter than air? If heavier, then you should look for it in low lying areas. Some spaces are so poorly ventilated that different gases and vapors will be in different parts of the space, like layers in a layer cake. When this happens chemicals with a higher vapor density will tend to sink toward the bottom. You will need to test at different levels in the space.



Often you need to probe the situation before sending anyone into it. Would you want to be in a flammable or oxygen deficient atmosphere to test it? No! How then do you test the air? Some instruments allow you to do this. A long hose or probe is attached to the instrument and air is drawn in by means of a pump; you and the instrument do not have to be in the space. When using the probe you need to wait for several minutes because it takes the instrument longer to get a reading. Some instruments require a separate pump to be attached for remote sampling.

As an emergency response team member, think about ways to monitor without jeopardizing the health of those taking the measurements.

For extremely hazardous chemicals, like chlorine, there are in-place detection devices that can be located near a process. These are set to alarm when certain levels are sensed. Some colorimetric tubes will have to sit for two minutes to give you a reading. Why wait in the area with the highest concentrations? Instead of having someone stand there for two minutes waiting, leave the pump and move away; then, when the two minutes are up, go back and read the tube.

Practice!

Practice with an instrument helps you gain confidence in using it. You also learn to anticipate problems with the instrument and you learn how the instrument works. You learn how to factor in things that might interfere with its accuracy. You figure out how to test for chemicals in situations you are concerned with. Don't use it without having it tested and maintained by the manufacturer!

COMPARED TO WHAT? EVALUATING YOUR READING

Once you have some readings, what do they mean? Your Emergency Response plan should designate action levels based upon air monitoring results. An action level specifies the action to be taken at a specific concentration. Actions that may be required are:

- immediate evacuation
- a change in protective clothing
- initiate engineering controls
- continue clean-up



We have already noted some important action levels:

- Flammable danger: 10% of a chemical is LEL → evacuate
- Lack of Oxygen: less than 19.5%. → evacuate
- High oxygen: greater than 23.5%. → evacuate

What about other hazards? In order to assess toxic hazards, we need to refer to a chemical's exposure limits: permissible exposure limits, short-term exposure limits, ceiling, and IDLH. (see Chapter 3 for a description of these exposure limits)

Such limits will be crucial in making an assessment of the risks, and in deciding whether a situation is under control.

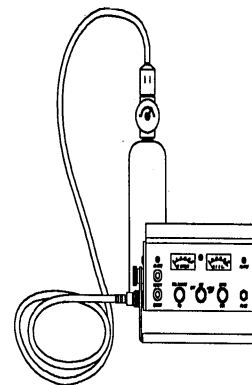
Data from personal sampling of workers and work areas can be helpful as a background level. **Personalsampling** is the collecting of the sample at the breathing zone of the worker. Sampling devices also may be placed at certain locations to perform **area sampling**. Samples are then sent off to a laboratory for analysis. Personal and area sampling are done to ensure that production workers are not overexposed to a particular chemical. By comparing these "background" levels to the levels during an emergency, you can get a sense of how much material was released or spilled.

MAKE SURE YOUR EQUIPMENT IS WORKING

You don't want sampling tubes that have expired. You don't want a gas meter to have a low battery. You don't want the sensor in your oxygen meter to fail. To make sure these things don't happen, periodically check your equipment and practice using it.

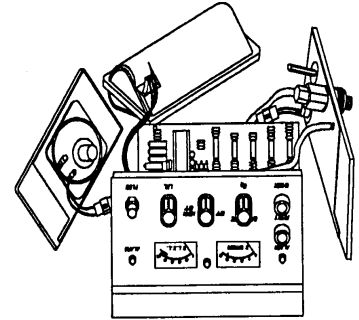
Calibration

Instruments need to be calibrated before and after each use and possibly at other times, preferably by an experienced technician. The manuals that come with the instrument will tell you how. Records should be maintained and included in the ER plan.



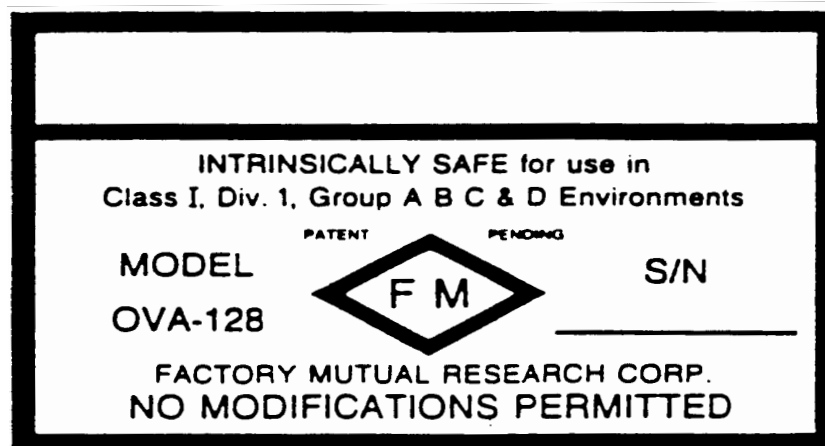
Maintenance

Instruments also need to be carefully maintained. This includes recharging and replacing batteries, cleaning lamps and detection surfaces, replacing sensors and making sure you have the correct detection tubes and that they haven't expired. Maintenance records must be kept on file. Instruments should be stored in a safe, temperature-controlled place where workers can get at them if needed.



Intrinsic Safety

When working in areas which may contain a flammable atmosphere you don't want your instrument to become an ignition source. For that situation you should use only instruments which have been certified to be **intrinsically safe** by a recognized testing laboratory, such as Factory Mutual Research Corp. (FM) or Underwriters Laboratory, Inc. (UL). An intrinsically safe instrument is one that will not become an ignition source when used in a flammable atmosphere. Certification should appear somewhere on the instrument. The correct certification is for Class I, Division 1, Groups A,B,C, and D Environments. Most CGIs will be intrinsically safe, but make sure.





Activity 7:

TESTING THE AIR

Purpose: To become familiar with the operation, use and limitations of air monitoring equipment.

Task: Each group will go to each station with equipment to work with. Once you have finished you will go on to the next station, then return to your tables and review the questions.

STATION 1 - COMBUSTIBLE GAS INDICATOR/OXYGEN METER (CGI/O₂)

Look at the instrument. Review how it operates. Come to an agreement within your group about the following information.

	CGI	Oxygen Meter
What it measures	_____	_____
Units	_____	_____
Range	_____	_____
Intrinsic safety	_____	_____

Using the instructions at the table, check out the instrument and get it ready for monitoring. Take a measurement of oxygen and percent of LEL from the bags at the station. Record your readings below.

Continued on the next page

Activity 7: (continued)

	Sample 1	Sample 2
Oxygen	_____	_____
% of LEL	_____	_____

STATION 2: USING THE FOUR-GAS MONITOR

Look at four-gas monitor and review how it works. As a group, fill in the information for three gases in the following table.

	Gases Measured		
	Flammability	Oxygen	CO
Units	_____	_____	_____
Range	_____	_____	_____
Intrinsic Safety	_____	_____	_____

Using the instructions at the table, check out the instrument and get it ready for monitoring. Take a measurement of oxygen and percent of LEL from the bags at the station. Record your readings below.

	Sample 1	Sample 2
% of LEL	_____	_____
Oxygen	_____	_____
Carbon Monoxide	_____	_____

continued on next page



Activity 7: (continued)

STATION 3: PHOTOIONIZATION DETECTOR

Look at the instrument. Come to an agreement within your group about the following information.

What it measures

Units

Range

Intrinsic safety

Using the instructions at the table, check out the instrument and get it ready for monitoring. Take a measurement from each of the bags at the station. Use a hose to connect the instrument to the bag. Record your readings below.

Bag 1: Toluene _____

Bag 2: Pentane _____

When you have taken your measurements answer the following question.

1. Did the instrument accurately measure the concentrations in the bag?

Continued on the next page

Activity 7: **(continued)**

2. Look up the ionization potential of pentane. Why is this information important?

3. Would you use this to measure percent of the LEL of a combustible atmosphere?
Explain.

4. How might you use this instrument on a hazardous waste site?



Activity 7: (continued)

STATION 4: USING COLORIMETRIC TUBES

Look at the two colorimetric tubes and their instruction sheets and fill in the information in the table below. Take your measurements after you have completed the table. Follow the instructions at the station.

COLORIMETRIC TUBE INFORMATION

INFORMATION	DRAEGER	SENSIDYNE
Chemical	_____	_____
Range of Tube/Units	_____	_____
Number of Pumps	_____	_____
Time per Pump	_____	_____
Color Change	_____	_____

MEASUREMENT

Draeger _____ Sensidyne _____

When you have taken your measurements, return to your table and work on the following.

This part of the activity involves thinking about the uses and limitations of the monitoring equipment. Once again, this is a team approach and you should use the manual.

Activity 7: (continued)

SECTION 1 (Everybody answers)

• When we measure for a chemical in the air we want to compare what we get with exposure limits. Using the NIOSH pocket guide and any MSDS, find the exposure limits for the chemicals we have used in this activity and for a chemical that you work with. Find the following limits for each chemical:

- LEL
- IDLH
- STEL
- Ceiling limits

Compare the LEL to the other exposure limits. To compare, multiply the LEL % by 10,000 to get ppm (for instance, a 3.6% LEL = 3,600 ppm).

Enter information you find valuable on the spill charts.

Answer Section 2 or Section 3

SECTION 2

- How accurate do you think the CGI/O₂ measurements are?
- Could you work in the atmospheres that you measured?
- Would you measure oxygen or flammables (percent LEL) first? Why?
- Where are you likely to find flammable or oxygen deficient atmospheres in facilities where you work?
- What are some of the problems you have with using colorimetric tubes?

Continued on the next page



Activity 7: (continued)

SECTION 3

- A technician reports finding a two gallon spill of nitric acid on the lab floor first thing in the morning. Three people have differing opinions on how to monitor the situation:
 - Person A wants to take colorimetric tubes;
 - Person B wants to use an oxygen/gas meter; and
 - Person C wants to use pH paper.

Who would you side with?

Using the Chemical Release Chart

Please enter the appropriate monitoring information on your chemical in the following section of your chemical release chart.

Chemical Release Chart

Product:		Date Prepared:		Reviewed:	
Location(s)		Quantity:		Container Size(s)	
Hazards					
Flash Point:		LEL:		UEL:	
Vapor Density:		Vapor Pressure:		Specific Gravity:	
PEL:			IDLH:		
Reacts with:					
Corrosive:		YES		NO	
Routes of entry into the body:					
Acute & chronic health effects:					
Protective Equipment					
Respirator:					
Type of filters (if needed)					
Suit: level and material					
Boots:					
Eye/Face:					
Gloves, outer: material:			Gloves, inter material:		
Spill Response Equipment					
Air Monitoring:					
Personnel Monitoring:					
Soil & Water Sampling:					
Absorbents:					
Decontaminates:					
Other Equipment:					



SUMMARY SHEET

CHAPTER 7 : MEASURING HAZARDS IN EMERGENCIES

- ✓ An emergency monitoring plan should be part of every ER Health and Safety Plan.
- ✓ A Combustible Gas Indicator (CGI) should be used in situations where there may be flammable vapors in the air. It reads out in % LEL. Remember, if the instrument reads over the UEL this does not mean it is safe to enter the environment.
- ✓ An oxygen meter should be used to check an unknown atmosphere. You should be wearing an air-supplying respirator.
- ✓ A PhotoIonization Detector (PID) should be used as a general purpose detector of organic and inorganic chemicals. Whether a chemical is detected depends only on the Ionization Potential of that substance.
- ✓ Colorimetric tubes should be used for the detection of one specific chemical. Interference can occur if you have more than one contaminant in the air. It has poor accuracy, but is a good screening device to verify the presence of known or suspected contaminants.
- ✓ There should be "intrinsically safe" certification on equipment used in flammable/explosive atmospheres.

References

Air Sampling Instruments for Evaluation of Atmospheric Contaminants, American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

Manual of Recommended Practice for Combustible Gas Indicators and Portable, Direct reading Hydrocarbon Detectors, American Industrial Hygiene Association, Akron, OH.

Martin, W.F. and Lavine S.P., Protecting Personnel At Hazardous Waste Sites, second edition, Butterworth-Heinemann, 1994.



OBJECTIVES

In this chapter we will look at some common methods to contain and control spills. There are many issues involved besides stopping the release. You need to consider, for instance, whether there are any people around, or whether the ventilation system is spreading vapors through the plant. In this chapter you will learn about the health and safety hazards associated with spill response procedures, and you will learn how to plan for an incident.

The goals of this chapter are to ensure that students understand:

- How to plan for spill control.
- Techniques for controlling, containing and cleaning up spills.
- How to outline a spill response approach to products in your facility.
- How to know when a spill is beyond your capacity.

On completion of this chapter, students will be able to:

- Describe five types of equipment and/or materials which should be available for spill control.
- Describe what steps you should take when responding to a spill.
- Describe an effective planning and drilling procedure for spills.
- Describe what can be done when a spill is beyond your capacity.

PLANNING FOR SPILL CONTROL

An effective and safe spill response depends upon the first step of planning: a serious “audit” of hazardous substances in the facility. A drill based on the audit helps to iron out kinks in the plan and may be very fruitful if it shows that a particular response cannot be undertaken safely.

There are many other parts to an emergency response plan other than spill control. These include:

- A rescue plan.
- An evacuation plan and identification of safe refuges.
- A communication system.
- A decontamination plan (see Chapter 9).



These topics should be addressed in your emergency response plan. They are discussed in more detail in Chapter 10.

WHAT DETERMINES SPILL CONTROL?

Your actual course of action during an incident depends upon a number of factors:

- **Identity of the spilled substance.**
- **Location of the incident.** Is it near other chemicals, ignition sources, or people? Did it happen in the production, maintenance, laboratory, or storage areas? What is the local building ventilation in that area?
- **Quantity:** How much was spilled? Is it still spilling?
- **Source of the spill:** How did the spill start? How are the work operations involved? During a release is there a way to shut down the process? Can the release be stopped by reducing pressure in a pipe? Who is responsible for shutting off electrical power to equipment?
- **Type of Danger:** Are there toxicity, flammability, and corrosivity dangers?
- **Additional considerations:** Are there injuries? Can we rescue the victims?
- **Methods of Control:** What are the appropriate methods to contain and control the spill?
- **Above all, can the team respond safely and effectively?**



CAN WE HANDLE THIS?

Spills are usually classified as either “small” or “large.” “Small” spills are typically dealt with by personnel already in the area. “Large” spills, on the other hand, often require bringing in the spill team or other assistance. Your ER plan should provide procedures for dealing with both large and small spills of specific materials. The plan should also define what “large” and “small” are.

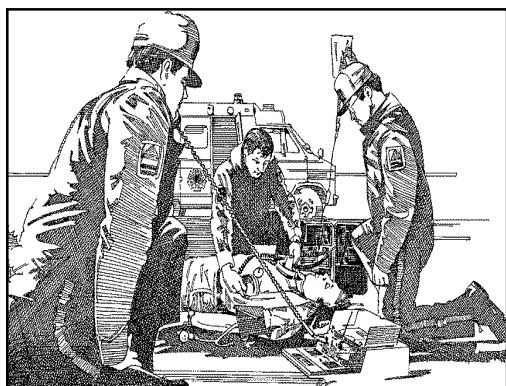
OSHA says that a spill or release is an emergency if:

- It may cause high levels of exposures to toxic substances.
- The release is life or injury threatening.
- Employees must evacuate the area.
- It poses conditions that are Immediately Dangerous to Life and Health (IDLH).
- It poses a fire and explosion hazard (exceeds or has the potential to exceed 100% of the Lower Explosive Limit).
- It requires immediate attention because of danger or presents an oxygen deficient condition.

According to OSHA, spills or releases which do not require immediate attention are not emergencies.

Chemical spill response may call for many different actions, including:

- Use of fire extinguishers and even more advanced fire fighting.
- First aid, rescue and CPR.
- Shutdown, lockout and evacuation.



Fire

A fire procedure must be in place. Can a spill team deal with a fire? If other employees are responsible for some level of fire suppression, what relationship do they have with your spill team?

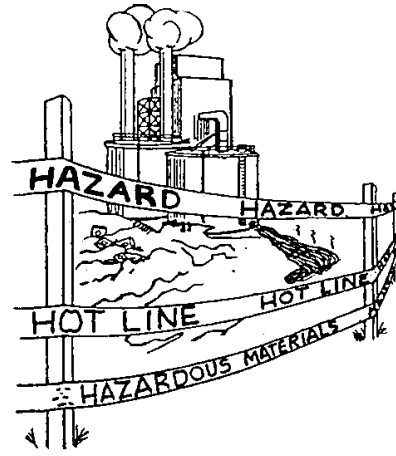
Rescue

There must also be a rescue plan. How are victims rescued, treated and handled during a response?

What is the role of the plant medical personnel (if there are any)? Where are any support medical facilities? Have the support medical facilities been notified that they may receive contaminated victims?

Evacuation

In addition, there has to be a procedure to evacuate non-essential personnel and to make sure that everyone is out of the area of concern. Who is expected to do that in your facility?



FOUR STEPS TO A GOOD PLAN

The questions outlined above must be addressed in your planning stages. The best way to figure this out is to plan and conduct a drill. Running practice drills gives you a chance to see what a team can safely handle. Drills will help in getting a clear idea of what you can accomplish, and what you **can not** do. (Each year after your initial training, OSHA requires that you have an annual refresher. By conducting a drill you gain a lot more than just sitting in a classroom.) Planning and drilling might go like this:

- 1) **Table top:** Start with a table top activity. Take an area where an incident has occurred or where it might occur. Develop a scenario for a spill and how you will respond to it.

Keep in mind that you want to think about not just how to contain and stop a spill but the related tasks as well, including:

- Isolate and establish a controlled area.
- Get some preliminary measurements of released materials.
- Notify key players.
- Contain and control the flow -- turn off valves, shut off power, block and bleed lines, etc.
- Patch or plug a leak if it is not too dangerous.
- Control from a distance -- ventilate the area until the vapor/gas is eliminated.
- Determine that the area is safe for entry.
- Wait and let the product evaporate.



- 2) **Walk-through:** After the desk top exercise, the entire team should walk through the incident area. This can help to focus your response and perhaps spot any gaps or unforeseen problems.
- 3) **Full scale drill:** Do a full scale drill as though you had a real spill.
- 4) **Drill evaluation and review:** Afterwards sit down and review the drill and the plan. You may encounter obstacles you didn't anticipate.

