



## **24-Hour Industrial Emergency Response Operations Level**

### **Participant Guide**

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Midwest Consortium for Hazardous Waste Worker Training

## Acknowledgments

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

We encourage you to comment on these materials. Please give your suggestions to those teaching the program in which you are now enrolled, or forward them to the Midwest Consortium for Hazardous Waste Worker Training by clicking on 'contact us' at <https://mwc.umn.edu>.

## Warning

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The Midwest Consortium has copyrighted this material for Hazardous Waste Site Worker training. A recipient of the material, other than the Federal Government, may not reproduce it without permission of the copyright owner. The material was prepared for use by instructors experienced in the training of persons who are or who anticipate being employed at a hazardous waste worksite. Authors of this material have prepared it for the training of this category of workers as of the date specified on the title page. Users are cautioned that the subject is constantly evolving. Therefore, the material may require additions, deletions, or modifications to incorporate the effects of that evolution occurring after the date of this material preparation.

## Disclaimer

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

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

Content was updated April 2, 2024 and all web links are active as of that date. If you find an error, please inform the facilitator so it can be updated.

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## **PROGRAM INTRODUCTION**

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The goal of this program is to develop skills needed to respond to an incident involving hazardous materials at an industrial facility. At the operations level, you are required to be trained to respond to an incident in a defensive fashion, without trying to stop the release at the point of the release.

During this program you will learn about:

- Risks of hazardous materials
- Possible outcomes of an emergency
- Ways to recognize hazardous materials
- Your role as an operations-level responder
- The need for other resources
- Basic hazard and risk assessment techniques
- Selecting and using proper protective equipment
- Basic hazardous materials terms
- Basic control, containment, and confinement procedures
- Basic decontamination procedures
- Standard operating procedures and incident termination

When you finish you will be better able to:

- Size up a scene
- Work within the system to participate in response actions
- Use protective equipment
- Perform certain basic response actions
- Minimize exposure to hazardous conditions

Each day includes time for review. Throughout the program, you are urged to ask questions. If an instructor does not have the answer to your question, it may be covered later during the week or it may be posted for response in a later part of the program. For example, a question on Day 1 about an air sampler would likely be deferred to the monitoring session. Sometimes instructors may place a question in a list posted in the room (called the 'parking lot'), so that it is not overlooked.

This program was developed by the Midwest Consortium for Hazardous Waste Worker Training, a group of trainers from nine states dedicated to interactive training to meet the needs of workers. The Consortium receives funding from the federal government (National Institute of Environmental Health Sciences, or NIEHS) to develop and present 'model' training programs. By this the government means that we have a certain number of instructors, include hands-on activities, and include methods to document the value of the training to participants through your feedback. This important program feedback evaluation is used to build more programs more aligned to participant needs and identify areas where materials and delivery can be improved. In addition, we are required to define "successful completion" for the participants. This program includes a combination of several measures to obtain successful completion: a final knowledge test with a score of 70% or better, achievement of all skills checklists and exercises and attendance at all sessions. Pre- and post-tests are used to measure knowledge gain during the course.

### **Get the Most from Training**

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

Most industries use some type of hazardous material in a manufacturing process or as a cleaning compound. As a result, thousands of hazardous chemicals may accidentally be spilled or released. Even though there is widespread use of hazardous materials, the potential for harm to people and property can be

reduced if proper prevention procedures are developed and response procedures are followed.

During this introductory session, you will:

- Review the goals of the program
- Describe successful completion and the role of evaluation
- Use a local example to identify or illustrate response hazards
- Complete a pre-test

### Recent Releases

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Your facilitator will introduce one or more recent hazmat responses in the Midwest. What information or skills would have been useful to the responders?

### Summary – Program Introduction

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The overall goals of the program to develop skills were reviewed:

- Size up a scene
- Work within the system to participate in response actions
- Use protective equipment
- Perform certain basic response actions
- Minimize exposure to hazardous conditions

Evaluation is used to document knowledge and skills and improve program content and delivery.

By reviewing a local example, the need for training prior to a response was illustrated.

# Introduction to HAZWOPER

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## Chapter Objectives

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

- Define the term 'hazardous material'
- Use HAZWOPER to identify training requirements
- Identify reasons why an Emergency Response Plan is needed

## What Is a Hazardous Material?

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

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

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

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

### HAZWOPER - Hazardous Waste Operations and Emergency Response

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

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

Requirements for Emergency Response Workers	
29	CFR 1910.120
29 =	OSHA regulations are located in Part <b>29</b>
CFR =	<i>Code of Federal Regulations</i> is the title of the government publication
1910 =	Part number <b>1910</b> covers General Industry
.120 =	Section number <b>120</b> covers hazardous waste operations and emergency response
(q) =	emergency response
(6) =	training





### Training Requirements of HAZWOPER

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Requirements for the Emergency Responders, **Awareness Level**:

- Understand hazardous materials and associated risks
- Understand potential outcomes of emergencies
- Have the ability to recognize hazardous materials
- Identify hazardous materials if possible
- Understand the role of the emergency responder
- Have the ability to contact appropriate personnel

Requirements for the Emergency Responders, **Operations Level**:

- Fulfill requirements of Awareness Level
- Know basic hazard and risk assessment techniques
- Select and use proper personal protective equipment that is provided
- Know basic hazardous materials terms
- Know basic control, containment, and/or confinement operations
- Know basic decontamination
- Understand relevant standard operating procedures
- Know termination procedures

Only individuals who have completed 24 hours of training which includes all topics required for the Awareness and Operations levels can begin training for **Hazardous Materials Technician Level**. The following three levels of training are distinct; they shouldn't be confused or substituted:

- Awareness
- Operations-level first responder
- Hazardous materials technician

For more information, consult the HAZWOPER standard, plant management, or your health and safety committee representative. The employer certifies competencies.