SETTING GUIDELINES

The employer has final responsibility in spill control. The employer must know which chemical products may pose these types of hazards. The employer must also have an effective hazard communication program. This means that the employer must know the full range of hazards of the various products used in the facility, and must communicate that information to employees.

In choosing a method of spill control you must look at the product and the situation together. On the next page is an example of a detailed spill response to give you an idea of what is involved.

GUIDELINES FOR CLEAN-UP OF MERCURY SPILLS

New Jersey Department of Health

- Mercury is a very dense silver gray liquid that will bead together, break apart and roll away from you very quickly. It evaporates very rapidly.
- Mercury forms small droplets that can come to rest in the smallest places. These droplets will give off odorless and colorless vapor. The warmer it is the more mercury vapor gets into the air.
- Spills on porous surfaces, such as wood and carpeting, will require an outside contractor to remediate.
- Mercury is very harmful to the brain. It can be inhaled or absorbed through the skin.
- A detection-use mercury vapor lamp is necessary. Air levels of mercury will increase 20 times when it is disturbed. Temperature is important, because an increase from 64°F to 78°F will double the vapor pressure of mercury.
- PPE respirators are needed. If air levels stay below .25 mg/m³ (10 times the TLV), a half mask with cartridges (mercury vapor/chlorine gas cartridges) can be used. If levels go higher but stay below 1.25mg/m³ (50 times the TLV) a full face respirator can be used. Levels above 1.25mg/m³ require an SCBA.
- Eye face and skin protection (2-ply tyvek) are needed. Try not to contact droplets.
- Isolate and evacuate area. Dike to prevent mercury from rolling. Divert liquid away from drains, cracks, crevices. Open windows and doors. Use fans to remove vapor directly to the outside. Turn off ventilation, heating, and air conditioning systems. Turn off or lower heat to keep mercury vapors down. Solution of 20% calcium sulfide or 20% sodium thiosulfate will inhibit mercury vapors from getting into air. Beads of mercury can be pushed together with a squeegee. Collect large droplets in pans, pour into plastic container/bags. Mercury beads can hide in cracks, corners, etc. A flashlight beam will reflect off of the silver. Sprinkle powdered sulfur on the area; if it turns from yellow to brown, mercury is still present. Sprinkle powdered zinc to keep mercury out of the air. Use a mercury vacuum; **DON'T USE SHOP VACUUMS or BROOMS.**
- Reoccupy the area when air levels equal 3ug/m³ (ACGIH TLV=25ug/m³). Take wipe sample, send to lab.
- Decontaminate any contaminated clothing with water and mild shampoo.
- Document on manifest as hazardous waste.

Source: *CONTROLLING METALLIC MERCURY EXPOSURE IN THE WORKPLACE*, Occupational Health Service, New Jersey Department of Health.



BASIC METHODS OF SPILL CONTROL

Ventilation

The release of vapors may create a fire/explosion hazard, a toxic hazard, or even displace oxygen. Among the best ways to reduce these hazards without sending anyone into the dangerous environment is to increase natural ventilation by leaving windows, doors, or loading dock doors open. You can also lower the concentration of a chemical by bringing in portable, non-sparking ventilation units.



Blowing fresh air into a contaminated space may be more effective than trying to draw it out of such a space. Many volatile substances will evaporate, so the longer you allow a volatile to sit, while blowing fresh air into the space, the less will be around to harm anyone.

The point is to bring levels of the material in the air below limits that are flammable or toxic. For example, if the chemical is a flammable, you might ventilate until the percentage of LEL is 5-10%. If the chemical is toxic, for instance, with an IDLH of 1,000 ppm, you might wait until 25% of the IDLH, or 250 ppm, is reached before allowing anyone into the area.

In confined spaces the air movement in the space can be very tricky. One drawback of ventilation, however, is that the vapors of the product may actually be above the upper flammable limits (the mixture of product and air is too rich to burn). By ventilating you may bring levels down into the flammable range and cause an explosion if any ignition sources are present! To avoid this, you should consider what sources of ignition may be present. You must **ventilate to bring vapor levels below 10% of the lower explosive limit** before allowing anyone to enter the space.

Containment

Containment means stopping a spill from spreading through any one or more of the following methods:

- Pans, pools, and berms.
- Diking and damming.
- Pigs, pillows, sand and clay.
- Shutting off valves and power.
- Wrapping pipes.
- Knocking down vapors with water or other materials.



Areas where small spills are likely to occur -- such as storage areas and areas where chemicals are transferred into small containers -- should have spill-containment features in place. Pans or wading pools can be left in place. Clay-lined containment berms could be constructed to keep liquids from spreading. “Area” response personnel can handle these spills.

Diking or damming are the most common ways to contain spills. You can use absorbent pigs, pillows, blankets -- sometimes clay, sand, or Speedi-Dri -- to stop the flow of liquids and at the same time reduce the amount of liquid surface area. (By reducing the surface area of a liquid, fewer vapors will be released into the air.) Depending on the size of the spill, the contained liquid may be pumped up or soaked up with a natural absorbent such as clay or synthetic absorbents such as polypropylene blankets.

Containing a spill or leak may mean turning off a valve or shutting off power to equipment. It could include actions like wrapping a pipe, or applying a water spray to a tank to suppress leaking vapors.

Finally, you could add a suitable product, such as a foam, to a spill to keep its vapors down.



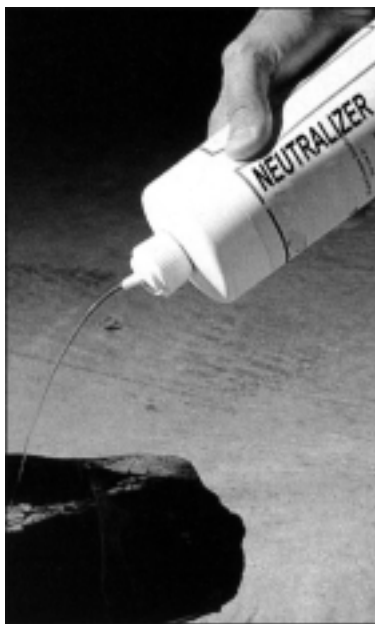
Absorption

Absorption means that you are taking up the spill with another product; for example, using a paper towel to absorb spilled coffee. Common absorbents include clay and sand, Speedi-Dri, or spill absorbent pillows. Absorbents vary in absorbent capacity, and must be compatible with the spilled product. You will need to determine how much absorbent is enough to tackle different size spills. Absorbents saturated with a highly volatile liquid may cause an increase in vapors coming off the material because the total surface area has increased.



Neutralization

You can add a chemical to a spill to form a harmless chemical. This is called neutralization. Sodium carbonate or soda ash and monosodium phosphate are often used to neutralize acids. Test the result with pH paper to make sure it has been neutralized. Other products besides corrosives can be neutralized.



Neutralization must be done with care. It requires the **correct** amount of the **correct** neutralizing agent. The wrong agent may cause a fire or even an explosion.

Most neutralization will produce enough heat so that if the spill is a flammable or combustible product, ignition may occur. Heat given off during a reaction can cause a corrosive to splatter. Sodium carbonate or soda ash can produce large quantities of carbon dioxide which can displace oxygen in a small space. (Some sorbents -- rather than neutralizers -- now available do not pose a threat of heat or violent reactions.)

Transfer to another container

A wet vac may be used to suck up liquids. For solids you may need a special high efficiency particulate air (HEPA) vac, especially when dealing with products like arsenic, cadmium, mercury, and other toxic dusts. (NOTE: Both machines need to be explosion proof if used for flammables!)

You can maneuver leaking drums into overpacks. Salvage drums or overpack drums usually come in 80- to 85-gallon sizes. One problem in overpacking drums is moving a 55 or 30-gallon drum into the overpack. A full 55-gallon drum can weigh up to 800 pounds. Use mechanical lifting aids. Make sure the overpack is rated for the substance. Inverting the leaking drum, putting a large poly bag over it, lowering the over pack over those two and then tipping that assembly upright may be a helpful strategy.



Bonding and Grounding

When a flammable material is transferred from a damaged drum to a new drum or vac truck, you face the possibility of a static spark causing a fire or explosion. This can be avoided by a practice known as **bonding and grounding**.



Static electricity can be generated when liquids on certain solids move in contact with certain materials, like a drum. Under certain conditions a static charge may accumulate. If the accumulation is sufficient, a static spark may occur. In the presence of a flammable liquid or vapor, this static charge must be safely discharged by bonding the two containers together and by grounding them.

Bonding is the process of connecting two or more containers (such as metal drums or tanks) by means of a conductor, such as a cable. **Grounding** is the process of connecting a metallic container to the ground.



There is a specific order in which bonding must occur:

- 1) Attach bonding to the container to be filled.
- 2) Then attach bonding to the container which holds the flammable liquid. To prevent ignition of vapors, the connection should be made away from openings. Use the same procedure for tanks.

A bond or ground is typically a wire or cable which is sufficiently conductive, strong, corrosion resistant, and flexible for the job. Conductors may be insulated or uninsulated. Inspect them every so often for defects such as frayed wires, tears and gouges. Temporary connections may be made with battery-type clamps, magnetic, or other special clamps which provide metal-to-metal contact.

Patch/Plug

Patching means putting something over a hole or crack, usually secured with a clamp to keep the substance inside the container. Plugging refers to putting something into a hole or crack to reduce the flow from the hole. Patches and plugs must be compatible with the substance; for example, if the substance reacts with metal, then don't use a metal patch.

The following are important considerations when plugging and patching leaking containers:

- Approach the leaking container with a specific game plan in mind.
- Always wear the proper protective clothing and respiratory equipment.
- Controlling a leak does not necessarily mean stopping the leak but, rather, making the leak manageable.
- Eliminate all ignition sources. Only non-sparking tools should be used.
- Contain as much of the spillage as possible by diking.
- Consider chemical compatibility when selecting the plug or patch to be used.



Activity 8A: SPILLS HAPPEN

For each of the three scenarios in the “Spills Happen” video answer the following:

1. What type of spill and hazards were there?
2. What spill control actions did the response team take?
3. Were there any things you might have done differently?
4. What would you suggest to prevent or control the spill beforehand?



Activity 8B:

SPILL RESPONSE

The aim of this activity is to have you plan a spill response for a particular chemical. Using the filled out Chemical Release Chart for mercury (in Chapter 2, pages 9-10) you should complete an identical chart for your two chemicals. Please complete the following sections on your Chemical Release Chart (as shown on page 15):

- *Small Spill*
- *Large Spill*
- *Absorbent*

1. Small Spill

In your groups and using the reference material provided determine how many gallons and square feet of each chemical constitutes a small spill. Once you have determined the size of a small spill develop procedures for responding to a small spill. Please fill out the section of the Chemical Release Chart entitled “Small Spill Response”.

2. Large Spill

Next, determine the largest spill you can handle of this product and annotate it on the form. Once you have determined the largest spill you can handle, determine when you are going to call for outside help and who are you going to call. If you feel you can handle any size spill, develop response procedures.

3. Absorbents

We have discussed the different kinds of absorbents. Using your manual and the catalogs provided, select the appropriate absorbents, and fill out the section of the Chemical Release Chart called “Spill Response Equipment: Absorbents and Decontaminants” on page 15. Please do not fill out any other section, however you may go back and fill out the Product, Hazard, Protective Equipment and Spill Response Equipment sections on other chemical release charts for additional chemicals if you wish.

SUMMARY SHEET

CHAPTER 8 : OSHA REGULATIONS FOR EMERGENCIES



The following is a summary of what to do when a spill happens; not necessarily in this order.

- ◆ Evacuate area and restrict entrance to hot zone.
- ◆ Identify chemical.
- ◆ Isolate the spill and eliminate sources of ignition.
- ◆ Report the incident.
- ◆ Contain the spill.
- ◆ Collect the runoff for disposal.
- ◆ Monitor the air for reentry.



The safest and most effective way to respond to spills is through planning and drilling. Good planning depends, first of all, on a rigorous audit of hazardous substances in the facility; secondly, it depends on drilling to work out the flaws in the plan.



A planning and drilling procedure might go as follows:

- ◆ Table-top scenario of a spill.
- ◆ Walk-through of incident area.
- ◆ Full-scale drill.
- ◆ Review the drill and plan.



Spill Response Equipment	
Air Monitoring:	
Personnel Monitoring:	
Soil & Water Sampling:	
Absorbents:	
Decontaminates:	
Other Equipment:	

Response Procedures
How many gallons or number of square feet covered is called a small spill?
Number of gallons _____ Number of square feet _____
Over this size spill is a large spill.
Small Spill Response
What is the largest size spill you can handle?
Large Spill Response
Call for outside help? Yes No

Hazards		
Flash Point:	LEL:	UEL:
Vapor Density:	Vapor Pressure:	Specific Gravity:
PEL:	IDLH:	
Reacts with:		
Corrosive:	Yes	No
Routes of entry into the body:		
Acute & chronic health effects:		
Protective Equipment		
Respirator:		
Type of filters (if needed)		
Suit: level and material		
Boots:		
Eye/Face:		
Gloves, outer: material:		Gloves, inter material:
Spill Response Equipment		
Air Monitoring:		
Personnel Monitoring:		
Soil & Water Sampling:		
Absorbents:		
Decontaminates:		
Other Equipment:		



OBJECTIVES

In this chapter you will learn why decontamination is important in protecting yourself, your co-workers, your families and the environment. You will learn about different decontamination procedures and their limitations. You will also evaluate your own experiences executing decontamination strategies in class. You will explore the difficulties that may be encountered in attempting decontamination procedures in your own work environment.

The goals of this chapter are to ensure that students understand:

- The purpose and principles of decontamination.
- The adaptability of decontamination principles for use in real life situations.
- The correct control strategies for decontamination and their relationship to health hazards.
- The potential for work-related exposure in using decontamination methods.
- What equipment is used in decontamination.
- The correct procedures for doffing chemical protective clothing.
- Methods of containing contaminated water.

On completion of this chapter, students will be able to:

- Describe the relevance of decontamination.
- Identify two decontamination principles in the field.
- Demonstrate the correct procedures for taking off chemical protective clothing.
- Explain the relationship of decontamination to health hazards.

DECONTAMINATION: KEEPING IT ALL CONTAINED

One consequence of responding to a chemical spill or release is that the spill team may track hazardous materials to other areas in the plant, such as the lunch area, locker rooms or restrooms. You may even take the chemicals with you in your car and eventually home. This can happen if you unknowingly carry material on your clothing, shoes or in your hair. (A recent study of bridge repair workers in Connecticut showed that there were very high levels of lead dust in workers' automobiles. Because the workers were not cleaning the lead off themselves before they left the job, they were carrying it home in their cars.)

A basic rule in all emergencies is to prevent the spread of the hazardous material. There are two basic ways we do this:

- **Spill control practices that minimize exposures.** Work zones must be established to contain the spill and to keep the hazard from spreading.
- **Decontamination:** Workers who have come into contact with the material must be decontaminated before they leave the area.

KEEPING IT ALL CONTAINED:

- Avoid or minimize contact with contaminants even when handling the material by using remote techniques, such as ventilating or remote drum openers.
- Leave contaminated areas only at designated exits.
- Clean contaminated clothing before removal.
- Remove clothing carefully; only protected personnel should touch contaminated clothing.
- Contain all contaminated clothing for disposal or decontamination.
- Contain all runoff for proper disposal.
- Decontaminate all equipment before reuse.



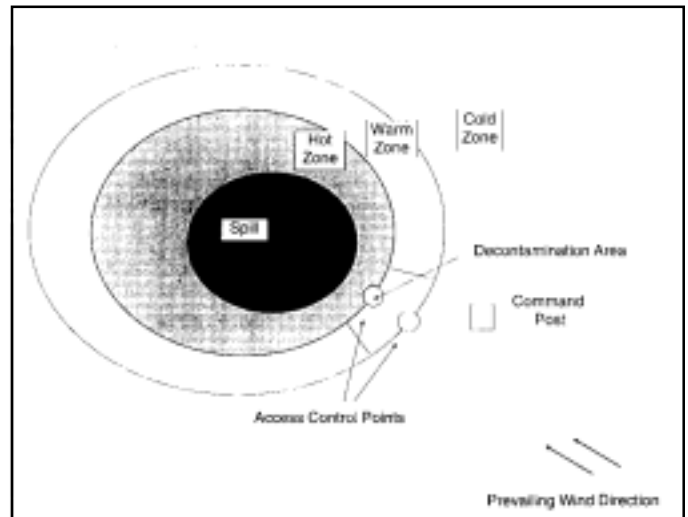
Specific decontamination (decon) procedures for an incident should be spelled out in the Emergency Response Plan. There is some very fancy decon equipment available, including special vans and trailers. Other decon setups are quite simple: a portable shower/decon, kiddie pools, hand-held sprayers and scrub brushes. How complicated your decontamination setup should be will depend on the nature of the hazards and the size and location of the spill to be remediated.

THE DECONTAMINATION PLAN

A decontamination (decon) plan must be developed as part of the emergency response plan. A few general rules should be followed to contain the spread of the contaminant and to control the flow of people and equipment.

First, three work zones must be set up:

- **HOT ZONE:** The area immediately surrounding the incident. This area has the highest levels of exposure. It is also called the exclusion zone or restricted zone.
- **WARM ZONE:** Also called the contamination reduction zone. This is where people and equipment are decontaminated.
- **COLD ZONE:** The area beyond the warm and hot zones where support functions are located. Also called the clean or support zone.



* Source of Graphic: "Emergency Response and Prevention Workbook," OCAW/Labor Institute.

Zones must be established and the decontamination corridor set up before any workers or equipment enter the hot zone.

In addition to work zones and the decon corridor, there are a number of procedures which should be followed to contain hazards. They are listed on the next page.

DECON PLAN: Controlling and Containing Hazards

Your decontamination plan should include the following tasks and points in order to control and contain the spread of contamination:

- Establish three work zones.
- Regulate entry to, and exit, from work zones.
- Establish clear procedures for anyone leaving the hot zone.
- Limit access to those who are supposed to be in the warm zone.
- Designate a person to oversee decontamination.
- Wear the appropriate PPE while in the hot and warm zones.
- Discard everything that cannot be thoroughly cleaned. (Stains, discoloration and visible changes such as blistering are signs that a suit has been affected.)
- Most decontamination will involve water. Be aware that some chemicals react with water; some with moisture in the air! If you do have a product as reactive as that, you probably should not attempt to do anything more than containment. Also, minimize the amount of water used since the wastewater may be hazardous.
- Double-bag contaminated items and keep them in the Contamination Reduction Zone (warm zone) until they can be decontaminated or properly disposed of.
- Always leave breathing apparatus face mask on until clothing has been washed and/or removed.
- Decontamination takes priority over modesty or short-term exposure to cold weather, but make every effort to reduce exposure to the elements in cold weather. Use comfortably warm water to wash.
- Porous materials – bunker gear, leather, canvas, and soft plastics – are difficult to decontaminate since they absorb contaminants. They may have to be thrown away.
- Work clothing should be laundered at work. Never take contaminated clothing home.
- Wash hair and body thoroughly before going home.



THE DECONTAMINATION TEAM

A procedure must be in place to clean (decon) all exposed personnel and any equipment involved in an incident. On the next page is a sample procedure. In some emergency response cases, entry team members may be required to decontaminate themselves. In such cases, buddies must help each other during decontamination procedures. In other cases, non-entry personnel will assist the decontamination team.

Decontamination personnel should be dressed in the same level of protection as, or one level down from, the entry team. If the entry team is wearing Level A, then the decontamination team will wear Level A or B. Decontamination team should be dressed in level C, minimum.

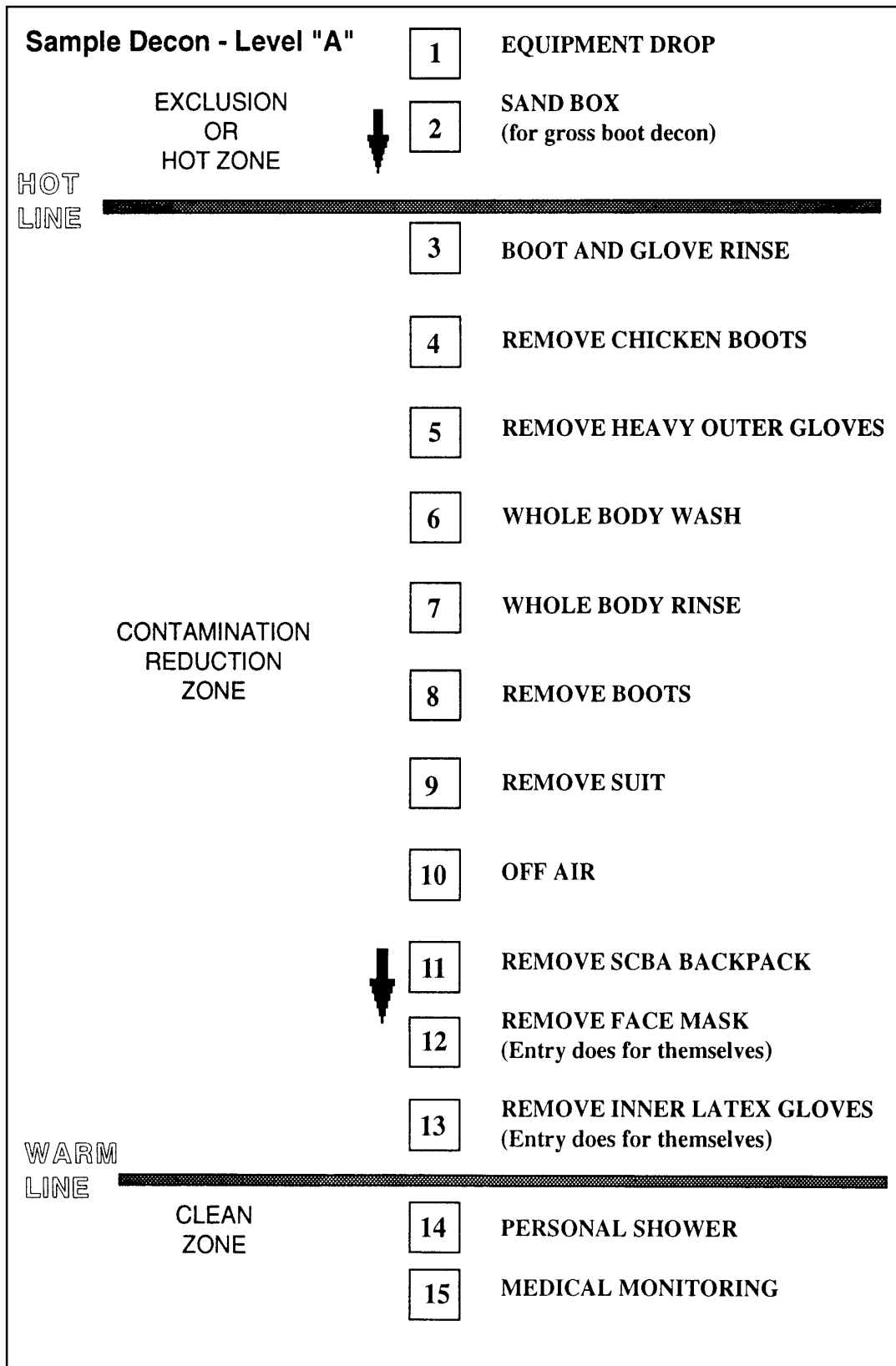
Sometimes the entry team can start decontaminating themselves before they leave the hot zone to reduce exposure to the decon line.

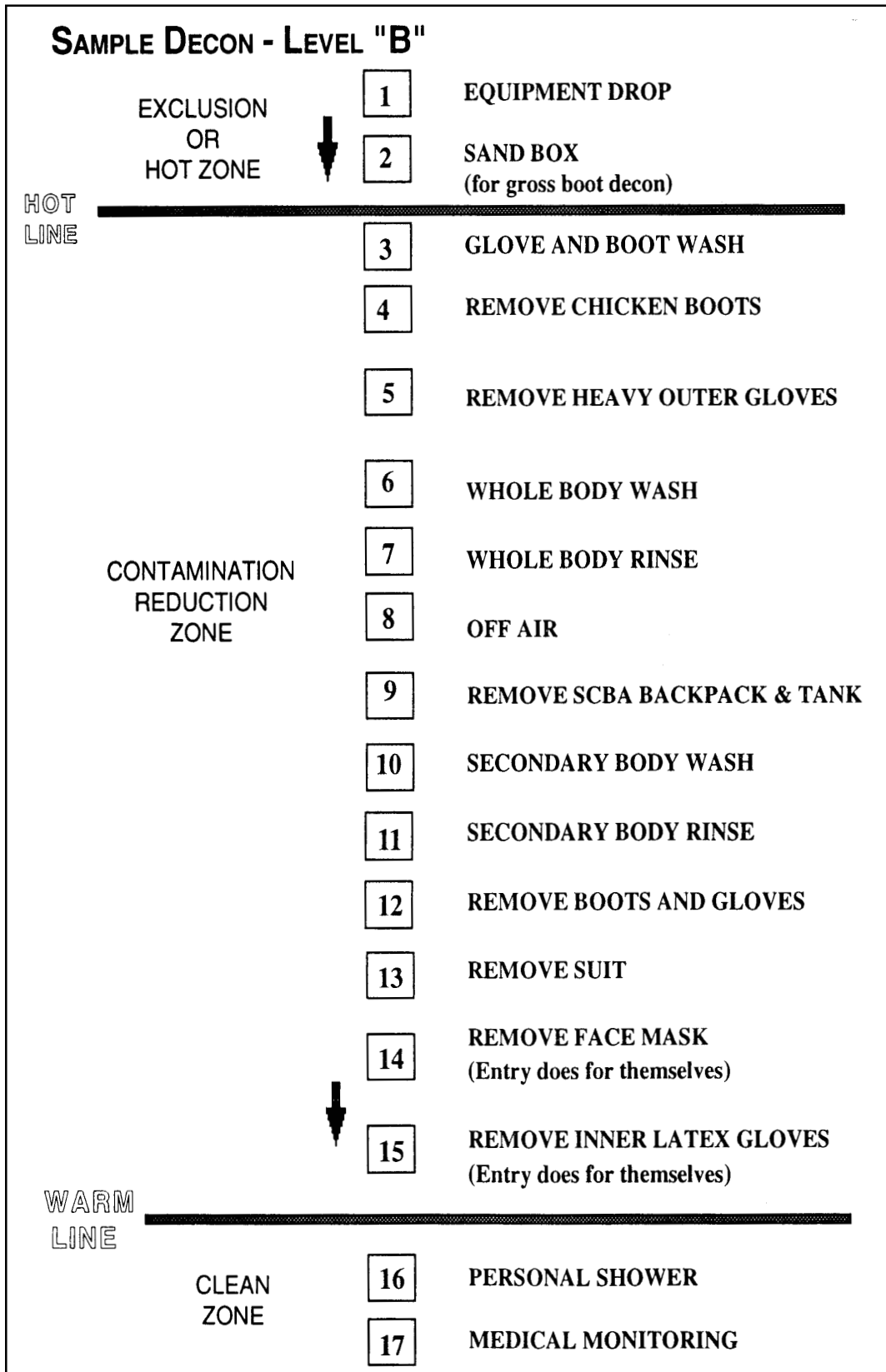
Many teams wear either disposable CPC or disposables over re-usable CPC. This makes decontamination simpler.

Decon personnel must decontaminate themselves at the end of the incident, prior to leaving the warn zone.

RULES FOR DECONTAMINATING THE DECON TEAM

- Let the most contaminated members of the team, those closest to the hot line, decontaminate first, with others assisting them as they pass through the line.
- Never travel up the line to a point of greater contamination, nor down the line, without decontaminating.
- Always work together as buddies.





DECONTAMINATION METHODS: WHAT TO USE

There are various ways to decontaminate CPC and equipment, either during or after personnel decontamination:

- **Chemical neutralization or degradation**

For example, sodium bicarbonate can be used to neutralize acids. However, it is possible that heat, a fire hazard, or toxic gases may be produced. To use this approach you need to be confident that you are not adding to your problems.

- **Physical removal**

Use soapy water and brushes for most contaminants. Use sand to physically remove particulates like dioxin.

- **Absorption**

Use absorbent pads for particular contaminants.

- **Disposal**

Dispose of all non-reusable clothing as hazardous waste (including paper suits, gloves, and boot covers). Dispose of any reusable clothing that is discolored, stained, or obviously affected.

A GUIDE TO SOME DECONTAMINATION SOLUTIONS Water-Based (Aqueous) Solutions

Compound	Mixing Procedures	Use/Remarks
Low-suds detergent	see product label	best all around solution
Sodium carbonate 5%	10 gal. water + 4 lbs. of carbonate	good for unstable bases (i.e. organophosphates)
Sodium bicarbonate 5%	10 gal. water + 4 lbs. of carbonate	amphoteric (i.e. neutralizes by acting as either acid or base)
Trisodium phosphate 2%	10 gal. water + 2 lbs. of phosphate	good for unstable bases (i.e., acts as wetting solution)
Calcium hypochlorite 10%	10 gal. water + 8 lbs. hypochlorite	cyanide salts, mustard gas
Ethylenediamine – tetra acetic acid (EDTA), versene	see product label	heavy metals, some radioactive particles



• **Containment and disposal of contaminated water**

Runoff of decon solution should be contained by using plastic sheeting or a wading pool. Contaminated water may be a hazardous waste and should not be allowed to run down the drain, unless drain water goes through a treatment process.

Contaminated water that has been contained needs to be managed as a hazardous waste if it meets the definition of hazardous waste. Waste is defined as hazardous based on:

1. The name of the chemical or chemicals in the waste.
2. The characteristics of the waste (corrosivity, ignitability, toxicity, and reactivity).

Decontamination Equipment

Common decontamination equipment used in emergency response incidents includes:

- | | |
|---------------------|-------------------------------------------|
| • Disposable towels | • Wading pools |
| • Detergents | • Garden hose with nozzle |
| • Wash tubs | • Synthetic scrub brushes |
| • Disposable gloves | • Deluge shower |
| • Sponges | • Buckets/trash barrels with covers |
| • Plastic sheeting | • Spare breathing apparatus air cylinders |
| • Handheld sprayers | • Heavy duty plastic bags |

In addition, a decon kit might also include the following items:

- | | | |
|------------------------|--------------------------|----------------|
| • Duffel Bag | • Scrapers | • Spic 'n span |
| • Monitoring Equipment | • Book w/CPC info | • Duct tape |
| • NIOSH guides | • 2 squeegies | • Caution tape |
| • Warning signs | • Traffic cones | |
| • Disp. camera | • Chemical extinguishers | |

VICTIM DECONTAMINATION

If someone has been injured by the spill, they must be decontaminated before they can be tended to by emergency medical personnel. Medical personnel and hospitals are now trained to approach only those who have been decontaminated. Decontamination must be carried out quickly when a victim is involved. Ordinarily, decontamination is a slow and methodical process. However, don't forget the health and safety of your emergency responders. Be sure they are fully decontaminated after you have tended to the victim.

- **Cut clothes off.**
- **Solid or particulate contaminants should be brushed off as completely as possible prior to washing**, in order to reduce the chance of reaction with water. Heavy liquid contaminants should also be blotted from the body prior to washing.
- **Rinse the patient with water (use warm water, if possible); remove contaminated clothing, jewelry, shoes, etc.,** and save in plastic bags marked with patient's name and marked as hazardous.
- **Wash patient, if possible, with Tincture of Green soap or other mild soap.** Liquid soaps dispensed from small squeeze bottles work very well. Pay special attention to hair, nail beds, and skin folds. Use soft brushes and sponges. Use extra caution over bruised or broken skin areas. Rinse patient with large quantities of water unless identified chemicals are water reactive. If it is appropriate to irrigate the eyes, remember to remove contact lenses.
- **If you have hose lines available, then use low water pressure on hose lines** to control the spray and avoid aggravating any soft-tissue injuries. Avoid overspray and splashing.
- **Contain the runoff.**
- **Wrap victim in a disposable blanket, sheeting or transport bag.**



Contaminated patients must be decontaminated or treated by specially equipped emergency medical vehicles or hospitals.

*Source of Graphic: Training for Hazardous Materials Team Members, International Association of Fire Fighters.

SOURCES FOR INFORMATION ON VICTIM DECON

- **CHEMTREC - (800) 424-9300.**
- **Local Poison Control Center.**
- **Phone number on an MSDS.**
- **Local Occupational Health Clinic/Service.**

**EMS personnel should NEVER
enter a designated HOT ZONE
(unless they are trained and are wearing appropriate PPE)**

**Begin medical treatment only after
the patient has been decontaminated**

The following are reasons why a victim should be decontaminated at the site:

- Prevents further exposure to the victim.
- Limits the spread of contamination.
- Prevents contamination and exposure of emergency personnel.

Activity 9A:

SETTING UP DECON

PURPOSE: To develop decontamination procedures for a product you work with.

TASK: The class will be split into two groups. Each group will plan a decontamination line for a potential spill of a product you work with (or a product assigned by the instructor), in a situation that is realistic to you. Include in your plan a typical decon procedure and one that involves a victim. Detail your decon plan in the appropriate section of the chemical release chart.

Personnel Decontamination Procedures

Include drawing:



Activity 9B: DECONTAMINATION BASICS

PURPOSE: The purpose of this activity is to have you think about how neglecting decontamination controls can cause serious problems and how to prevent serious mistakes from happening.

TASK: Please read the situation and answer the questions.

A truck filled with aluminum phosphide spilled some containers near the loading dock. Aluminum phosphide comes as a tablet or pellet packed in gas tight containers. A utility crew was ordered to sweep up the spill. They wore tyvek suits and full face APRs.

Aluminum phosphide can react with moisture in the air to produce phosphine, a very toxic gas (see MSDS).

After successfully cleaning up the spill the two workers went to their lockers and tossed their clothing into open garbage cans. They went to take showers. The steam from the shower filled up the locker room and reacted with the aluminum phosphide dust on their clothing. Phosphine gas was present when they both returned. Both men collapsed and were found unconscious.

1. Make a list of problems with the way the response to this incident occurred.

2. If this happened in your plant, what changes would you recommend to an ER/cleanup team?

SUMMARY SHEET

CHAPTER 9: DECONTAMINATION

- ✓ In an ideal situation:
 - The hazardous material is positively identified.
 - You have the correct neutralizer on hand.
 - There are personnel trained in the proper decontamination/neutralization procedures.
- ✓ Organize decontamination properly. Don't rush decontamination.
- ✓ If you need to make adaptations in the field, use common sense and remember these basic decontamination principles:
 - Avoid inhalation, absorption or ingestion of hazardous material.
 - Keep whatever is outside the suit on the outside of the suit.
 - Leave all hazardous materials at the site. Don't take them home on your clothes or on your body.
- ✓ Take off your clothes and gloves in a manner that prevents your skin from becoming contaminated.
- ✓ Always decontaminate your skin (shower or bathe) when exposure was likely, or known, to have occurred.



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OBJECTIVES

In this last chapter we will look at what a response team might need to do during an emergency. You may need to evacuate areas and shut down equipment. You may need to search an area to see that everyone is out. We will discuss the roles and responsibilities of the team members. We will briefly examine what a response team should consider in non-chemical emergencies. And we will revisit how to anticipate emergencies.

The goals of this chapter are to ensure that students understand:

- The importance of anticipating and preventing emergencies.
- The various tasks necessary to deal with chemical emergencies.
- The importance of training for each member of the emergency response team.
- The importance of communication for an emergency response team.
- How to be prepared for non-chemical, physical emergencies.
- How to recognize confined spaces, their hazards, and the procedures for entering them.
- How to set up work zones, safe distances, and evacuation routes.
- The importance of decontamination during an emergency response.

On completion of this chapter, students will be able to:

- Describe the tasks, roles, and responsibilities of the emergency response team.
- Describe the different methods of communication, within the team and between team members and outside parties.
- Describe how to secure an area, establish work zones, evacuation procedures, and set-up for decontamination.
- Describe four non-chemical, physical hazards you might encounter when responding to a chemical emergency.
- Describe the hazards of confined spaces and the proper procedures for entering these areas.

YOUR FIRST STEP: PREVENT AND ANTICIPATE EMERGENCIES

We cannot emphasize it enough: **the best way to protect your health and safety is to prevent emergencies from happening in the first place.** As we discussed in Chapter 2, the planning process is a way to help you identify and understand processes, procedures, and habits in the work environment that can cause chemical spills and emergencies. Again, emergency planning can help you prevent spills from happening in the first place, and can help you to prepare to deal with spills if they do happen.

In this chapter we will discuss primarily the second point: What to do in the event of an emergency. But first let's quickly review the first point: preventing and anticipating emergencies. Anticipating where emergencies could occur is a central part of emergency planning. You can take the following steps to anticipate emergencies:

- Look around the plant to identify what chemicals are used, where they are stored, and what hazards they present.
- Notice whether chemicals are stored and labeled properly.
- Examine each operation to see how production processes, machinery, air temperature, and proximity to highways may contribute to an emergency situation.