## **The Emergency Response Plan**

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Standard Operating Procedures (SOPs) are carefully planned and detailed work instructions intended to provide workers with necessary guidelines to carry out work tasks safely. Some SOPs are used in routine plant operations; others provide guidelines for actions that should and should not be taken during an emergency.

An Emergency Response Plan (ERP) is an SOP detailing what will be done in emergency situations. Employers who decide to have employees respond when an incident occurs must prepare a written ERP. These plans include important information needed for responding to hazardous materials emergencies.

### **What Is An Emergency?**

A **hazardous material emergency response** is conducted when a spill or release of hazardous materials that cannot be controlled without help from those outside the area of the release or maintenance personnel.  
This definition also includes the threat of a spill or release.

The legal definition of hazardous material emergency is found in health and safety standards. In the OSHA standard, *outside help* means anyone other than employees working in the immediate area or maintenance personnel.

There are three areas where spills or releases of hazardous materials can occur: on land, in the air, or in water.

### Requirements for the ERP

The law requires that the following topics be included in an Emergency Response Plan.

- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination procedures

- Emergency medical treatment and First Aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- Personal protective equipment and emergency equipment

Each of the required topics must be covered in an Emergency Response Plan. This plan will be discussed during later sections of this course.

### **Summary – Introduction to HAZWOPER**

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

Training in safe emergency response practices will reduce the chances of harm to people or property.

Employers are required to develop an Emergency Response Plan to prepare for potential hazardous materials incidents, if employees are to respond.

Hazardous materials emergency incidents are spills or releases into the workplace or environment, or the threat of such spills or releases. Spills or releases can occur on land, in the air, or in water.



## **RIGHTS AND RESPONSIBILITIES**

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This section covers several laws and regulations regarding response to hazardous materials incidents, including the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the Occupational Safety and Health Act (OSHAct) that authorized development of the Occupational Safety and Health Administration (OSHA), a governmental agency that develops and enforces regulations to help assure safe working conditions. Worker and employer rights and responsibilities are important protections through OSHA.

### **Chapter Objectives**

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

- Identify two laws that impact worker health and safety
- Identify application of federal and state OSHA enforcement of health and safety regulations
- Describe key rights and responsibilities workers and employers have under OSHA

### **SARA**

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

#### **Title I**

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

#### **Title II – Not applicable at this time**

#### **Title III (Community Right-to-Know)**

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

**Exercise – Worker and Employer Rights and Responsibilities**

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The following set of questions is intended to see how much you already know about worker and employer safety and health rights and responsibilities. For each of the following questions, answer “True” (“T”) or “False” (“F”), using your current understanding of the law. You will review the answers to each of these questions at the end of this section.

- |        |     |  |
|--------|-----|--|
| T or F | 1.  | The employer must pay for all health and safety equipment required by OSHA standards.  |
| T or F | 2.  | OSHA can fine workers for violating OSHA standards.  |
| T or F | 3.  | The employer doesn't have to correct problems cited by OSHA until all legal Appeals are exhausted.   |
| T or F | 4.  | OSHA violations can be issued when workplace hazards are causing serious physical harm.  |
| T or F | 5.  | If OSHA conducts an inspection of the work site, the union or employee representatives must be paid for time they spend on the walk-around, according to OSHA regulations. |
| T or F | 6.  | OSHA has the right to enter the workplace and conduct an inspection at any time, whether the employer wants it or not.   |
| T or F | 7.  | The “general duty clause” can be used by OSHA if a serious hazard exists but no specific safety and health standard covers the problem.                                    |
| T or F | 8.  | According to the OSHAct, the employer and the employees have an equal duty to provide a safe and healthful workplace.  |
| T or F | 9.  | If employers receive an OSHA citation, they must appeal it within a certain number of days or the citation becomes final.  |
| T or F | 10. | The OSHA 300A form must be posted during the months of February, March, and April and presents the annual summary of recordable employee injuries.                         |



### OSHAct and OSHA

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

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

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

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

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

In addition to setting standards, OSHA is charged with:

- Inspecting workplaces to ensure standards are being met
- Issuing citations and fines to companies that do not meet the standards
- Overseeing state plans for safety and health

- Encouraging the development of training programs for workers, management, and health professionals

### Rights and Responsibilities Under OSHA

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

#### Worker Rights

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



A brief summary follows.