Not all emergencies are chemical emergencies but may be non-chemical, physical emergencies, such as:

- First aid/ medical.
- Structural/equipment malfunction.
- Fire.
- Noise.
- Temperature extremes.
- Confined space.



The planning process means anticipating how these non-chemical emergencies can happen. Planning also involves preparing how to respond to such emergencies. Each type of emergency may have a different response.

We are focusing here on chemical response, but a chemical response may also involve a fire or medical response. You need to know what role or tasks you may have—or not have—given the situation.



WORKING AS A TEAM

Emergency Response Tasks

An emergency response team might have the following tasks:

- Evacuating the area/emergency escape.
- Assessing hazards.
- Rescuing and giving medical/first aid.
- Shutting off equipment/processes.
- Shutting down lines or closing valves.
- Controlling, containing, or confining a release of gas, liquid or solid.
- Participating in the remediation of spilled hazardous materials.



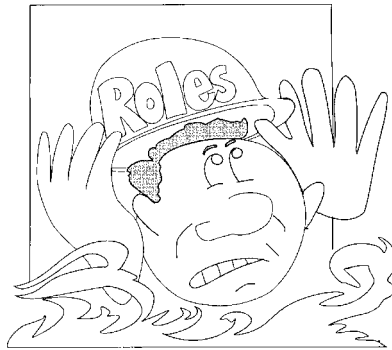
Who's In Charge Here? Roles And Responsibilities of An Emergency Response Team

Someone must be in charge, and will have the following responsibilities:

- Determining whether an emergency exists, what kind, and how serious.
- Directing efforts in the area, including evacuation, spill control and response.
- Coordination with outside agencies and services (fire, medical, environmental, etc.).
- Directing the shutdown of plant operations when necessary.

Everyone should know who has the authority to make decisions. Using an established chain of command will help keep an emergency from turning into chaos. The fire services chain of command is called the **Incident Command System (ICS)**. The ICS should be fully described in the Emergency Response Plan, including the lines of authority, communication systems, and responsibilities. The Emergency Response plan should include the name of the person who will be in charge of the emergency (the Incident Commander), as well as the names of all other emergency response staff. The Incident Commander and others on the team must be people who know the building well and have enough authority to take charge during an incident.

Different emergencies call for different responses -- a small spill of a corrosive is not going to call for the same response as a large spill of a flammable solvent. The number of people involved and the role(s) of each person depends on the types of emergencies that could occur. This means that how you set up the ICS depends on the types and sizes of spills or releases.



Typically it is necessary to have people responsible for the following functions, (one person may have more than one function):

- Coordinating the response to the entire incident (Incident Commander).
- Keeping people away from the incident (security).
- Keeping communication simple, clear, and accurate (communications).
- Assessing the seriousness of the incident. Revising that assessment as the incident unfolds (Incident Commander, science/safety).
- Assessing the hazards and how they are to be controlled (Commander, science/safety).
- Responding to the incident, and containing and controlling the release/spill (entry teams/backup).
- Keeping equipment in order (equipment).
- Assessing the safety of the responding team (Incident Commander, science/safety).



TASKS DURING A RESPONSE

Your response team consists of whoever will be engaged during a response. It is often not easy to figure out how many people that will be. This is why planning is so very crucial. You need to plan for different shifts, and think about when people are on vacation. Are there situations where production personnel in the affected area can perform simple tasks like diking drains, or shutting off machinery?

Everyone in the facility, including top management, staff, maintenance and other personnel, must know who will be in charge in case of an emergency. Everyone must be prepared to follow instructions. They must know which personnel are on a response team.

SAMPLE

EMERGENCY RESPONSE TEAM

- **Project leader/on-scene coordinator/incident commander:** Has clearly defined authority and responsibility to manage and direct all response operations.
- **Engineering:** Maintains continuity of water supplies, electrical power and fire pump operations. Provides on-the-scene emergency lighting. Develops plans to isolate damaged pipelines, electrical lines and other utility services.
- **Emergency and fire:** Responsible for rescue, firefighting and material release control activities. Trains firefighting and rescue personnel for all shifts. Maintains equipment. Establishes working relationship with off-site firefighters.
- **Medical:** Responsible for caring for injured. Provides training for medical emergencies, including those resulting from toxic exposures.
- **Public information:** Releases information to news media and public concerning site and emergency activities.
- **Security:** Manages general site security. Provides contact with local law enforcement and fire departments. Controls site access.
- **Recordkeeper:** Maintains official record of site activities.

SAMPLE EMERGENCY RESPONSE TEAM (continued)

- **Operations:** Directs activities of team leaders. Coordinates these activities with scientific advisor and safety officer.
- **Team leaders:** Manages specific tasks such as entry teams, decontamination, sampling, monitoring, equipment, communication, etc.
- **Science officer:** In charge of technical and equipment data.
- **Safety officer:** Recommends that work be stopped if there is a potential health and safety problem for workers or public. Responsible for notifying local public officials of emergency and for providing emergency medical care on site.
- **Entry teams:** Make initial entry to establish character of hazardous materials or may make rescue attempts during emergency. Always at least two individuals, properly trained and protected, including back-up entry team.
- **Communication officer:** Provides communication links and communication with local emergency services.
- **Decontamination officer:** In charge of setting up decontamination zones, providing decontamination equipment and supervising correct decontamination procedures.
- **Equipment officer:** In charge of the provision, maintenance and calibration of all necessary equipment.

The Emergency Response Team outlined above may include other personnel, such as specialists in dealing with possible environmental damage and for particular hazards associated with special problems (e.g., biological and radiological hazards). Some individuals may have more than one role. The Emergency Response Team should be adapted for each specific event. Lines of authority should be very clear and there must be a designated leader (project team leader, on-scene coordinator, site safety officer or field team leader). The leader should:

- Be identified in the emergency plan.
- Be backed up by alternates.
- Have authority to resolve disputes about health and safety, and have enough knowledge.
- Have control over who enters site.



Once site evaluation is complete and the results included in the emergency plan, care should be taken to set up the following system for handling emergency response.

AN EMERGENCY RESPONSE SYSTEM

- All emergency responders and their communication should be coordinated through the Incident Commander.
- The person in charge of a particular task should determine what hazardous substances are present and should recommend the appropriate site analysis, controls, handling, and exposure limits, etc.
- The individual in charge of a task should implement appropriate emergency response procedures and assure that appropriate personal protective equipment is worn.
- Employees engaged in emergency response should wear positive pressure breathing apparatuses until it is determined by air monitoring that a decreased level of respiratory protection is safe.
- The number of emergency response personnel at the scene should be limited to those actively engaged in operations.
- Backup personnel should be on-scene and the buddy system should be used.
- A safety official should be designated by the incident commander.

PREVENTING EMERGENCIES

Training

Planning ahead, training and practice are ways to ensure that each person on the response team knows his/her role. This is required under the HAZWOPER Standard. Each member of the team must receive training on the role and activities he/she will be expected to carry out in case of an incident. On-going training for emergency responders should include frequent drills and, at a minimum, knowledge about:

- The chain-of-command during an emergency.
- Communication methods and signals.
- Emergency equipment and how to use it.
- Emergency evacuation procedures.
- Steps for removing injured personnel.
- Recognition and treatment of injuries related to chemicals or other causes, including treatment of symptoms of cold and heat stress. Workers who are designated to deal with emergencies should be trained in first aid and CPR.

You may have to call firefighters or emergency medical personnel. You need to make sure they are informed of the following:

- Site-specific hazards.
- Response techniques.
- Site emergency procedures.
- Decontamination procedures.

If you can, bring in outside agencies for practice drills. Familiarize local medical personnel with types of exposure that they may have to treat. Some employees may need to be trained to don escape masks and/or perform basic shutdown procedures. All employees should be trained in evacuation/shutdown procedures, alarm systems, types of emergencies, and how to recognize and report emergencies.



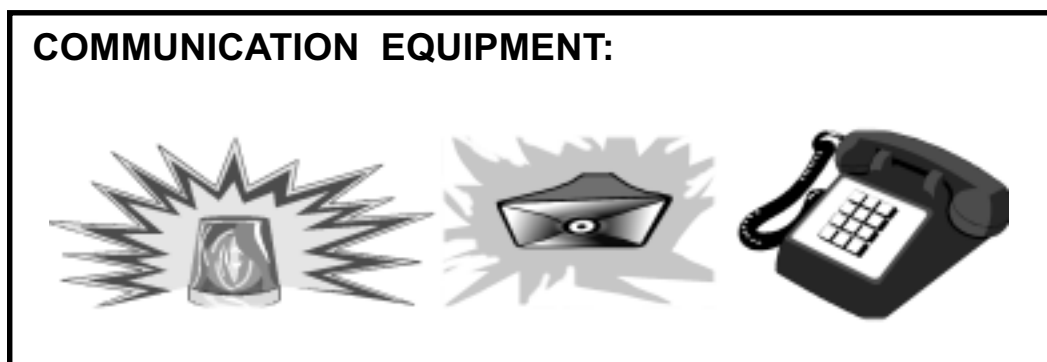


TASKS DURING A RESPONSE

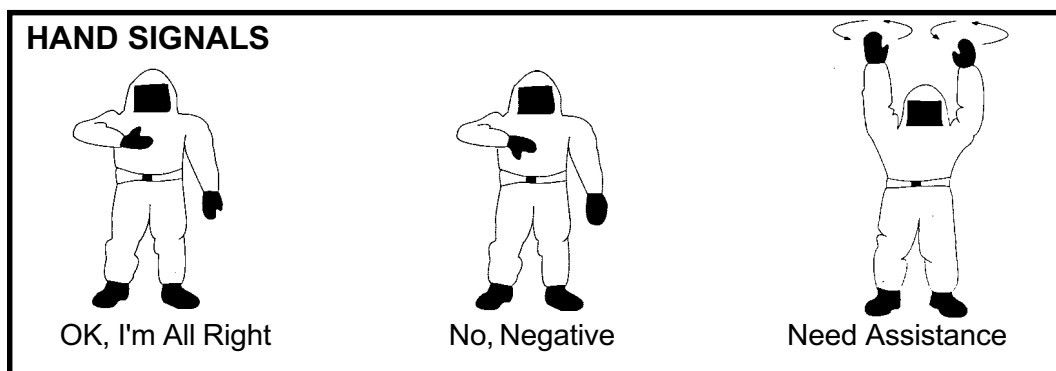
COMMUNICATION

Communication in a chemical emergency involves first getting information to the personnel who make decisions. What happened, when, and how serious is it? Unfortunately, your task will be much harder if production workers and those most likely to spot a spill lack training in recognizing chemical hazards and emergencies. The better prepared and trained your production “front line” personnel are, the more easily you will get clear and accurate information.

Next comes putting the plan into action. How do you signal for people to evacuate safely?



Alarm systems can include signals you can hear such as bullhorns, megaphones, sirens, bells, or whistles. They can also include signals you can see such as colored flags, flares, lights, and hand signals. Alarms must be distinctive and recognizable so that people understand exactly where they are supposed to go and what to do (for instance, shut off machine, turn off power, shut down a loading dock). Workers wearing protective equipment, such as respirators, cannot see or hear clearly. Also some workers may be in isolated areas or spaces. Because communication may be very difficult during the noise and confusion of an emergency, it is best to combine both visual signals and noise signals.



All systems and signals should be established ahead of time and clearly understood by all workers. Practice drills should include testing and using the communication systems and alarms. You also need a set of signals for your response team.

Next, there are communication issues during the response. This involves communication among team members so that information is relayed accurately up and down the chain of command. Field telephones, personal radios and visual signals may be used. There must be a back-up system in case the main system fails.

Finally, communication must be established with outside agencies and services. Fire, police, medical, local emergency planning committees, state agencies and, possibly, the National Response Center must be notified of the emergency situation.

Establishing Safe Distances And Refuges

How far away do you need to get your people from the “hot zone,” the spill /release point? This is an important step in planning ahead. In deciding about safe distances and refuges (or safety stations), consider the following factors:

- Where may potential problems occur? What sorts of emergencies are possible, including how much of a substance might possibly be released?
- What are the potential sources of the release? (tanks, pipes, drums, vats, etc.)
- If outdoors, where could the wind carry released materials? (know the wind speed and direction)

Pre-designated site safety areas may help in making sure a team is ready with equipment and instruction. These safety areas also may serve as command posts and as rest areas.

Securing The Area

It is important to make sure that only authorized personnel can approach the site and that all others are evacuated. You also may have to make a sweep of the area, making sure everyone is out.

Accidents, by their nature, make it difficult to determine the danger zone (or hot zone) before an incident occurs. By planning you can narrow down some incident zones just by carefully looking at areas where spills may happen and by using knowledge about how chemicals behave.



TASKS DURING A RESPONSE

Securing the site involves the following:

- Where and when physical barriers, such as line tape, will be set up to restrict access into work zones.
- Who will be allowed into the various zones.
- What medical resources will be available.
- What engineering controls will be used.
- If the emergency involves fire, what steps will be taken for shutting down ignition sources.
- What decontamination procedures will be used.



Emergency Evacuation Plans

Procedures should be in place for alerting all workers to evacuate. This means that there be an adequate alarm system and safe places of refuge. A log of all personnel should be available at the evacuation point so that everyone can be accounted for.

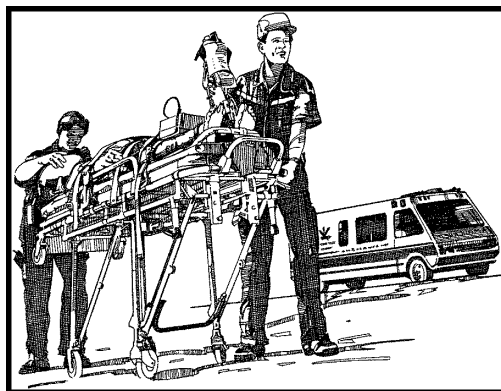
Planning For Decontamination

Personnel who have come in contact with hazardous substances will have to be decontaminated. As part of planning for emergencies, procedures should be developed for:

- How personnel and any victims of the incident will be decontaminated.
- How medical personnel will be protected.
- How contaminated protective equipment and wash solutions will be disposed.
(See Chapter 9 for more details)

Emergency Medical Treatment

The emergency team should be trained in CPR, first aid, and special measures for dealing with chemical exposure. A relationship should be established with off-site medical personnel and emergency medical services. They should be notified of the hazards on-site and agree to provide emergency medical assistance. On-site first aid stations should be set up and restocked immediately after each emergency use.



NON-CHEMICAL HAZARDS

As you respond to a chemical spill there may be many other hazards that you must be prepared for. There may be equipment in the area which can cause people to trip and fall. The area may be congested so that it is hard to move in or into the space.

The situation may call for response teams to climb up or down stairs or ladders. You may be climbing ladders or you may have to climb into small areas. You may be confronted with materials that are stacked or piled overhead. There may be processes or equipment -- such as saw blades, gears, rotating shafts, fans, cutting or bending devices and presses -- that pose hazards.

The shape of the space may pose hazards. An entrance or exit may be narrow or blocked. You may be facing a confined space which calls for specialized training.

You also need to consider other major hazards such as noise and electrical hazards. The emergency may occur in an area where it is very hot or very cold.

Noise

Noise can add additional stress during an emergency response. High levels of noise can make it more difficult for responders to communicate with each other, especially if they are wearing Level A or Level B protection and are communicating by radio. A noisy emergency situation can make communicating by radio difficult. A noisy emergency situation can also make it difficult for responders to think clearly. Noise, therefore, can





TASKS DURING A RESPONSE

really interfere with the ability of responders to do their job effectively. When planning for emergencies, you need to be prepared for noisy situations which could hamper communication and an effective response.

Even under normal, non-emergency conditions the work environment can be noisy. Your work environment is too noisy if you have trouble hearing someone speaking in a normal voice several feet from you. Likewise it is too noisy if you sense a temporary loss of hearing or a ringing in your ears after getting off of work. Noise and the accompanying vibration may cause a great deal of damage to your body and you may not be conscious of it.

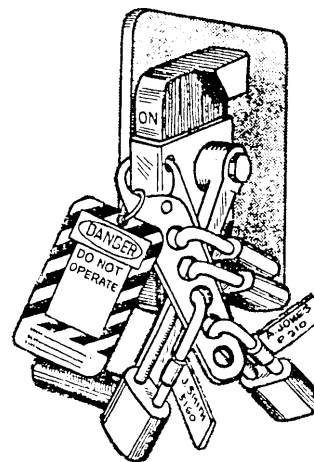
Excessive noise exposure causes temporary, followed by permanent, hearing loss. Noise may also contribute to high blood pressure, heart disease and nervous system damage.

People often mistakenly think that if they wear hearing protection they will not be able to hear their co-workers. Ear protectors block out high frequencies, so if the noise is at a higher frequency than human speech, you can hear voices better with protectors. However, if the noise is below speech frequencies, then voices will be just as hard to hear as they are without protectors. OSHA requires a Hearing Conservation Program whenever workers are exposed to noise at or above 85 dBA (decibels).

Electrical Hazards

During an emergency response, you may need to shut off power to a machine or process or to an entire area. If you do shut off power, then put a lock on the main on/off switch. Companies should already have in place a lock-out/tag-out program which is designed to isolate and control any form of energy or equipment.

In addition to electricity, injuries can be caused by water pressure, air pressure, mechanical or chemical forms of energy. For instance, even though there is no power on, the sheer weight of a moving part in a raised position may make it drop down. Other examples of possible hazards include: steam under pressure, compressed air, energy stored in springs, electrical capacitors and suspended parts.



Sometimes, however, you will need to keep the power on. In that event, you have to prepare for working safely. This means staying clear of moving parts and machinery that contain stored energy (under pressure or in springs), and keeping sources of electricity shielded from spilled liquids.

These electrical hazards can themselves become emergency situations, injuring workers doing routine operations or maintenance work. But electrical hazards can also pose dangers to emergency personnel responding to chemical or other non-chemical emergencies. During an emergency response, you need to be aware of all potential electrical hazards to response personnel. Whether the power remains on or off, you need to make sure that the responders remain clear of energy stored in machines, electric lines, and pipes.

Cold Exposure

You may respond to an incident outdoors in the winter, or your facility may use cold rooms or cold storage. Cold dangers are worse if there are high winds, or if workers are wet. Workers also may receive cold burns from cryogenic liquids (such as liquid nitrogen, liquid oxygen, and liquid argon) and compressed gases.



The most severe danger of cold weather is **frostbite**, where the skin tissue freezes. The hands and feet may become numb. After prolonged exposure to cold, they may become frostbitten as ice forms in the fingers and toes. Severe frostbite may require amputation. Prolonged exposure to cold raises the risk of hypothermia, which means that the body loses its ability to produce its own internal heat. In extreme cases, this can result in unconsciousness and death.