#### Worker Right to Have an Inspection of a Workplace

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

The inspection priority defined by OSHA is:

- Imminent danger
- Catastrophic (a fatality or three or more workers are hospitalized overnight as a result of an on-the-job exposure)

- Complaint inspection (filed by a worker or worker representative)
- Scheduled inspection (general OSHA inspection not because of a complaint or catastrophe, but because injury statistics show that the employer has more injuries and illness than similar employers)
- General inspection or “pick of the hat.” (Previously inspected sites are pooled, and, through random selection, two sites are drawn and visited in a given year)

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

### Worker Right to Participate in the OSHA Walk-Around Inspection

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

### Worker Right to Be a Witness or to Give Information

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

### Worker Right to Be Informed of Imminent Dangers

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

### Worker Right to Be Told About Citations

Notices of OSHA citations must be posted in the workplace near the site where the violation occurred and must remain posted for three days or until the hazard is corrected, whichever is longer. Citations and penalty notification forms are, in general, available upon request from the OSHA Area Office. When an OSHA

industrial hygiene inspection has taken place, the hygienist's report, which includes substances collected, procedure used, and measurement results, may also be obtained by the employees, their representatives, or their union upon request.

### Worker Right to Appeal OSHA Performance

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

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

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

### Worker Right to Have a Closing Conference After an Inspection

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

### Worker Right to Know of Hazards

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

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

### Worker Right to Have Access to OSHA Records

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

### Worker Right to Participate in Development of New Standards

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

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

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

### Worker Right to File a Discrimination Complaint

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

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

**For the General Public:**

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

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

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

**For Federal Employees:**

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

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

**Instructions:**

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

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

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

**Paperwork Reduction Act Statement:**

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

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

Do not send the completed form to this Office.



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

		Complaint Number			
Establishment Name					
Site Address					
	Site Phone		Site Fax		
Mailing Address					
	Mail Phone		Mail Fax		
Management Official			Telephone		
Type of Business					
HAZARD DESCRIPTION/LOCATION. Describe briefly the hazard(s) which you believe exist and on what date you last observed the hazard(s). Include the approximate number of employees exposed to or threatened by each hazard. Specify the particular building or worksite where the alleged violation exists.					
Has this condition been brought to the attention of:		<input type="checkbox"/> Employer	<input type="checkbox"/> Other Government Agency (specify):		
<p><i>The OSH Act gives employees and employee representatives the right to request that their names not be revealed to their employer. Providing your name and address will only allow OSHA staff to communicate with you regarding your complaint.</i></p> <p>Please Indicate Your Desire:</p>		<input type="checkbox"/> Do NOT reveal my name to my Employer <input type="checkbox"/> My name may be revealed to the Employer			
<p>The Undersigned believes that a violation of an Occupational Safety or Health standard exists which is a job safety or health hazard at the establishment named on this form. (Mark "X" in ONE box).</p>		<input type="checkbox"/> Former Employee <input type="checkbox"/> Current Employee <input type="checkbox"/> Representative of Employees <input type="checkbox"/> Federal Safety and Health Committee <input type="checkbox"/> Other (specify)			
Complainant Name			Telephone		
Address (Street, City, State, Zip)					
Email Address					
Signature			Date		
If you are an authorized representative of employees affected by this complaint, please state the name of the organization that you represent and your title:					
Organization Name:			Your Title:		

### **Worker Responsibilities**

#### Worker Responsibility to Abide by Established Safety Rules

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

#### Worker Responsibility to Wear and/or Use Required Safety Equipment

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

#### Worker Responsibility to Seek Prompt Medical Treatment When Required

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

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

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

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

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



### Employer Rights and Responsibilities

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

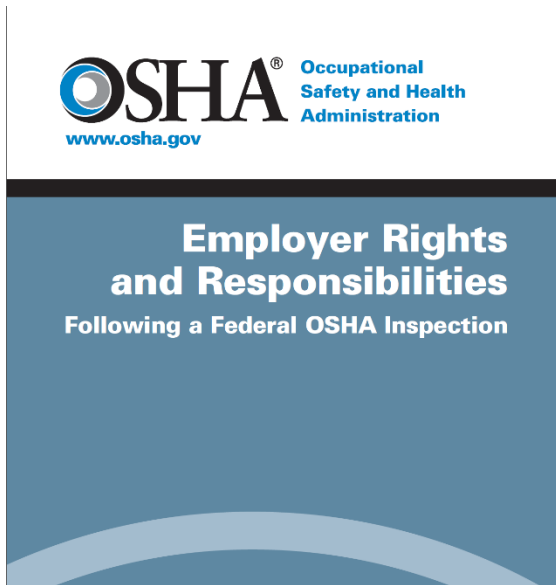


Image at: <https://www.osha.gov/Publications/osha3000.pdf>

### Employer Rights

#### Employer Rights following an OSHA inspection

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

### Employer Responsibilities

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

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

### Employer Responsibility to Pay for Personal Safety Equipment

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

### Employer Responsibility to Comply with OSHA Standards

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

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

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

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

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

### Employer Responsibility to Report Fatalities and Injuries

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

### Employer Responsibility to Maintain Records of Injuries

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

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

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

### Employer Responsibility to Post Information

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

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

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

### Employer Responsibility to Not Retaliate

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

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

*OSHA's Form 300A*

**Summary of Work-Related Injuries and Illnesses**

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

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

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

**Number of Cases**

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

**Number of Days**

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

**Injury and Illness Types**

Total number of . . .  
(M)

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

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

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

*OSHA's Form 300A*

**Summary of Work-Related Injuries and Illnesses**

Establishment information

**Your establishment name** \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

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

\_\_\_\_\_

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

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

Annual average number of employees \_\_\_\_\_

Total hours worked by all employees last year \_\_\_\_\_

Sign here

**Knowingly falsifying this document may result in a fine.**

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

\_\_\_\_\_  
Company executive Title

(\_\_\_\_\_) \_\_\_\_\_  
Phone Date

## **Summary – Rights and Responsibilities**

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There are a variety of Federal and state agencies with various laws and regulations which bear directly on worker safety and health.