TASKS DURING A RESPONSE

To ward against cold hazards dress in layers (wearing chemical protective clothing itself provides warmth), keep dry, provide a warm place to rest and have hot water for showering and heated areas for dressing.

Heat Exposure

Emergency Responders are at special risk for heat-related illness. The demands of the job—including physical labor, working in hot temperatures, and wearing protective clothing—significantly contribute to heat stress. It is important that you recognize the warning signs and know the steps for preventing and treating heat-related illness.

When the body loses excessive amounts of water and salts, a person becomes tired, stressed and worn down. This causes loss of energy, irritability, lack of concentration and increased anxiety. Heat stress can increase the chance of mistakes, trips, falls and other injuries. (See Chapter 6 on Chemical Protective Clothing for more information.)



CONFINED SPACES

A 33 year old man died while cleaning out an ink tank. He entered the tank through a small opening wearing a respirator that supplied air from outside the tank. Dangerous vapors began to collect in the tank. His respirator failed and no one was prepared to rescue him.

Confined spaces exist in many workplaces. Common examples include degreasers, boilers, utility vaults, sewers, silos, storage tanks, vats and trenches. Each year about 60 workers are killed and almost 15,000 accidents occur in confined spaces. Over half the workers who die are rescuers. How can you protect yourself and co-workers from confined space injury?

- Know how to recognize confined spaces and the kinds of hazards they can pose.
- Know what should-and should not-be occurring in such spaces.
- Know to stay out if you are not properly trained and equipped to work in such spaces.

OSHA's Confined Space Standard: 29 CFR 1910.146

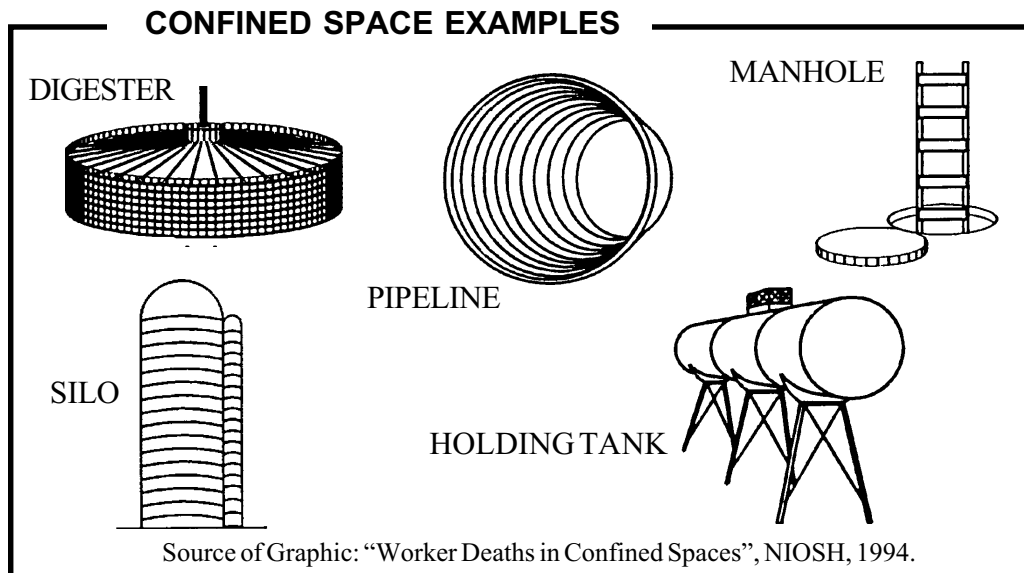
OSHA has a comprehensive standard governing confined spaces in general industry. Employers must develop and implement a written program that explains where confined spaces are located and how, when and why workers will enter them. Employers must ensure that only designated specially trained and equipped workers can enter hazardous confined spaces. Such a program must address procedures for evaluating spaces, precautions during entry, protection during work and backup in case of emergencies. The program should be sufficiently thorough to allow for entry once, and only once, to perform necessary tasks.

OSHA defines two kinds of confined space:

1. Non-Permit Required Space
2. Permit Required Confined Space

A **non-permit required confined space** is defined by OSHA as a confined space that does not contain, or have the potential to contain, any hazard of causing death or serious physical hazard but:

- Is large enough for a worker to enter and perform work.
- Has limited or restricted entrances or exits.
- Is not designed for continuous employee occupancy.



OSHA has designated certain confined spaces as especially hazardous. These are called **permit-required confined spaces**. A permit required confined space may present any one or more of the following threats:

- Lack of oxygen.
- Presence of a flammable atmosphere.
- Contain a toxic atmosphere.
- Threaten to engulf an entrant.
- Is shaped so that a worker can become trapped inside.
- Poses threats such as excessive noise, radiation, mechanical or electrical hazards.

Facilities must be surveyed to check if there are permit-required spaces present. The employer must look at a wide range of possibilities:

• **Hazardous atmosphere:** By far the biggest danger confined spaces pose is that it is easy to mistake a hazardous atmosphere for a normal atmosphere. Confined spaces may hold an atmosphere very different from the normal atmosphere we breathe. The space may not contain enough oxygen or it may be filled with an invisible deadly gas. The space also may allow the concentration of a hazardous chemical to build up to such a level that a spark may cause a fire or an explosion.

• **Flammable or toxic vapors:** A space may not normally contain flammable or injurious vapors. However, on certain occasions, for instance, when performing repairs and maintenance, you may generate toxic or flammable vapors.

Example: Using a can of spray paint containing a volatile organic propellant in a confined space can lead to a build-up of the volatile chemical in the air. Employers, therefore, must consider that any tools and/or materials brought in for use in a confined space might increase the hazards.

• **Monitor the air first:** One should carefully monitor the atmosphere in any confined space before opening it fully for entry. For example, monitoring is usually done around a manhole cover. This is to ensure that no flammable or toxic substances flow out suddenly when the confined space is opened and affect the person entering. Once the space is tested and found safe, it can be opened. Monitoring should then be performed around the rim of the opening. If monitoring results are satisfactory, only then can the space be entered safely. Monitoring should be performed continuously while the confined space is occupied in case conditions start to change.

• **Engulfment by loose material:** Finely divided loose materials such as sand, gravel or grain can surround and engulf someone in a silo or bin. Objects can fall into a confined space or material caked on the walls of a confined space can suddenly dislodge and injure or bury a worker.

• **Dangerous equipment:** Electrical or mechanical equipment in the space may be started. Rotating blades, agitators and mixers can be very dangerous. Materials may be released into the space because someone turns a valve or opens a line. Lock out and tag out all forms of energy.

• **Extreme temperatures:** Confined spaces may be extremely hot or extremely cold.

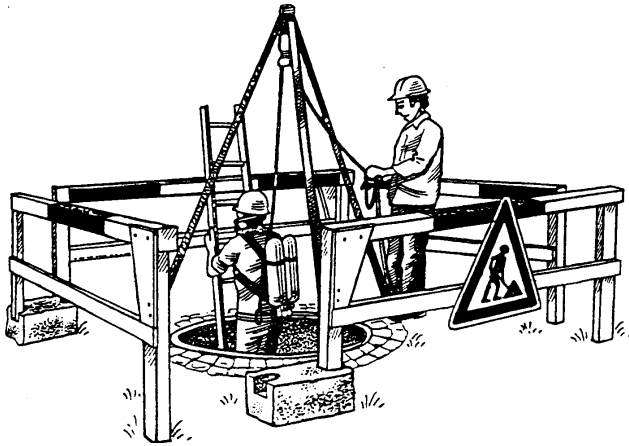
Once the confined space survey is completed, employees must be:

- Informed about the locations and dangers in each space.
- Prohibited from entering, unless specifically trained and designated to enter.

The Written Program

An employer's confined space permit program must:

- Identify the hazards in each space.
- Prevent unauthorized entry.
- Identify who is authorized to enter, why and for how long.
- Eliminate, isolate, or control hazards.
- Specify how the space will be monitored for atmospheric and other hazards.
- Mandate use of a trained lookout or attendant outside the confined space.
- Ensure that there is effective communications.
- Provide appropriate equipment, personal protection and training for personnel.
- Ensure that there is a means of rescue in place **before anyone enters**.



In most cases, an attendant **MUST be present whenever someone enters a permit-required confined space.**

Source of graphic: " Safety, Health and Welfare on Construction Sites, A Training Manual", International Labor Office, 1995, p. 42.

Entry Permit System

Whenever workers enter a confined space, a supervisor must sign an entry permit to authorize their entry. The permit must be made available to all entry personnel. It is valid only for the amount of time it takes to complete the tasks specified on the permit. It must be cancelled on completion of the job. Permits must be kept on file for at least one year. A sample Confined Space Entry Permit can be found at the end of this section. Examine it and note especially the level of documentation required before any entry is attempted.

Training

The OSHA standard requires special training for workers supervising, entering or acting as attendants for confined spaces. Confined space rescue workers must receive additional special training.

Contractors

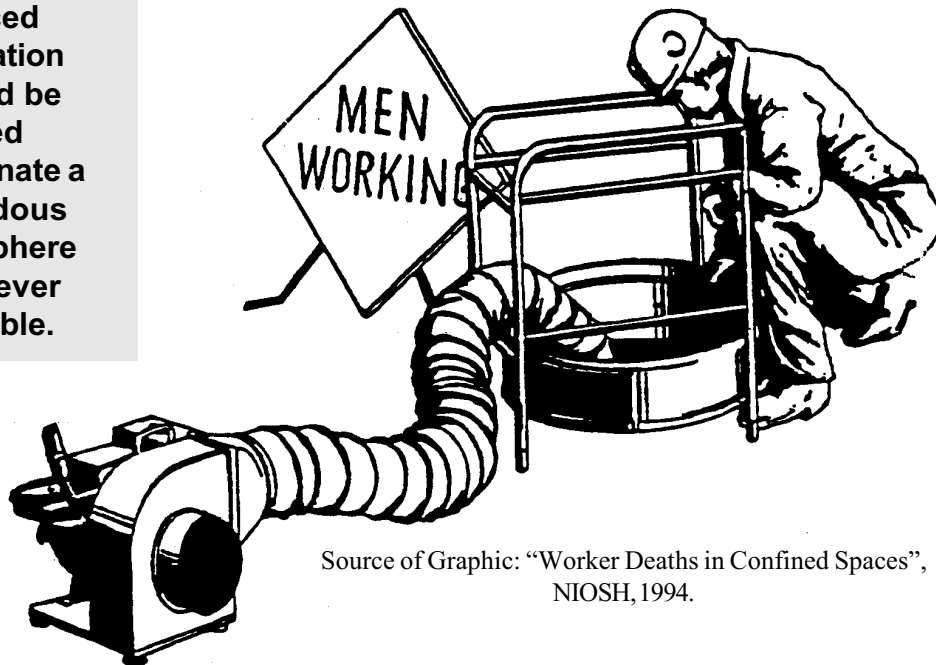
When contractors are required to enter a confined space, the host employer must inform the contractor of the confined space hazards and of the procedures for entry into the space. The host employer and the contractor must coordinate entry operations when both will be working in or near confined space.

Alternative Rules For Confined Space Entry

If the only hazard in a confined space is atmospheric and it can be controlled and eliminated by mechanical ventilation, OSHA allows a modified version of their confined space requirements. However, to properly ventilate a space is not as easy as it sounds. Knowledge of the dynamics of how air flows in, through and out of spaces is essential. OSHA's modified permit entry includes the following key points:

- Written certification that the space is safe for entry.
- Forced ventilation must be used to eliminate the hazardous atmosphere before and throughout an entry.
- Testing of the atmosphere both before entry and during work time in the confined space.
- Employees must leave immediately if a hazardous atmosphere develops while performing work in the confined space.

Forced ventilation should be used to eliminate a hazardous atmosphere whenever possible.



Source of Graphic: "Worker Deaths in Confined Spaces", NIOSH, 1994.



CONFINED SPACE ENTRY PERMIT

Date and Time Issued: _____ Date and Time Expires: _____

Job site/Space I.D.: _____ Job Supervisor: _____

Equipment to be worked on: _____ Work to be performed: _____

Stand-by personnel: _____

1. Atmospheric Checks: Time _____

Oxygen _____ %	Yes	No
Explosive _____ % L.F.L.	()	()
Toxic _____ PPM	()	()

2. Tester's signature _____

3. Source Isolation (No Entry):
Pumps or lines banded, disconnected, or blocked: _____ Yes _____ No _____

4. Ventilation Modification:
Mechanical _____ () _____ ()
Natural Ventilation only _____ () _____ ()

5. Atmospheric check after Isolation and Ventilation:
Oxygen _____ % > 19.5%
Explosive _____ % L.F.L. < 10%
Toxic _____ PPM < 10 PPM H2S
Time _____

6. Communication procedures: _____

7. Rescue procedures: _____

8. Entry, standby, and back up persons:
Successfully completed required training?
Is it current? _____ () _____ ()
Yes _____ () _____ ()
No _____ () _____ ()

9. Equipment:
Direct reading gas monitor tested _____ () _____ ()
Safety harnesses and lifelines for entry and standby persons _____ () _____ ()
Hoisting equipment _____ () _____ ()
Powered communications _____ () _____ ()
SCBA's for entry and standby persons _____ () _____ ()
Protective clothing _____ () _____ ()
All electric equipment listed Class I, Division I, Group D and Non-sparking tools _____ () _____ ()

10. Periodic atmospheric tests:

Oxygen _____ %	Time _____	Oxygen _____ %
Oxygen _____ %	Time _____	Oxygen _____ %
Explosive _____ %	Time _____	Explosive _____ %
Explosive _____ %	Time _____	Explosive _____ %
Toxic _____ %	Time _____	Toxic _____ %
Toxic _____ %	Time _____	Toxic _____ %

We have reviewed the work authorized by this permit and the information contained here-in. Written instructions and safety procedures have been received and are understood. Entry cannot be approved if any squares are marked in the "No" column. This permit is not valid unless all appropriate items are completed.

Permit Prepared By: (Supervisor) _____

Approved By: (Unit Supervisor) _____

Reviewed By (Cs Operation Personnel) _____ (signature)

This permit to be kept at job site. Return job site copy to Safety Office following job completion.
Copies: White Original (Safety Office) Yellow (Unit Supervisor) Hard (Job site)

Activity 10:

DEVELOPING AN EMERGENCY RESPONSE PLAN

Working in your groups, return to the risk map you created in Activity 2. Based on that risk map, develop a simple emergency response plan. This Emergency Response plan should address any chemical hazards, as well as physical hazards, such as confined spaces, heat, cold, slips, trips, falls, etc. If you haven't finished filling in the chemical release chart for your chemical(s), please do so at this time. A blank chemical release chart is provided on the next two pages.

Your group should **choose one chemical and one of the following three areas** to focus on:

- loading dock.
- lab.
- storage area.

In particular your plan needs to determine the following:

- The roles of the Emergency Response team members. Outline the key tasks of the team members, including hazard assessment, entry, hazard control and mitigation, and decontamination.
- How to secure the area.
- How to communicate.
- How to isolate and evacuate the area.



Chemical Release Chart		
Product:	Date prepared:	Reviewed:
Location(s)		
Quantity:	Container Size(s)	
Hazards		
Flash Point:	LEL:	UEL:
Vapor Density:	Vapor Pressure:	Specific Gravity:
PEL:		IDLH:
Reacts with:		
Corrosive:	YES	NO
Routes of entry into the body:		
Acute & chronic health effects:		
Protective Equipment		
Respirator:		
Type of filters (if needed)		
Suit: level and material		
Boots:		
Eye/Face:		
Gloves, outer: material:		Gloves, inter material:
Spill Response Equipment		
Air Monitoring:		
Personnel Monitoring:		
Soil & Water Sampling:		
Absorbents:		
Decontaminates:		
Other Equipment:		

Personnel Decontamination Procedures
Include drawing:
Response Procedures
How many gallons or number of square feet covered is called a small spill? Number of gallons _____ Number of square feet _____ Over this size spill is a large spill.
Small Spill Response
What is the largest size spill you can handle?
Large Spill Response
Call for outside help? Yes No



SUMMARY SHEET

CHAPTER 10: TASKS DURING A RESPONSE

- ✓ Preventing and anticipating emergencies is the best way to protect your health and safety, and should happen well before you ever respond to an emergency situation. You can anticipate emergencies by looking closely at the chemical and non-chemical hazards at your worksite.
- ✓ Each member of the emergency response team must receive training on the role(s) and activities he/she is expected to carry out. Each emergency responder should understand how he/she fits in with other responders.
- ✓ In an emergency, it is crucial that workers in a facility be able to communicate easily and effectively with each other and with the outside world. Communication systems and alarms should be established and practiced.
- ✓ Emergency responders should be prepared for non-chemical, physical emergencies, as well as chemical emergencies:
 - medical and first aid.
 - structural/equipment malfunction.
 - fire.
 - noise.
 - temperature extremes.
 - confined space.
 - rescue.
- ✓ Responders should know how to recognize confined spaces and the hazards present, such as dangerous atmospheres, electrical and equipment hazards, temperature extremes, loose material, and falling objects. You should know the rules and procedures for entering confined spaces.
- ✓ Responders should secure an emergency site, determine the boundaries of the hot zone (once the emergency is somewhat under control), and establish safe distances and evacuation locations for non-emergency personnel. These procedures and distances should be prepared as much as possible in advance.

continued on the next page

SUMMARY SHEET

CHAPTER 10: TASKS DURING A RESPONSE

- ✓ Employers who decide to evacuate all employees from the workplace during an emergency, rather than respond, do not have to have an emergency **response** plan. However, all companies using hazardous material must have an emergency **action** plan that follows the requirements of OSHA Standard 1910.38 (Employee Emergency Plans and Fire Prevention Plans).
- ✓ As part of emergency planning, decontamination procedures should be in place for personnel who are exposed to hazardous substances.



APPENDIX A – SOURCES OF INFORMATION AND RESPONSE ASSISTANCE

Introduction

Many reference texts and organizations can provide you with technical data and physical assistance.

It is advisable to get data from at least two sources. Use the latest edition of any reference, especially when searching for hygienic standards or toxicological data.

Basic References

A. NIOSH/OSHA Resources

1. NIOSH/OSHA Pocket Guide to Chemical Hazards. U.S. Government Printing Office, Washington, DC 20402. Telephone: 202-783-3238.

Information in this pocket guide comes from the NIOSH/OSHA Occupational Health Guidelines.

2. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. U.S. Government Printing Office, Washington, DC 20402. January 1981, DHHS (NIOSH) Publication No. 81-123.

This three-volume document provides technical data for most of the substances listed in the NIOSH/OSHA Pocket Guide. The information is much more detailed and is designed primarily for use by industrial hygienists and medical surveillance personnel. In addition to the information found in the “Pocket Guide,” “Occupational Health Guidelines” includes recommended medical surveillance practices, air monitoring and measurement procedures, personnel sanitation, and spill and disposal techniques. This document is also available online at: www.cdc.gov/niosh/81-123.html

B. 2000 North American Emergency Response Guidebook. U.S. Department of Transportation. Available from J.J. Keller, 800-327-6868.

A must-have item for the first responder. This guidebook provides information on placarding, public safety and emergency response -- including evacuation and zone site distances -- for a wide range of hazardous chemicals.

APPENDIX A • Pg 2

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

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

- D.** Fire Protection Guide on Hazardous Materials. National Fire Protection Association (NFPA), Quincy, MA 02269.
Telephone: 617-770-3000.

The NFPA has combined five manuals into one comprehensive guide on hazardous materials. This manual presents a large amount of information, but deals with pure chemicals, not mixtures. Some experience is required to interpret the manual properly.

- E.** TLVs and BEIs (1997). ACGIH, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634. Telephone: 513-742-2020.

This pocket guide, from ACGIH, contains TLVs for chemical substances and physical agents, as well as biological exposure indices for chemical substances, in the work environment.

- F.** OHMTADS: Oil and Hazardous Materials Technical Assistance Data System, developed by the EPA. Available on CD-ROM at EPA Region I Library.

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

- G.** Hazardous Chemicals Desk Reference, 4th edition, Richard J. Lewis

This Desk Reference lists many types of commonly used industrial chemicals with their reported exposure limits, chemical properties and associated health effects. It lists chemicals in alphabetical order and presents all of the information in an easy to follow format. This guide can be used as a quick reference to determine the general hazard level of a chemical.



Telephone Hot Lines

A. OSHA HAZWOPER Compliance Hotline: 1-301-515-6796.

24-hour phone message capability. Staffed Mon.-Fri., 8 a.m. - 5:30 p.m. Eastern Time. Provides information about compliance with OSHA's HAZWOPER requirements, including emergency response under paragraph (q).

B. National Response Center (NRC) Hotline: 1-800-424-8802.

This hotline, operated by the U.S. Coast Guard, is available 24 hours a day, every day of the year. NRC is the sole federal point of contact for reporting oil and chemical spills.

C. Emergency Planning and Community Right-to-Know Information Hotline: 1-800-535-0202.

Operates Mon.-Fri., 8:30 a.m. - 7:30 p.m. Eastern Time. Provides communities and individuals with help in preparing for accidental releases of toxic chemicals. This hotline, which complements the RCRA/Superfund Hotline, is maintained as an information resource rather than an emergency number.

D. RCRA/CERCLA (Superfund) Hotline: 1-800-424-9346.

Operates Mon.-Fri., 8:30 a.m. - 7:30 p.m. Eastern Time. Provides information about RCRA and Superfund and responds to requests for documents.

E. Chemical Transportation Emergency Center (CHEMTREC) 24-Hour Emergency Hotline: 1-800-424-9300.

CHEMTREC is a 24-hour public service of the chemical industry that provides immediate emergency response information and assistance during emergencies involving chemicals.

Non-Emergency Inquiries: 1-800-262-8200. Operates during regular business hours, Eastern Time.

F. Toxic Substances Control Act (TOSCA) Hotline: 1-202-554-1404.

Operates Mon.-Fri., 8:30 a.m. - 5 p.m. Eastern Time. Provides both general and technical information and publications about toxic substances, including asbestos and lead.

Computer Systems and Software

- A. HACS: Hazard Assessment Computer System. Access through the National Response Center, telephone 800/424-8802. HACS, the computerized counterpart of Volume 3 of the CHRIS manuals, makes it possible to obtain very detailed hazard evaluations through the computer at Coast Guard Headquarters. The system is intended primarily for use by the OSC.
- B. CAMEO: Computer Aided Management of Emergency Operations, National Oceanic and Atmospheric Administration Hazardous Materials Response Branch, Seattle, Washington, 98115. (206) 526-6317. Contains a chemical database and community planning program.
- C. SKIM: Spill Clean-Up Inventory System, developed by the U.S. Coast Guard.
- D. CIS: Chemical Information System; administered for the U.S. Government by Interactive Sciences Corporation, Suite 301, 918 16th St., N.W., Washington, DC 20006. This system contains 12 subfiles of toxicological, analytical and physical properties of chemical substances.



Internet Resources

Various information sources are available through the Internet. Much of this information can be accessed through Internet homepages established by organizations. Web browser software is needed to access these homepages. A homepage is like a menu. The following are some Internet sites which are particularly important for emergency responders:

- **OSHA - <http://www.osha.gov>**
Provides access to a growing body of federal OSHA information, including the Technical Manual, compliance directives, and regulations.
- **OSHA - <http://www.osha-slc.gov/SLTC/EmergencyResponse/index.html>**
OSHA's HAZWOPER emergency response web page. This site contains the ways to recognize, control, enforce, and train for emergency response. The site contains fact sheets that can be downloaded.
- **National Response Center - <http://www.nrc.uscg.mil/index.html>**
NRC is the sole federal point of contact for reporting oil and chemical spills. This web site offers information about reporting requirements and the source legislation, incident summaries, and an electronic copy of the reporting form.
- **National Response Team - <http://www.nrt.org>**
This site deals specifically with emergency response issues. Many of the links that come from this site were developed from actual incidents and exercises.
- **EPA Chemical Emergency Preparedness and Prevention Office - <http://www.epa.gov/swercepp/>**
Provides EPA information about accident preparedness and community right-to-know, emergency response, accident histories and investigations, links to information about emergency response for governments, and guidance for implementing EPA's Risk Management Plan rule.
- **EPA RCRA, Superfund, and EPCRA Hotline - <http://www.epa.gov/epaoswer/hotline>**
This site provides links to the EPA program areas supported by the hotline, hotline reports, regional and state contacts, and hotline training information.
- **LEPC/SERC Net - <http://www.rtk.net/www/lepc/webpage/mosaic.html>**
Local Emergency Planning Committee/State Emergency Response Commission on-line network. Provides information about LEPCs and SERCs, an LEPC newsletter, an LEPC/SERC database, and other information.

- **CHEMTREC (Chemical Transportation Emergency Center) -**

<http://www.cmahq.com/chemtrec.html>

CHEMTREC is a 24-hour public service of the chemical industry that provides immediate emergency response information and assistance during emergencies involving chemicals. The types of information provided include: spill control and firefighting, emergency medical treatment, manufacturer contact, and chemical information from a database of 1.5 million MSDSs.

- **Vermont SIRI (Safety Information on the Internet) -**

<http://www.siri.org/msds/hazard.com>

Maintains one of the most extensive archives of Material Safety Data Sheets, which are easily downloaded.

- **NIOSH - <http://www.cdc.gov/niosh/homepage.html>**

NIOSH home page and access to NIOSHtic, published health and safety articles.

- **University of Akron - Hazardous Chemical Database -**

<http://ull.chemistry.uakron.edu/erd>

Focuses on emergency response to releases of hazardous substances. Provides physical properties of almost 2,000 chemicals, incompatibilities, registry numbers, NFPA ratings, and the DOT safety guide for these chemicals.

- **Agency for Toxic Substances and Disease Registry (ATSDR) -**

<http://atsdr1.atsdr.cdc.gov:8080/hazdat.html>

Hazardous Substance Release/Health Effects Database (HazDat) provides information on the release of hazardous substances from Superfund sites or from emergency events and on the effects of hazardous substances on the health of human populations.

- **National Oceanic and Atmospheric Administration (NOAA) - Chemical Reactivity Worksheet -**

<http://response.restoration.noaa.gov/chemaids/react.html>

This web site can help you find the reactivity of substances or mixtures. The worksheet includes a database of reactivity information for over 4,000 hazardous chemicals, information about the special hazards of each chemical and about whether a chemical reacts with air, water, or other materials, and a way for you to virtually "mix" chemicals and find out what dangers could arise from accidental mixing.



SOURCES OF INFORMATION • Pg 7

- **Envirosources - <http://www.envirosources.com>**

This is a search engine for environmental, health and safety, civil engineering and related fields.

Other useful web sites include:

- Canadian Center for Occupational Health and Safety -
<http://www.ccohs.ca/resources/www.htm>
- Center to Protect Workers Rights - <http://www.cpwr.com>
- Environmental Health Centers/National Safety Council - <http://www.envirolink.org>
- Federal and State Regulations - <http://www.gate.net/~gwarbis/solutions>
- FedWorld - <http://www.fedworld.gov>
- Firenet - <http://www.life.anu.edu.au/firenet.html>
- Institute for Global Communications - <http://www.igc.apc.org>
Maintains news, information and resources for a democratic labor movement (LaborNet) and for environmental activists (EcoNet).
- NIEHS Superfund Information Systems
<http://www.niehs.nih.gov>
- Occupational Health Resources on the Internet: Prepared by the Pacific Northwest section of American Industrial Hygiene Association
<http://users.aol.com/dehawes2/pnsaiha.html>
- Safety Online - <http://www.safetyonline.net>
- U.S. Centers for Disease Control - <http://www.cdc.gov>
- U.S. National Institutes of Health - <http://www.nih.gov>
- Workplace Safety and Health Law
<http://www.law.cornell.edu/topics/workplacesafety.html>
- World Health Organization - <http://www.who.ch>

Technical Assistance Organizations

A. Public

1. National Institute for Occupational Safety and Health (NIOSH). NIOSH publishes technical reports, a Publications Catalog, and also the NIOSH Bookshelf. You can contact NIOSH directly at: NIOSH Headquarters, Building 1, Room 3007, Centers for Disease Control, 1600 Clifton Road, Atlanta, GA 30333, 800-356-4674 ; publications, 404-639-3061.
2. IRAP: Interagency Radiological Assistance Plan. Access through CHEMTREC telephone 800-424-9300 (24 hours). IRAP is designed to assist in coping with radiation emergencies. It operates through DOE.
3. Coast Guard National Strike Force. National Response Center, telephone 800-424-8801.
4. U.S. Army Technical (Escort Center). Chemical Emergency Response Team. Department of the Army, Operations Center, telephone 301-521-2185.
5. Department of Transportation (DOT) Hotline, telephone 202-426-2075. Provides information regarding DOT regulations, as defined in CFR Chapter 49.
6. The Agency for Toxic Substances and Disease Registry, Public Health Service, Atlanta, Georgia 30332. Telephone: 404-639-0700 This agency provides health information about protection from hazardous wastes and substances.
7. Massachusetts Poison Information Center, 300 Longwood Avenue, Boston, MA. Telephone: 617-232-2120. A 24-hour hotline providing information and guidance on common household and industrial exposures.
8. Nuclear Regulatory Commission (NRC), King of Prussia, PA. Telephone: 215-337-5000. Provides radiological assistance.



SOURCES OF INFORMATION • Pg 9

9. National Technical Information Services (NTIS). NTIS is a self-supporting agency of the U.S. Department of Commerce and the largest single source for public access to federally-produced information. NTIS, Springfield, VA 22161, 703-487-4650, 703-321-8547 (fax). Call 703-487-4679 for assistance first.
10. National Libraries of Medicine (NLM) - MEDLARS system; phone: 800-638-8480. The National Library of Medicine manages a computerized system of over 40 databases and databanks called MEDLARS (MEDical Literature Analysis and Retrieval System).
11. University of Connecticut Health Center, Lyman Maynard Stowe Library, 263 Framingham Ave, Farmington, Connecticut 06034-4003, phone: 203-679-4500, fax: 203-679-1305.

B. Private

CHEMTREC is a clearinghouse providing a 24-hour telephone number for chemical transportation emergencies. It covers over 3,600 chemicals which have been submitted by manufacturers as the primary materials they ship. CHEMTREC is sponsored by the Chemical Manufacturers Association, although nonmembers are also served.

When an emergency call is received by CHEMTREC, the person on duty writes down the essential information and then gives the caller information on hazards of spills, fire, or exposure that the manufacturers of the chemicals involved have furnished.

CHEMTREC's function is to serve as the liaison between the person with the problem and the chemical shipper and/or the manufacturer, the people who know the most about the product and its properties.

1. CHLOREP: Chlorine Emergency Plan. Access through CHEMTREC.
2. Bureau of Explosives, Association of American Railroads (AAR), telephone 202-639-2100 This 24-hour emergency number can be used for assistance for hazardous materials incidents involving railroads. This office is often contacted through CHEMTREC.

WHERE TO GET INFORMATION ON HEALTH AND SAFETY RIGHTS

The following is a list of organizations and federal and government agencies that will help you understand your rights under federal, state and local laws. They are also sources of information about job hazards and actions you can take to protect yourself.

Federal Agencies

Occupational Safety and Health Administration
Region I (CT, MA, ME, NH, RI, VT)
John F. Kennedy Federal Building, Room E340
Boston, MA 02203
617-565-9827, Fax 617-565-9860

National Institute for Occupational Safety and Health
Region I (CT, MA, ME, NH, RI, VT)
John F. Kennedy Federal Building
Boston, MA 02203
617-565-7164

Environmental Protection Agency
Region I (CT, MA, ME, NH, RI, VT)
John F. Kennedy Federal Building
Boston, MA 02203
617-565-3420



OSHA Area Offices

Connecticut

Bridgeport
One Lafayette Square
Suite 202
Bridgeport, CT 06604
203-579-5516 (fax)
203-579-5581

Hartford
Federal Building, Room 508
450 Maine Street
Hartford, CT 06103
860-240-3155 (fax)
860-240-3152

Maine

Augusta
Federal Building- Room 121
40 Western Avenue
Augusta, ME 04330
207-626-9120 (fax)
207-622-8417

Bangor
202 Harlow Street
Room 211
Bangor, ME 04401
207-941-8179 (fax)
207-941-8177

Massachusetts

Boston
John F. Kennedy Federal Building
Room E340
Boston, MA 02203
617-565-9860 (fax)
617-565-9827

Braintree
639 Granite Street
4th Floor
Braintree, MA 02184
781-565-6923 (fax)
781-565-6929

Methuen
13 Branch Street
Methuen, MA 01844
978-565-8115 (fax)
978-565-8110

Springfield
1145 Main Street
Springfield, MA 01103
413-785-9136 (fax)
413-785-0123

New Hampshire

Concord
279 Pleasant Street
Room 126
Concord, NH 03301
(603)225-1580 (fax)
(603)225-1629

Rhode Island

Providence
380 Westminster Mall
Room 243
Providence, RI 02903
401-528-4663 (fax)
401-528-4667

New England Region State Agencies

CONNECTICUT

Connecticut OSHA
Connecticut Department of Labor
200 Folly Brook Blvd.,
Wethersfield, CT 06109
860-566-7184 (Safety)
860-566-2339 (Health)

Division of Worker Education
Workers' Compensation Commission
1890 Dixwell Avenue
Hamden, CT 06514
203-789-7783

Connecticut State Emergency Response
Commission
Department of Environmental Protection
Room 161 State Office Building
Hartford, CT 06115
860-566-4856

Department of Environmental Protection
State Office Building
Hartford, CT 06115
860-566-2110

Solid Waste Management Unit
Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, CT 06115
860-566-3672

Connecticut Resources Recovery
Authority
179 Allyn Street
Hartford, CT 06103
860-549-6390

Hazardous Waste Materials
Management Unit
Department of Environmental
Protection
122 Washington Street
Hartford, CT 06115
203-566-5148

MAINE

Department of Environmental Protection
State House
Office of the Commissioner
Station 17
Augusta, ME 04333
287-2812 Secretary
207-287-7688 central reception

Bureau of Hazardous Materials and Solid
Waste Control
Department of Environmental Protection
State House
Station 17
Augusta, ME 04333
207-287-2651

Land Quality Control Bureau
Department of Environmental Protection
State House
Station 17
Augusta, ME 04333
207-287-2111



MASSACHUSETTS

Massachusetts Department of Labor and Industries
Division of Occupational Hygiene
1001 Watertown Street
West Newton, MA 02165
617-969-7177

Massachusetts Attorney General
Division of Fair Labor and Business Practices
One Ashburton Place
21st Floor, Room 1
Boston, MA 02108
617-727-2200 x3476

Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202
617-727-9800

Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02202
617-292-5504

Department of Environmental Management
100 Cambridge Street
Boston, MA 02202
617-727-3260

Department of Public Health
Occupational Health Surveillance Program
250 Washington Street
Boston, MA 02108
617-624-5632

Division of Hazardous Waste
Office of Incident Response
One Winter Street
Boston, MA 02202
617-292-5851

Department of Environmental Protection
Division of Water Pollution Control
One Winter Street
Boston, MA 02202
617-727-3855

NEW HAMPSHIRE

NH Emergency Management Agency
State Office Building
State Park South
107 Pleasant Street
Concord, NH 03301
603-271-2231

Department of Environmental Services
Water Supply and Pollution
Commission Hazen Drive, P.O. Box 95
Concord, NH 03301
603-271-3503

Bureau of Solid Waste Management
Health and Human Services
6 Hazen Drive, P.O. Box 95
Concord, NH 03301
603-271-2900

Department of Labor
95 Pleasant Street
Concord, NH 03301
603-271-3176

NEW HAMPSHIRE (Cont.)