- SARA (EPA)
- OSHAct
- OSHA (Federal and State)
- HAZWOPER (OSHA)

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

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

The OSHAct is a major law concerned with worker health and safety. Both employees and employers have rights and responsibilities established by the OSHAct. A major employer responsibility is to furnish a workplace free from recognized safety and health hazards likely to cause serious physical harm (known as the general duty clause). A major employee responsibility is to follow reasonable employer safety rules; major rights include access to information, filing a complaint regarding work conditions without retaliation. See additional details here: [www.osha.gov](http://www.osha.gov) and <https://www.osha.gov/Publications/osha3000.pdf>. To find the contact information for the OSHA Federal or State Program office nearest you, see the Regional and Area Offices map at <http://www.osha.gov/html/RAmap.html>.

In addition to setting standards, OSHA is charged with:

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

HAZWOPER is an OSHA regulation developed as a result of SARA.



# HAZARD RECOGNITION

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

## Chapter Objectives

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

- Identify several types of hazards that pose risks during a response
- Identify information on hazardous materials placards and labels, and from container shapes
- Use the Emergency Response Guidebook (ERG) to find information on a hazardous material
- Identify the types of information on shipping papers and SDSs

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



## **Recognizing an Emergency**

---

Some of the ways industrial plant workers may become aware of emergencies include:

- Seeing a spill or release
- Smelling an unusual odor
- Hearing a release or process alarm
- Witnessing a fire or explosion
- Hearing a warning signal

The actions that emergency responders should take when they become aware of an emergency are described in the Emergency Response Plan (ERP).

The actions of the operations-level first responder may include:

- Assessing the hazards
- Putting on protective equipment
- Controlling the spread of a release by containing, or confining the hazardous material while working away from direct contact using activities such as
  - Block a drain
  - Build a dike
  - Lay out absorbent material
- Participating in removal of hazardous material from protective clothing and equipment (decontamination)

## **Types of Hazards - Overview**

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

### **Chemical**

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

### **Biological**

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

### **Physical**

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

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

## **Recognizing Chemical Hazards**

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The National Fire Academy (NFA) has identified six sources of information that will help you organize observations about potential hazards if first-on-the-scene. These are:

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

Each of these topics provides information useful to the responders as they assess the hazards and develop a response consistent with the ERP.

### **1. Occupancy and Location**

Identify the purpose or activity conducted in the area of the incident. If the location is the waste water treatment plant, you may know the process and be able to describe the materials used in the plant to responders; if you do not know about the process, it is sufficient to identify the waste water treatment plant. Plant or community responders will be able to identify any hazardous materials that may be in the location. Location can provide information on whether a hazard may be present. Certain areas of your facility may be known to contain hazardous materials. Releases or leaks in these areas (such as production vessels, laboratories, tank farms, reactors, etc.) should always be suspected of involving hazardous materials. Location also requires a description of the area. This includes any:

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

## 2. DOT Placards and Labels

The DOT system of placards and labels is required on hazardous materials during shipment. It is important to understand the systems which are used to identify hazardous materials. Hazard information is included on DOT placards fixed to large containers (trailers, rail cars, tanks) and manufacturer labels fixed to small containers (drums, packages, boxes).

Caution must be exercised, because labels and placards may be missing, incorrect, or difficult to read.

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

- Diamond-shaped
- Color-coded

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

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



- Word-coded (hazard class name)

For example:

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

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



- Symbol-coded

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

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



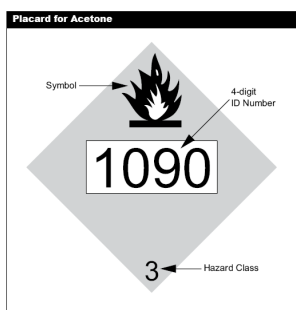
- Number-coded

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

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

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

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



The acetone placard is called a “number placard,” which means that the number in the center of the placard specifies the exact contents of the container. “Word placards” are so named because a word designating a type of hazard (e.g., flammable) will be printed in the middle of the placard. Number placards must be displayed on large portable tanks, tank trucks, and rail cars. A word placard means that drums or smaller containers are present.

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

### Using the DOT Emergency Response Guide

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

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

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

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

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

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

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

**Exercise – Using the ERG**

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The facilitator will provide an exposure scenario involving a hazardous material. Use the ERG to find information about the hazard. Use the information to describe operations level response actions.

Complete the Worksheet provided and be prepared to share the decisions made in your group with the other participants.