Air Resources Agency
64 North Main Street, 2nd Fl
Concord, NH 03302-2033
603-271-1370

Department of Health and Welfare
Division of Public Health Services
Office of Waste Management
6 Hazen Drive
Concord, NH 03301
603-271-2900

RHODE ISLAND

Rhode Island Emergency Management
Agency
State House Room 27
Providence, RI 02903
401-277-3039

Department of Environmental
Management
Division of Air Resources and
Hazardous Materials
291 Promenade Street
401-277-2808
Providence, RI 02908
HAZMAT: 401-277-2797
OIL SPILLS: 401-277-2234

VERMONT

Department of Labor and Industry
National Life Bldg., Drawer 20
Montpelier, VT 05620-0341
802-828-2286

Agency of Environmental Conservation
103 South Main Street
Waterbury, VT 05671-0408
802-241-3770

Hazardous Waste Management Division
West Office Bldg.
103 South Main Street
Waterbury, VT 05671-0404
802-241-3888

Vermont Occupational Safety and
Health Agency (OSHA)
National Life Bldg., Drawer 20
Montpelier, VT 05620-3401
802-828-2765

Vermont Department of Health
(Community Right-to-Know)
108 Cherry Street, P.O. Box 70
Burlington, VT 05402
802-865-7730

Agency of Environmental Conservation
Air Pollution Control
Bldg. 3 South
103 South Main Street
Waterbury, VT 05671
802-241-3840

Department of Environmental
Conservation
Water Quality Division
103 South Main Street -10-N
Waterbury, VT 05671-0408
802-241-3777



NON-GOVERNMENTAL ORGANIZATIONS

CONNECTICUT

Connecticut Council on Occupational
Safety and Health (ConnectiCOSH)
77 Huyshope Avenue
Hartford, CT 06106
860-549-1877
connecticosh@snet.net

Yale Occupational Medicine Program
333 Cedar Street
New Haven, CT 06510
203-785-5885

MAINE

Maine Labor Group on Health (MLGH)
P.O. Box V
Augusta, ME 04330
207-622-7823

MASSACHUSETTS

Massachusetts Coalition for
Occupational Safety and Health
(MassCOSH)
12 Southern Avenue
Dorchester, MA 02124
617-825-7233
masscosh@shore.net

Western Massachusetts Coalition for
Occupational Safety and Health
(Western MassCOSH)
640 Page Boulevard
Springfield, MA 01104
413-731-0760
wmcosh@javanet.com

NEW HAMPSHIRE

New Hampshire Coalition on
Occupational Safety and Health
(NHCOSH)
110 Sheep Davis Road
Pembroke, N.H. 03275-3709
603-226-0516
nhcosh@totalnetnh.net

RHODE ISLAND

Rhode Island Committee on
Occupational Safety and Health
(RICOSH)
741 Westminster Street
Providence, RI 02903
401-751-2015
jobhealth@juno.com

VERMONT

Vermont Public Interest Research
Group (Vermont PIRG)
43 State Street
Montpelier, VT 05602
802-223-5221

Other Organizations

Alternatives for Community and
Environment (ACE)
2343 Washington St.
Roxbury, MA 02118
617-442-3343

APPENDIX A • Pg 16

American Society of Safety Engineers
(ASSE)
1800 East Oakton Street
Des Plaines, IL 60018-2187
312-692-4121

American National Standards Institute
(ANSI)
11 West 42nd Street
NY, NY 10036
212- 642-4900

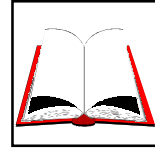
National Fire Protection Association
(NFPA)
1 Batterymarch Park
P.O. Box 9101
Quincy, Ma 02269-9101
617-770-3000

American Conference of Governmental
Industrial Hygienists (ACGIH)
Kemper Woods Center
1330 Kemper Meadow Drive
Cincinnati, Oh 45240
513-742- 2020 Fax 513-742- 3355

American Society for Testing and
Materials (ASTM)
1916 Race Street
Philadelphia, PA 19103-1187
215-299-5585 Fax 215-977-9679

American Industrial Hygiene
Association (AIHA)
2700 Prosperity Avenue Suite 250
Fairfax, VA 22031
703-849-8888 Fax 703-207- 3561

National Safety Council
444 N. Michigan Avenue
Chicago, IL 60611
312-527-4800



APPENDIX B –

Absorption

(1) The process of picking up or taking up hazardous substances to prevent the enlargement of a contaminated area. Absorbent materials such as soil, clay, kitty litter, or commercially available products are used.

(2) A route of exposure to certain chemicals by skin contact. These chemicals are absorbed through the skin on contact and are carried directly to the blood stream.

Acid

A compound with a pH less than 7. Acids turn litmus paper red. Strong acids react violently with strong bases. They are corrosive and can "eat" through metals and destroy skin tissue.

Activated Charcoal

Carbon which is steam heated to increase its surface area. It is used as an absorbent for purifying gases. Solvent vapors cling to its surface. It is used as a collection material in some respirator cartridges and sampling tubes.

Acute Effect

A harmful effect upon the human body following an exposure to a dangerous substance or material. An acute reaction or illness usually occurs within 24 hours after an exposure.

Additive Effect

One in which the combined effect of two chemicals is equal to the sum of the agents acting alone.

Administrative Control

Policies and practices written before work begins to minimize exposure to chemical and physical hazards. An example of an administrative control is scheduling frequent breaks for workers exposed to excessive heat.

Absorbent

A material which causes gases or vapors to cling to its surface when they pass over it. Absorbents such as activated charcoal are used in respirator cartridges or canisters to remove toxic gases and vapors from air.

Aerosol

The suspension of very small particles of a liquid or solid in a gas.

Air-purifying Respirator

A protective mask that uses filters (cartridges) to remove toxic materials from air.

Alkali (Base)

A chemical with a pH that greater than 7. Alkalis are usually hydroxides (OH) or carbonates (CO₃). When mixed in water they are bitter, slippery, and caustic. Strong or concentrated alkalis are corrosive and can damage skin and mucous membranes. Lye and ammonia are examples of alkalis.

Alveoli

The small air spaces within the lungs where oxygen diffuses into the blood, and carbon dioxide escapes. They are in direct contact with the blood supply. The exchange of oxygen and carbon dioxide actually takes place in these tiny air sacs.

American Conference of Governmental Industrial Hygienists (ACGIH)

An organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits and threshold limit values (see TLV) for hundreds of chemical substances and physical agents. ACGIH also develops and publishes recommended occupational exposure programs.

Anhydrous

Free from water.

Asphyxiant

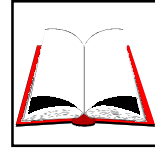
A vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Asphyxiation is one of the principal potential hazards of working in confined spaces.

Asphyxiation

Suffocation from lack of oxygen. Chemical asphyxiation is produced by a substance, such as carbon monoxide, that will combine with hemoglobin to reduce the blood's capacity to transport oxygen. Simple asphyxiation is the result of exposure to a substance, such as carbon dioxide, that displaces oxygen.

Base (Alkali)

A compound with pH higher than 7. It has the ability to neutralize an acid and form a salt. Example: Sodium hydroxide, referred to as caustic soda or lye. Bases turn litmus paper blue. Bases feel slippery and are corrosive to skin and mucous membranes.



Boiling Point

The temperature at which a liquid changes to a vapor or gas; it is the temperature at which the vapor pressure of the liquid equals atmospheric pressure.

Bronchial Tubes

Branches or subdivisions of the trachea (windpipe) leading into the lungs.

Bronchitis

Inflammation of the bronchial tubes, or infection of the bronchi (airways branching off the bronchial tubes). It results in increased mucous production and reduced breathing capacity. Both acute and chronic forms of the disease occur.

Buddy System

A work practice in which workers team up in pairs during work activities.

Bung

The cap or plug that fits into the holes in a drum.

Cancer

A group of more than 120 different diseases — one for each type of cell in the human body. Cancer cells multiply uncontrollably and invade surrounding tissue, as in lung cancer. In some cases, overproduction of cells affects the functioning of a body system, as in leukemia, the overproduction of white blood cells. Such uncontrolled growth eventually leads to death.

Carcinogen

A cancer-causing agent or substance.

Carboy

A large glass bottle, up to 15 gallons, that is protected by a crate or some other protective device. It may also be a small plastic drum that ranges from 10-15 gallons. It is used especially for holding corrosive liquids.

CAS Number

A unique number assigned to a chemical by the Chemical Abstract Service.

Catalyst

A substance that speeds up a chemical reaction.

Caustic

A corrosive chemical with a high pH (basic or alkaline).

cc

Cubic centimeter, a metric measurement about the size of a sugar cube.

Ceiling Limit

The maximum concentration of a chemical, dust, or physical agent that is allowed at any time under OSHA standards.

Central Nervous System (CNS)

The body system made up of the brain and spinal cord.

Chemical Cartridge

A filtering device which is attached to an air-purifying respirator.

Chemical Reaction

A change in which elements and compounds are combined or decomposed to produce different chemical combinations. Such changes are accompanied by energy release.

Chemical Resistance

Ability of a material to prevent chemicals from penetrating.

Chemical Protective Clothing (CPC)

Personal protective clothing, such as boots, gloves, suits, goggles, which provide some level of skin and/or eye protection from chemicals. CPC must be selected based on the chemicals to which a person is expected to be exposed.

Chromosome

Part of the cell's genetic material. Damage to chromosomes can cause harmful changes to an individual's body and may also result in birth defects.

Chronic Effect

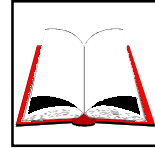
An adverse effect upon the human body which develops from a long-term or frequent exposure to a harmful substance such as a carcinogen. Chronic effects or diseases may not show up for years after exposure.

Cilia

Tiny hair-like projections in the bronchi and other respiratory passages that aid in the removal of dust trapped on these moist surfaces.

Colorimetric Detector Tubes

Tubes filled with granular material, whose color may change, indicating the presence and approximate air concentration of some specific substance.

**Combustion**

A process in which a fuel is rapidly oxidized. Such rapid oxidation usually produces heat and light (or other forms of energy).

Combustible Gas Detector

Lightweight, battery-powered indicator used for field testing for the presence of combustible gas mixtures.

Combustible Liquid

Any liquid that has a flash point at or above 100°F and below 130°F.

Compatibility Chart

A chart that rates the strength of a protective clothing material against exposure to a specified chemical.

Compound

A compound is a pure substance made of elements that are chemically combined. Example: the elements sodium and chlorine combine to make the compound sodium chloride, which is table salt. Hydrogen and oxygen combine to make the compound, water. See: molecule; mixture.

Comprehensive Environmental Response, Compensation And Liability Act (CERCLA)

The federal legislation which authorized government money for clean-up of abandoned hazardous waste sites, clean-up and emergency response to transportation incidents involving chemical releases, payment to injured or diseased citizens, etc. This is commonly known as Superfund. It was amended in 1986.

Compressed Gas

Any containerized material or mixture having an absolute pressure exceeding 40 p.s.i. at 70°F or having an absolute pressure exceeding 104 p.s.i. at 130°F.; or any liquid flammable material having a vapor pressure exceeding 40 p.s.i. absolute at 100°F.

Concentration (Air)

The amount of a chemical, dust, or other substance in a given amount of air. Example: 50 micrograms of lead in one cubic meter of air (50 ug/m³) is a concentration.

Confined Space

A space which is large enough for a person to enter, has limited means of entry and exit, and is not designed for continuous occupancy. Confined spaces have limited natural ventilation, making it easier for gases or vapors to accumulate.

Contact Dermatitis

An inflammation of the skin caused by direct contact with an irritating substance.

Contaminant

A harmful substance which may be in any of the following forms: solid, liquid, vapor, gas, mist, or particulate in the air.

Corrosive

A substance that can wear away another substance. Corrosive chemicals, such as strong acids and alkalis, can cause burns and irritation when they come in contact with human skin.

Cylinder

A compressed gas or liquefied gas container. A container having 1000 pounds of water capacity or less in accordance with Department of Transportation specifications.

Decibels (dB)

A unit of measurement to detect noise levels. The OSHA permissible exposure limit for noise is 85 dB over 8 hours.

Decomposition

The breakdown of a material (by heat, chemical reaction, decay, or other processes).

Decontamination

The removal and containment of toxic or poisonous substances from people and equipment.

Decontamination Line

A line set up with stations for decontamination procedures between the Exclusion Zone and the Support Zone.

Degradation

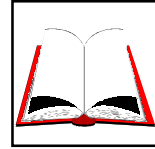
A chemical breaking up as a result of exposure to other chemicals, heat, light, time, etc.

Demand Regulator

Reduces tank pressure to provide air only when the wearer inhales. A pressure demand regulator provides the respirator wearer with continuous positive pressure and additional air when the wearer inhales.

Department Of Transportation (DOT) Hazard Classification

The hazard class designations for specific hazardous materials as found in DOT regulations.



Department Of Transportation (DOT) ID Number

The four-digit identification number assigned to a hazardous material by the Department of Transportation. It may include the prefix “UN” or “NA”. These numbers are posted on placards and shipping labels to identified hazardous chemicals during shipping.

Dermatitis

Inflammation of the skin, such as redness, a rash, dry or cracking skin, blisters, swelling, or pain. It may result from exposure to toxic, corrosive, or abrasive substances.

Dilution

A method of reducing the concentration of a chemical to a level at which it is no longer harmful; water is usually used, except when the possibility of a chemical reaction exists.

Dioxins

Common name for a family of chlorine-containing chemicals, some of which are very toxic. Extremely small concentrations of dioxins are known to cause certain types of cancers in humans and to affect the endocrine, reproductive, and immune systems of the offspring of exposed adults. The by-products of combustion-based technologies involving chlorine, dioxins have been identified in the emissions of incinerators (municipal waste, hazardous waste, medical waste, tires, and sewage sludge), cement kilns that burn hazardous waste, metal smelters and other high-temperature processes. Dioxins have also been identified in the effluents of pulp and paper mills that use chlorine as a bleaching agent as well as in the sludge of sewage plants that use chlorine for disinfection.

Dose

The quantity of a chemical taken into the body.

Dose Response

The relationship between the amount of the chemical and the degree of its effect in humans or animals.

Dose Response Curve

A graph that shows how much of the chemical dose causes an observed effect.

Dust

Fine particles of a solid that can remain suspended in air. Sometimes airborne solid particles are created by work processes, such as grinding, crushing, etc.

Emergency

An unexpected or unplanned event requiring remedial action.

Emergency Response Plan

Written descriptions of planned actions and personnel responsibilities for emergency response actions.

Engineering Controls

Engineering controls are used to eliminate chemical, biological, radiological and other hazards by mechanical means or designing the hazard out of the system. Engineering controls are the first consideration for eliminating or controlling hazards.

Environmental Protection Agency (EPA)

The federal agency responsible for the quality of the environment. EPA is mandated by the Superfund law to administer clean-up of hazardous waste sites.

Epidemiology

The study of the patterns of disease and their causes (e.g., from toxic exposure) in groups of people.

Evaporation Rate

How fast a liquid enters the air when compared with a known material. The evaporation rate can be useful in evaluating the health and fire hazards of a material.

Exclusion Zone (Hot Zone)

The area where the hazard is present. Also called the contaminated area.

Exhalation Valve

A device that allows exhaled air to leave a respirator and prevents outside air from entering the respirator.

Explosive Level

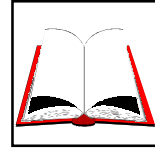
The concentrations of a gas or vapor in air which can explode. It is usually expressed as a range between a “lower explosive level” (LEL) and an “upper explosive level” (UEL). It is commonly measured by an explosimeter which reads out the concentration of a possible dangerous gas in percent of LEL.

Exposure

An exposure is the amount of chemical that is in the air that you breathe, is on your skin, or in the material you ingest.

Exothermic

A chemical reaction that produces heat.

**Explosive**

Any substance that is capable of a sudden high-velocity reaction with the generation of high temperatures and pressures.

Facepiece

That portion of a respirator that covers the wearer's nose and mouth in a half-mask facepiece; or nose, mouth, and eyes in a full facepiece. It is designed to make a gas-tight and dust-tight fit with the face, and includes the headbands, exhalation valve(s), and/or the connections for the air-purifying device of a respirable gas source.

Filter Mask

Any mask that uses a filtering material in order to remove contaminants from the air that is being breathed. An air purifying respirator.

Flammable

A liquid with a flash point below 100°F (37.8°C): Class IA, those having flash points below 73°F and having a boiling point below 100°F; Class IB, those having flash points below 73°F and having a boiling point at or above 100°F; and Class IC, those having flash points at or above 73°F and below 100°F. and having a boiling point at or above 100 °F. Flammable liquids can be fire hazards.

Flammable (Explosive) Range

The range of a gas or vapor concentration (percentage by volume in air) that will burn or explode if an ignition source is present. Concentrations at the beginning of the flammable range are commonly called the "lower flammable (explosive) limit" (LFL/LEL), and those at the end of the flammable range are called the "upper flammable (explosive) limit" (UFL/UEL). Below the lower flammable limit, the mixture is too lean to burn, and above the upper flammable limit, it is too rich to burn.

Flash Point

The minimum temperature at which a liquid gives off enough vapor to form an ignitable mixture with air.

Fume

Small solid particles of condensed vaporized metal that are formed when a metal is heated or burned.

Gram (gm)

A metric unit of weight. One U.S. ounce is about 28.4 grams.

Gas

A phase of matter that has no definite shape or volume. Material that is normally airborne at room temperature; not solid or liquid. In comparison to solids and liquids, gases have low density, diffuse readily, and have the ability to expand.

General Ventilation

A ventilation system that lessens airborne contamination by diluting workplace air.

Hazard Abatement

The process of controlling and eliminating hazards.

Hazardous Material

To be considered hazardous, a waste must be on the list of specific hazardous waste streams or chemicals, or else it must exhibit one or more of certain specific characteristics including flammability, corrosivity, reactivity, and toxicity. The definition excludes household waste, agricultural waste returned to the soil, and mining overburden returned to the mine site. It also excludes all wastewater returned directly or indirectly to surface waters. However, hazardous waste may physically be in the liquid state.

Hazardous Substance

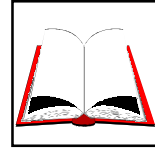
A legal term, defined in the nation's basic hazardous waste law, the Resource Conservation and Recovery Act (RCRA). In ordinary, non-legal usage, a hazardous substance is any material which in normal use can be damaging to the health and well-being of humans, plants, and animals. (To avoid confusion with the legal term, you could avoid the word "hazardous" and substitute the word "dangerous". There are many dangerous materials and substances that are not legally "hazardous".)

Hazardous Waste

This is a legal term defined in the Resource Conservation and Recovery ACT (RCRA), the nation's basic law on waste. See: Hazardous Substance.

Hazardous Waste Operations And Emergency Response (HAZWOPER)

OSHA standard which was developed to protect hazardous waste personnel and emergency response personnel.

**Heat Of Combustion**

The amount of heat that is released when a certain quantity of fuel has been consumed.

Heat Exhaustion

A condition caused by exposure to heat, resulting in the depletion of body fluids and causing weakness, dizziness, nausea, and often collapse. The condition can be alleviated by rest and by drinking fluids and electrolytes to compensate for those lost through excessive sweating. Also called heat prostration.

Heat Stroke

A life-threatening condition during prolonged exposure to intense heat when the body is unable to sweat; extremely high body temperature and collapse may result.

Heavy Metals

The major toxic metals, such as lead, mercury, and cadmium.

Hema

Blood. (Hematotoxic: harmful to blood or organs where blood is made)

Hepatic

Referring to the liver. (Hepatotoxic: harmful to liver)

Herbicide

A poison that kills plant life or vegetation.