### 1. Markings and Colors (and Other Label Systems)

#### Markings

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

- Orientation arrows
- Words
  - Inhalation Hazard
  - Poison

If first-on-the-scene, make careful note of any marking on a container; responders will find all of the information useful.

#### Color

Color is an important feature of placards and labels. Your observation of the color of a placard or label will help emergency responders, even if other parts cannot be seen.

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

##### *Globally Harmonized System for Labeling - Hazard Communication Standard*

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










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

If a chemical is transferred from a labeled container to a portable container that is

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

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

### HCS2012 Pictograms and Hazard Classes

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

A sample HCS label is shown on the next page. As a first-on-the-scene responder, you may be able to read the pictograms on labels from a distance.

## SAMPLE LABEL PRODUCT IDENTIFIER

### CODE

Product Name

## SUPPLIER IDENTIFICATION

### Company Name

Street Address

City

State

Postal Code

Country

Emergency Phone Number

## PRECAUTIONARY STATEMENTS

Keep container tightly closed. Store in cool, well ventilated place that is locked.

Keep away from heat/sparks/open flame. No smoking.

Only use non-sparking tools.

Use explosion-proof electrical equipment.

Take precautionary measure against static discharge.

Ground and bond container and receiving equipment.

Do not breathe vapors.

Wear Protective gloves.

Do not eat, drink or smoke when using this product.

Wash hands thoroughly after handling.

Dispose of in accordance with local, regional, national, international regulations as specified.

**In Case of Fire:** use dry chemical (BC) or Carbon dioxide (CO<sub>2</sub>) fire extinguisher to extinguish.

### First Aid

If exposed call Poison Center.

If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.

## HAZARD PICTOGRAMS



## SIGNAL WORD

Danger

## HAZARD STATEMENT

Highly flammable liquid and vapor.

**May cause liver and kidney damage.**

## SUPPLEMENTAL INFORMATION

### Directions for use

Fill weight:

Lot Number


Gross weight:

Fill Date:


Expiration Date:

## Hazard Recognition

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



**ToxiFlam (Contains: XYZ)**



**Danger! Toxic If Swallowed, Flammable Liquid and Vapor**

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

**IF SWALLOWED:** Immediately call a POISON CONTROL CENTER or doctor/physician. Rinse mouth. In case of fire, use water fog, dry chemical, CO<sub>2</sub>, or “alcohol” foam.

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

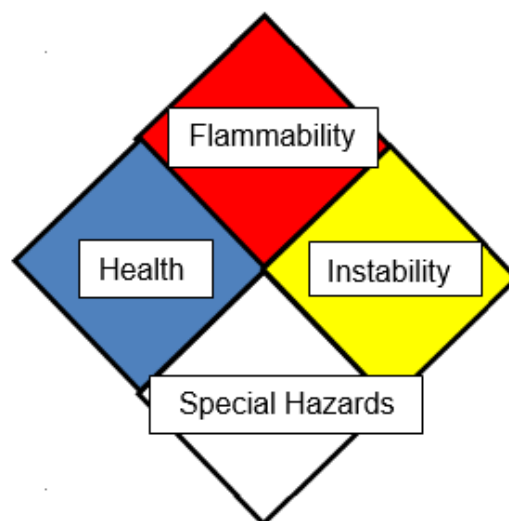
MyCompany, MyStreet, MyTown, NJ 00000, Tel: 444 999 9999

### National Fire Protection Association (NFPA) - 704 System

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

What does the NFPA system look like?

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



<u>Color</u>	<u>Hazard</u>
Red	Flammability
Blue	Health
Yellow	Instability
White	Special Hazards

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

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

### NFPA-704 Standard Symbols

~~W~~

Do not use  
Water

OX

Oxidizer

SA

Simple Asphyxiant

### Non-Standard Symbols

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

**Hazardous Materials Information System (HMIS)**

These labels are used on storage vessels and containers.

What does the HMIS label look like?

- Rectangular
- Color-coded

The labels alert workers to:

<u>Color</u>	<u>Hazard</u>
Blue	Health risk
Red	Flammability
Orange	Physical hazards
White	Personal protection

- Number-Coded

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

- Letter-coded

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

Propane	
Health	2
Flammability	4
Reactivity	0
<b>Personal Protection</b>	

Example of a HMIS Label

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

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

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

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

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

HMIS labeling must, through training, ensure that its employees are fully aware of the hazards of the chemicals used.

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

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

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

### *Labels And Placards Checklist*

*What should I observe from labels/placards?*

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

*How do I observe them?*

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



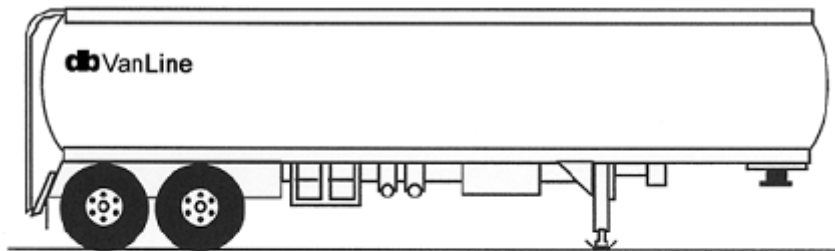
### 1. Container Shapes and Sizes

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

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

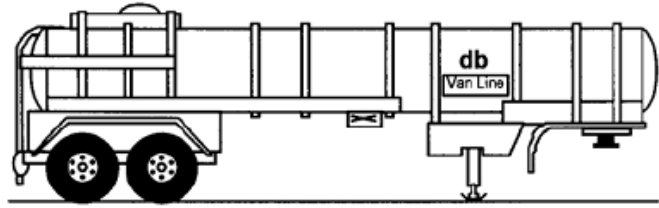
#### Atmospheric Pressure Tank Truck

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



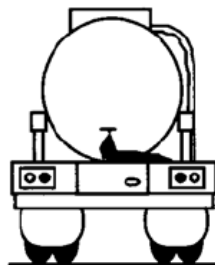
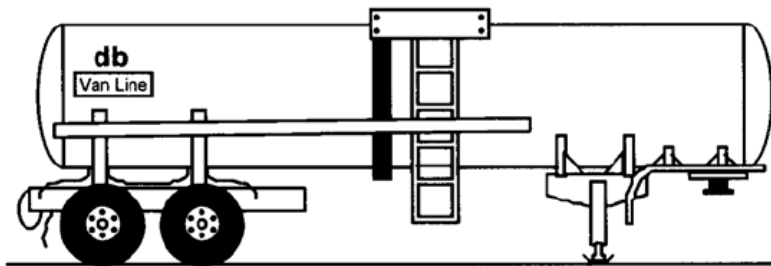
### Low-Pressure Chemical Carrier

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



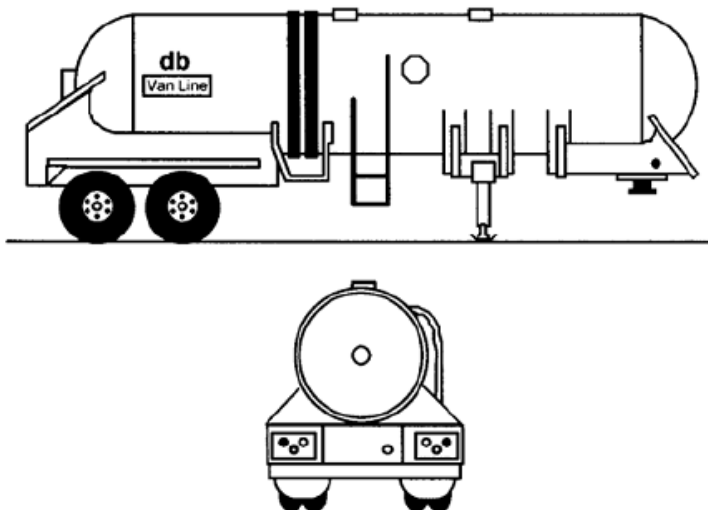
### Corrosive Liquid Carrier

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



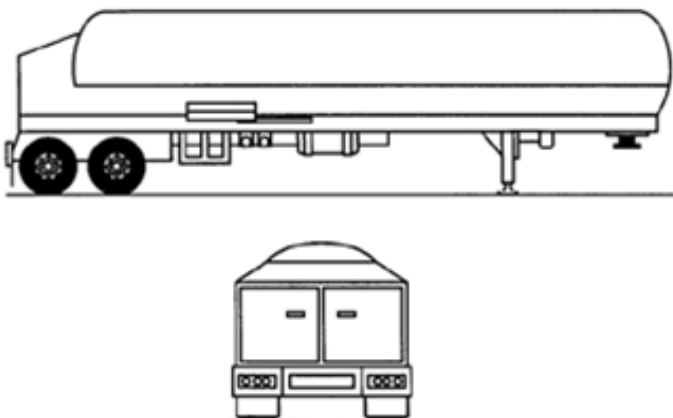
### High-Pressure Liquefied Gas Tanker

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



### Cryogenic Cargo Tanks

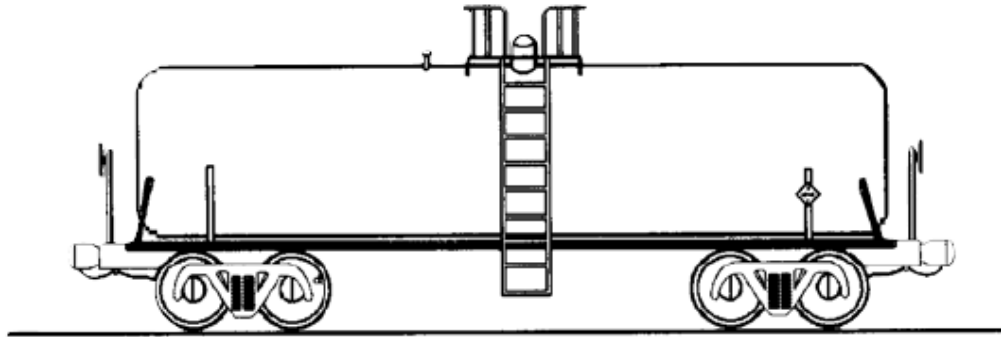
Cryogenic cargo tanks transport cryogenic liquids, which must be kept below  $-200^{\circ}\text{F}$ . The cryogenic tank is actually a tank within a tank. The space between the inner and outer tanks is filled with insulation and normally maintained under vacuum. MC338, TC338, SCT-38; TC341, CGA341.