High Explosive

Any explosive with a detonation rate at three or four miles per second. High explosives may be primary or secondary. Primary high explosives are very sensitive to heat and shock. Secondary explosives are not.

Ignition Temperature

The ignition temperature of a substance, whether solid, liquid, or gaseous, is the minimum temperature required to initiate or cause self-sustained combustion independently of the heating or heated element.

Immediately Dangerous To Life Or Health (IDLH)

IDLH conditions include those that pose an immediate threat to life or health and conditions that pose an immediate threat of severe exposure to contaminants which are likely to have delayed adverse health effects.

Incident Command System (ICS)

An organized system of personnel and delegation of responsibilities which controls the response to an emergency.

Incident Commander

Person in charge of on-site management of all activities at a hazardous materials emergency.

Incompatible

Materials which could cause dangerous reactions from direct contact with one another.

Industrial Hygienist

A person with special training and experience in assessing and controlling occupational health and safety hazards.

Inflammable

It means the same thing as flammable; a material that can burn easily.

Inflammation

A condition of the body, or portion of the body, characterized by swelling, redness, pain, and heat.

Inhalation

The process of breathing something into the lungs.

Inhalation Valve

A device that allows respirable air to enter the respirator facepiece and prevents exhaled air from leaving the facepiece through the intake opening.

Ingestion

The process of taking a substance through the mouth.

Inorganic Compound

One of two major classes of chemical compounds. Inorganic compounds contain no carbon. See: Organic Compounds.

Insecticide

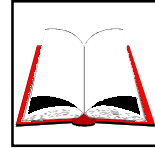
A poison that kills insects.

Integrated Emergency Management System (IEMS)

The Integrated Emergency Management System, developed by FEMA, provides a generic system for dealing with chemical spills or other emergencies.

Irritant

A substance which causes an inflammatory response when brought into contact with the eyes, skin, or respiratory system.

**Isolation**

Method of decontamination in which contaminated equipment and materials are bagged or covered and set aside, usually for subsequent shipment to an approved landfill for disposal.

Latency

The time interval between exposure to and the development of a disease.

Local Emergency Planning Committees (LEPCs)

Local Emergency Planning Committees include representatives from state and local government, law enforcement, fire fighting, health, environmental and transportation agencies, hospitals, the media, community groups, and businesses that are subject to EPCRA requirements. LEPCs develop an emergency plan to prepare for, and respond to, chemical emergencies. They also receive emergency release and chemical inventory information from local facilities and make this information available to the public on request. LEPCs serve as a focal point for the community to discuss hazardous substances, emergency planning, and health and environmental risks.

Local Exhaust Ventilation

A system which removes air contaminants from the workplace air by sucking them away from the breathing zones of workers by means of hoods, canopies, or ducts.

Lock-out

A procedure to prevent use of any electrical and mechanical equipment which must be temporarily out of service, for example during maintenance operations.

Lower Explosive Limit

The lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, flame) is present.

M

Meter; a metric unit of length equal to about 39 inches.

Main-line Valve

Controls air flow to the regulator on supplied-air respirators.

Manifest Form

Required by EPA to track hazardous wastes.

Material Safety Data Sheet (MSDS)

An MSDS is prepared by the manufacturer of a chemical, as required by federal law. It provides basic information on a chemical's physical properties and related health effects. The MSDS also gives guidance on using, storing, and handling substances to prevent or minimize health damage on the job and in emergencies such as fires and spills.

Melting Point

The temperature at which a solid substance changes to a liquid state. For mixtures, a melting range may be given.

Metabolism

The chemical reactions that go on in the body to maintain life.

Mg/M³

Milligrams per cubic meter of air. An unit for measuring the amount of a chemical or substance in the air.

Mists

Suspension of very small liquid droplets, generated by a gas condensing to a liquid state or by the aerosolization of a liquid.

Mitigation

Actions which lessen or reduce the potential for emergencies, short or long term.

Monitoring

Measuring concentrations of substances in the workplace.

Morbidity

Non-fatal disease from an exposure.

Mortality

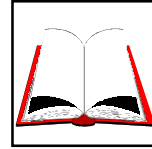
Death from an exposure.

Mucous Membrane

The moist, soft lining of the nose, mouth, and eyes.

Mutagen

A chemical or other substance (for example, an x-ray), that causes a mutation (a usually harmful change) in the genetic material of a cell. When it occurs in a sperm cell or egg cell, a mutation can be passed on to future generations.

**Mutation**

A change (usually harmful) in the genetic material of a cell. When it occurs in the sperm or egg the mutation can be passed on to future generations.

National Fire Protection Association (NFPA) Hazard Classification

The National Fire Protection Association produces many standards, including the four-color diamond used on labels to indicate hazard. The numerical designation of a substance's relative accident potential, based on probable outcomes should an accident occur. The system is used at fixed sites. Health, fire, and reactivity hazards are rated from 0 (none) to 4 (extreme). The Health rating is in the blue section, Fire in red, and Reactivity in yellow. The white section is reserved for other Specific Hazards (for example, radiation: do not use water, or fire).

National Institute For Environmental Health Sciences (NIEHS)

A federal agency responsible for issues related to the environment.

National Institute For Occupational Safety And Health (NIOSH)

The federal research agency responsible for issues related to occupational safety and health. NIOSH rates and approves respirators and advises OSHA on standard setting.

National Response Center (NRC)

The National Response Center, a communications center for activities related to response actions, is located at Coast Guard headquarters in Washington, DC.

National Response Team (NRT)

The National Response Team, consisting of representatives of 14 government agencies, is the principal organization for implementing the (National Contingency Plan) NCP. When the NRT is not activated for a response action, it serves as a standing committee to develop and maintain preparedness, to evaluate methods of responding to discharges or releases, to recommend needed changes in the response organization, and to recommend revisions to the National Contingency Plan.

Nephritis

Inflammation of kidneys. (Nephrotoxic: harmful to kidneys)

Neural

Relating to nerves. (Neurotoxic: harmful to brain and nerves)

Noise Pollution

Any unwanted, disturbing, or harmful sound that impairs or interferes with hearing, causes stress, hampers concentration and work efficiency, or causes accidents.

Nuisance Dust

A dust which is not recognized as the direct cause of a serious pathological condition, but may be irritating at high concentrations.

Occupational Health Hazard

Any type of job-related noise, dust, gas, toxic chemical, substance, or dangerous working condition which could cause an accident, injury, disease, or death to workers.

Occupational Safety And Health Administration (OSHA)

The federal agency responsible for creating and enforcing regulations relating to worker safety and health.

Oral

Taken into the body through the mouth.

Organic Compounds

One of two major classes of chemical compounds. Organic compounds all contain carbon. See: Inorganic Compounds.

Oxidation

A reaction in which a substance combines with oxygen, the oxygen being provided by an oxidizer or oxidizing agent.

Oxidizers

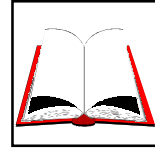
A type of reactive chemical which can feed a fire and make materials ignite more easily. In some cases, strong oxidizers may ignite spontaneously. Examples: Nitric acid, calcium peroxide, and fluorine.

Oxygen Deficient

Air which contains less than 19.5% oxygen.

Oxygen Enriched

Atmosphere containing more than 23.5% oxygen.



Parts Per Million (PPM)

A unit used to measure the concentrations of vapors or gases in contaminated air.

Percutaneous Absorption

Absorption into the skin.

Permissible Exposure Level (PEL)

The Permissible Exposure Level is an OSHA legal limit for worker exposure to particular hazards. It is illegal for a worker to be exposed above the PEL.

Penetration

This is the flow of a dangerous liquid or vapor through porous materials, seams, pinholes, zippers, or other imperfections in protective clothing.

Permeation

The process by which a chemical passes through protective clothing material at a molecular level.

Peroxides

Highly unstable compounds which can act as oxidizing agents and thus present a fire hazard.

Pesticides

A class of chemicals designed to kill or inhibit life forms that humans consider to be pests. Pesticides include fungicides, herbicides, insecticides, and rodenticides.

Petrochemicals

Chemicals obtained by refining (distilling) crude petroleum (oil) and which can be used as raw materials in the manufacture of most industrial chemicals, fertilizers, pesticides, plastics, synthetic fibers, paints, medicines, and other products.

pH

Acidic or basic corrosives are measured on a pH scale. 7.0 is the neutral point on the scale. Corrosives with a pH below 7.0 are considered acidic and those above 7.0 are considered to be basic (or caustic).

Physical Agent

Heat, noise, radiation, vibration.

Placard

A sign that identifies hazardous materials (and may indicate appropriate precautions). Placards are used on large containers.

Pneumoconiosis

This ailment is also called dusty lung. It is a scarring of lung tissue, resulting from the continued inhalation of various dusts and other particles.

Point Source

A single identifiable source that discharges pollutants into the environment. Examples are the smokestack of a power plant or industrial factory, the drainpipe of a meat-packing plant, the chimney of a house, or the exhaust pipe of an automobile.

Pollution

Substances introduced into air, water, soil, or food that are not normally present (or not normally present in such high concentrations) and that can adversely affect the health, survival, or activities of humans or other living organisms.

Polychlorinated Biphenyls (PCBs)

A Group of 209 complex chlorinated hydrocarbons that were used in the electric and electronics industries, primarily because of their great chemical and physical stability. These chemicals cause cancer. They are similar to dioxin in their persistence in the environment, their tendency to bioaccumulate in living organisms, and their toxicity.

Poison

Any substance that has the ability to destroy life when exposure is limited to small amounts that are inhaled, absorbed, or ingested over a short period of time.

Polymerization

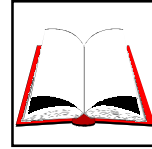
A chemical reaction in which two or more small molecules combine to form a larger molecule. Molecules of a chemical can react with each other, altering their properties. The process can make chemicals hazardous or release a hazardous gas.

Personal Protective Equipment (PPE)

Devices worn by workers to protect them against work-related hazards such as air contaminants, falling materials, and noise. While it is important to wear such equipment when required, these devices usually provide only minimal protection to workers and should have to be worn only when all other efforts have been initiated to correct an unsafe work environment. Examples of personal protective equipment include hard hats, ear plugs, respirators, and steel-toe work shoes.

Pulmonary

Having to do with lungs.



Pyrophoric Liquid

Any liquid that ignites and burns spontaneously in dry or moist air at or below 130°F.

Qualitative Fit-test

Measures effectiveness of a respirator by exposing wearer to a test atmosphere containing an irritating smoke, sweet smelling mist or sweet tasting vapor. The wearer should not be able to detect the substance.

Quantitative Fit-test

Measures effectiveness of a respirator in preventing substance from entering the facepiece while wearer is in a test chamber. The actual concentration of the substance is measured inside the facepiece of the respirator.

Radioactive

Any type of substance that liberates radioactive particles or energy due to unstable atoms that have disintegrating nuclei.

Reactive Materials

Any element or compound that will spontaneously enter into a chemical reaction.

Regional Response Teams (RRT)

Regional Response Teams are composed of representatives of federal agencies and a representative from each state in the federal region. During a response to a major hazardous materials incident involving transportation or a fixed facility, the On-Scene Coordinator may request that the Regional Response Teams be convened to provide advice or recommendations on specific issues requiring resolution. Regional contingency plans specify detailed criteria for activation of Regional Response Teams. Regional Response Teams may review plans developed in compliance with Title III, if the local emergency planning committee so requests.

Renal

Referring to the kidney.

Residual Volume (RV)

The amount of air remaining in the lung after maximum expiratory effort.

Resource Conservation And Recovery Act (RCRA)

The Resource Conservation and Recovery Act of 1976 established a framework for the proper management and disposal of all wastes. RCRA directed EPA to identify hazardous wastes, both generically and by listing specific wastes and industrial process waste streams.

Risk

The probability that something undesirable will happen from deliberate or accidental exposure to a hazard.

Risk Analysis

The process of identifying hazards, evaluating the nature and severity of risks (risk assessment), using this and other information to make decisions about allowing, reducing, increasing, or eliminating risks (risk management), and communicating information about risks to decision makers and/or the public (risk communication).

Route Of Entry

How a material gets into the body: inhaled, ingested (through the mouth), dermal (through the skin), or through the eye(s).

Self-Contained Breathing Apparatus (SCBA)

A supplied-air respirator consisting of an oxygen tank, carrying assembly, gauge, safety valve, and full facepiece for use when exposures are unknown or particularly toxic.

Sensitizer

A substance that causes an individual to react when later exposed to the same or other irritant, as in a skin reaction or allergy.

Short-Term Exposure Limit (STEL)

The maximum average concentration of a chemical allowed for a continuous 15-minute period. Usually only four short exposures a day are permitted, each at least 50 minutes apart. Only some chemicals have STELs.

Smoke

An air suspension of particles, often originating from combustion or sublimation.

Solubility

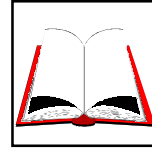
The ability of a solid, liquid, gas, or vapor to dissolve in water; the ability of one material to blend uniformly with another, such as a solid liquid.

Solution

Mixture of one or more substances in another substance, usually a liquid in which all the ingredients are completely dissolved.

Solvent

A liquid substance capable of dissolving a solid substance, e.g., toluene, xylene.

**Sorbent**

A material which removes toxic gases and vapors from air inhaled through a canister or cartridge.

Specific Gravity

The weight of a material compared to the weight of an equal volume of water; an expression of the density (or heaviness) of the material. Insoluble materials with specific gravity of less than 1.0 will float in water; insoluble materials with specific gravity greater than 1.0 will sink in water.

Stability

An expression of the ability of a material to remain unchanged. For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions which may cause instability (dangerous change) are stated. Examples are temperatures above 150°F or shock from dropping.

Standard Operating Procedures (SOP)

Written descriptions of tasks and activities to be followed during work.

State Emergency Response Commission (SERC)

Each state has a State Emergency Response Commission which serves as a link between the state and the EPA, coordinates all Right-to-Know information, and reviews plans of the Local Emergency Planning Committees (LEPCs). A SERC provides the LEPCs and other organizations with direction, technical assistance, and training on emergency response issues.

Superfund

The trust fund established under CERCLA to provide revenue and training resources for hazardous waste-site clean up activities.

Superfund Amendments And Re-authorization Act (SARA)

The Superfund Amendments and Reauthorization Act of 1986. Title III of Right-to-Know SARA includes detailed provisions for community planning and community .

Superfund Amendments And Re-authorization Act Title III -- The Emergency Planning and Community Right-to-Know Act (EPCRA)

The Emergency Planning and Community Right-to-Know Act of 1986 which is part of Superfund Amendments And Re-authorization Act. EPCRA specifies requirements for organizing the planning process at the state and local levels for extremely hazardous substances; minimum plan content; requirements for fixed-facility owners and operators to inform officials about extremely hazardous substances present at the facilities; and mechanisms for making information about extremely hazardous substances available to citizens.

Support Zone (Cold Zone)

Area where administrative and support functions not requiring respiratory protective equipment are performed.

Synergistic Effect

Two or more agents that act together to produce a total effect greater than the sum of their separate effects.

Systemic Effect

A chemical's effect on the body that takes place somewhere other than at the point of contact. For example, some pesticides are absorbed through the skin (point of contact), but affect the nervous system (site of action).

Teratogen

Substances or agents that affect an embryo or fetus, causing birth defects or other abnormalities.

Threshold

The lowest dose or exposure to a chemical at which a specific effect is observed.

Threshold Limit Value (TLV)

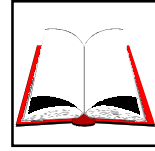
The Threshold Limit Value is an exposure level under which it is assumed that most people can work consistently for eight hours a day, day after day, with no harmful effects. A table of these values and accompanying precautions is published annually by the American Conference of Governmental Industrial Hygienists.

Time-weighted Average (TWA)

The average of several samples taken over time during a normal work day.

Toxic Substances Control Act (TSCA)

A list of reviewed harmful substances that require precautions and safe work practices by the community as well as by workers.

**Toxicity**

A relative property of a chemical agent. It refers to a harmful effect on some biological mechanism and the condition under which this effect occurs.

Toxic Substance

A chemical that can cause damage to living organisms either through ingestion, inhalation, or absorption through the skin.

Toxicology

The branch of medical science devoted to the study of poisons, including their mode of action, effects, detection, and countermeasures.

Toxic Products Of Combustion

The by-products of a combustion reaction that endanger life or the environment (e.g., carbon monoxide, hydrogen cyanide, hydrogen sulfide, sulfur dioxide, hydrochloric acid, nitrogen oxides).

mg/m³

Micrograms per cubic meter of air; 100 micrograms equal one milligram.

Unstable Material

Any material that will readily decompose or polymerize due to heat, temperature, pressure, or contaminants.

Vapors

The gaseous form of substances which are normally in the solid or liquid state (at room temperature and pressure). The vapor can be changed back to the solid or liquid state either by increasing the pressure or decreasing the temperature alone. Vapors also diffuse. Evaporation is the process by which a liquid is changed into the vapor state and mixes with the surrounding air.

Vapor Pressure

Indicates the tendency of a liquid to evaporate into the air.

Ventilation

One of the principal methods to control health hazards, it consists of a duct and fan system which removes airborne contaminants from the workplace.

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Viscosity

The property of liquid; resistance to flow.

Volatility

The tendency of a liquid to evaporate or vaporize rapidly. A volatile liquid has a high vapor pressure and can readily be inhaled.

Waste Profile Sheet

A document which is provided by the laboratory that conducted the analysis of the hazardous waste. Describes the physical and chemical properties of the waste sample.

Water Pollution

The introduction into water of a substance that is not normally present (or not normally present in such a high concentration) and that is potentially toxic or otherwise undesirable.

Water-reactive Material

Any substance that readily reacts with or decomposes in the presence of water with substantial energy release. Water reactive materials can burn or explode when exposed to water.

Basic Electrical Safety

10-hour Objectives

By the end of this module, each participant will be able to:

- Recognize some basic electrical terminology
- Identify safe work practices when using electrical equipment
- List the primary hazards of electricity
- Identify the purpose of grounded equipment
- Recognize how various protective devices (such as circuit breakers, fuses, and GFCIs) work
- Differentiate between the different classes of hazardous locations
- List types of personal protective equipment that help protect workers from electrical hazards

PERSONAL PROTECTIVE EQUIPMENT

(29 CFR 1910 - Subpart I)

**10 hour
Objectives**

By the end of this module, each participant will be able to:

- Identify elements of a PPE Program
- Recognize where PPE falls in the hierarchy of controls
- Identify when PPE is needed
- Limitations of PPE
- Identify when training is needed under Subpart I
- Match the PPE to where the standard is found for that PPE in CFR 1910