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

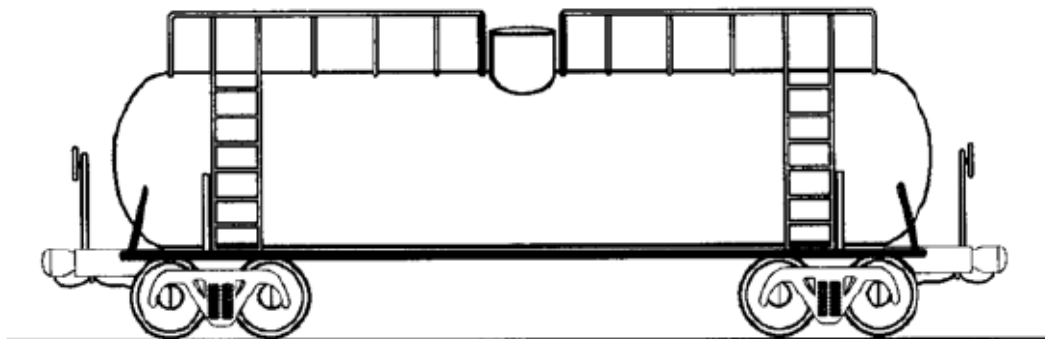
### Non-Pressurized Rail Tank Cars

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



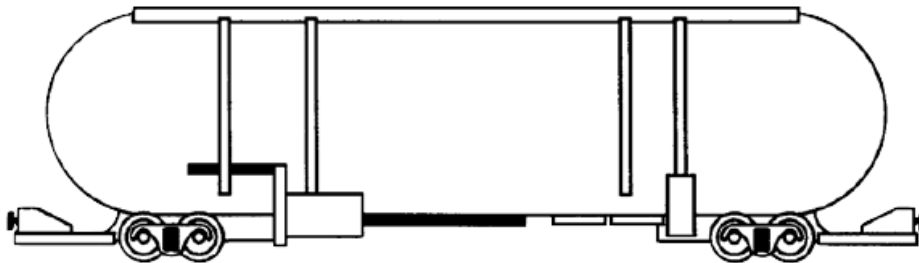
### Pressurized Rail Tank Cars

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



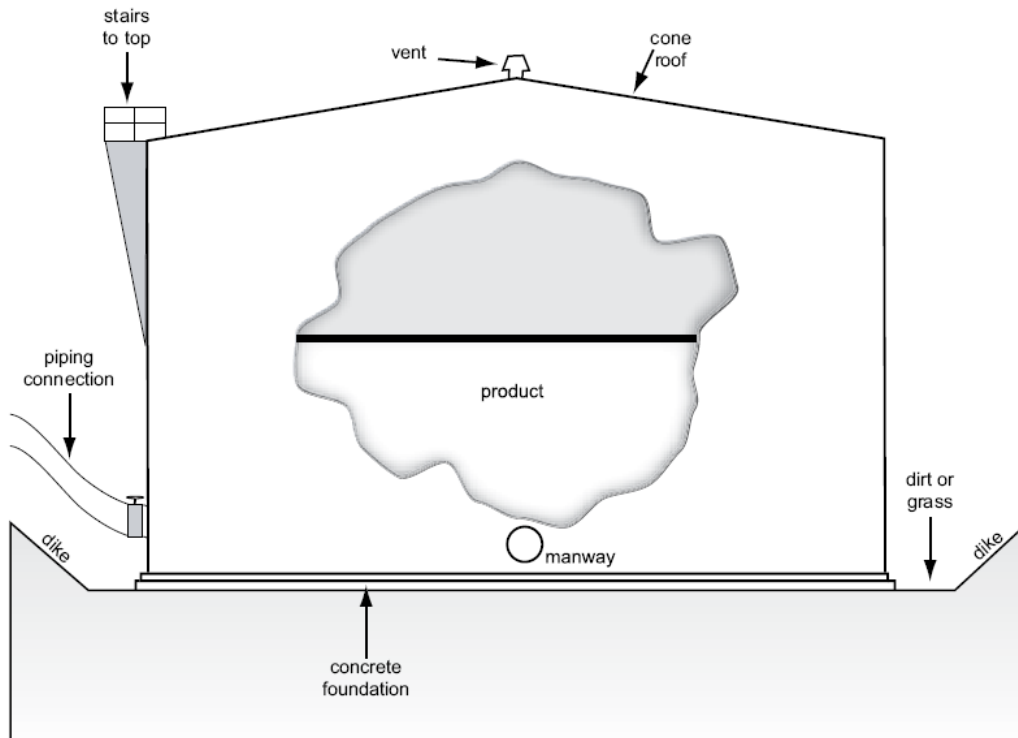
### Specialized Tank Cars - Cryogenic

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



## Fixed Roof Tanks

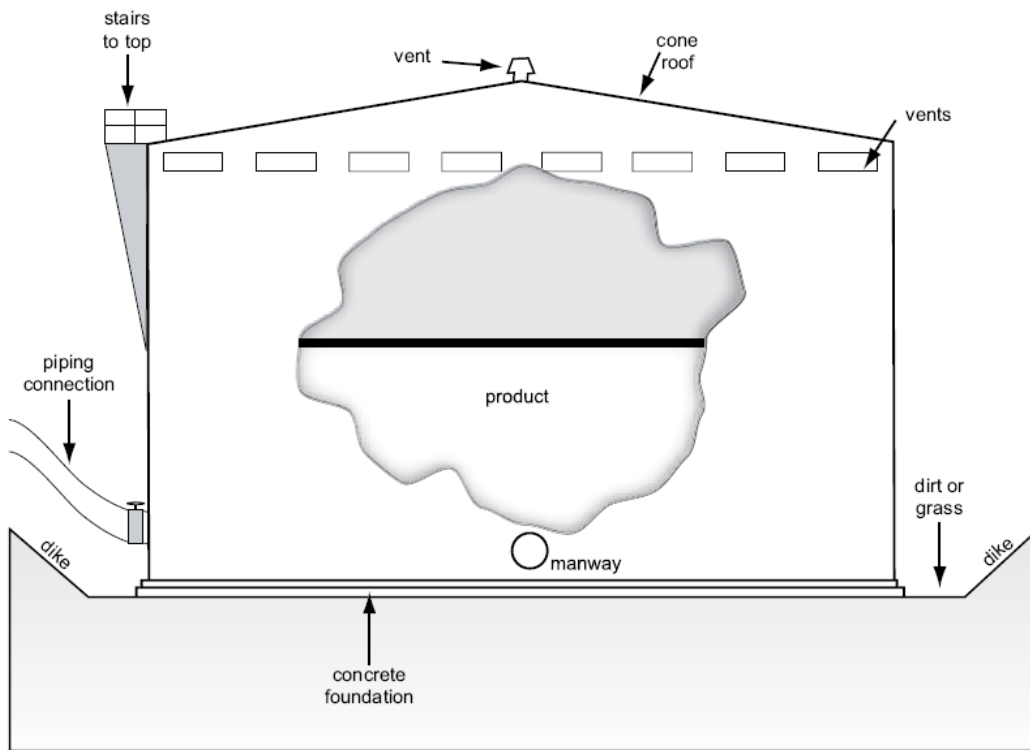
Fixed roof tanks are often identified by a cone roof. These tanks frequently contain hydrocarbons.



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

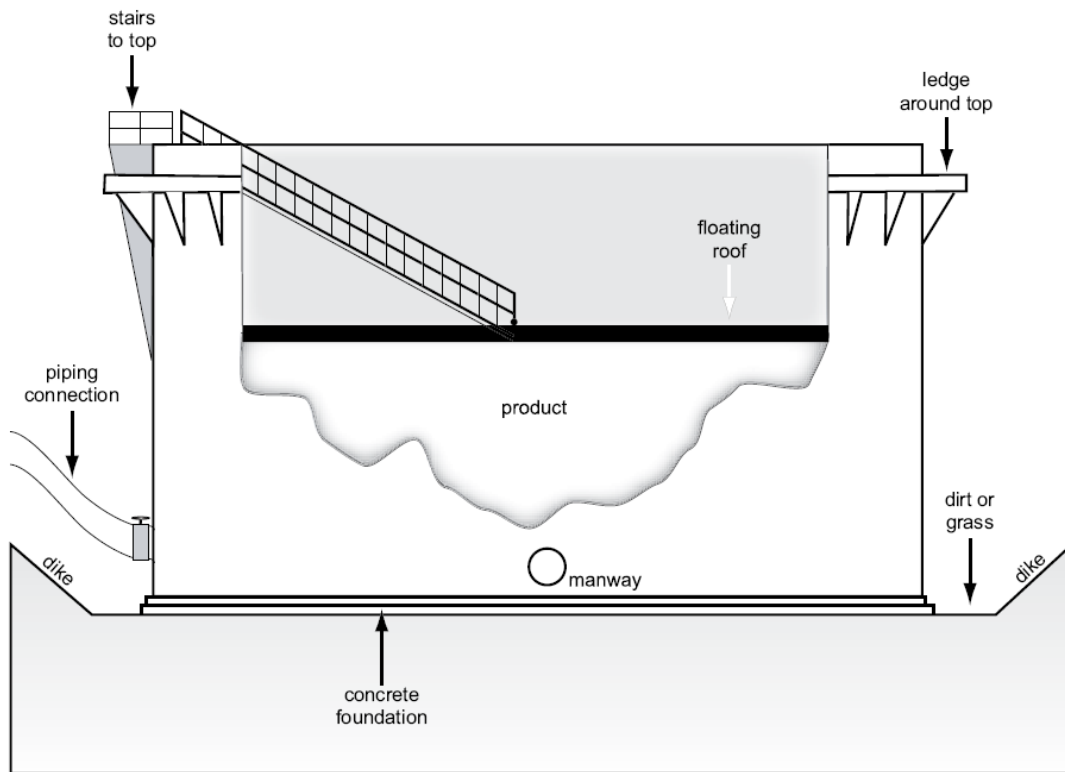
### Internal Floating Roof Tank

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



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

## External Floating Roof Tank

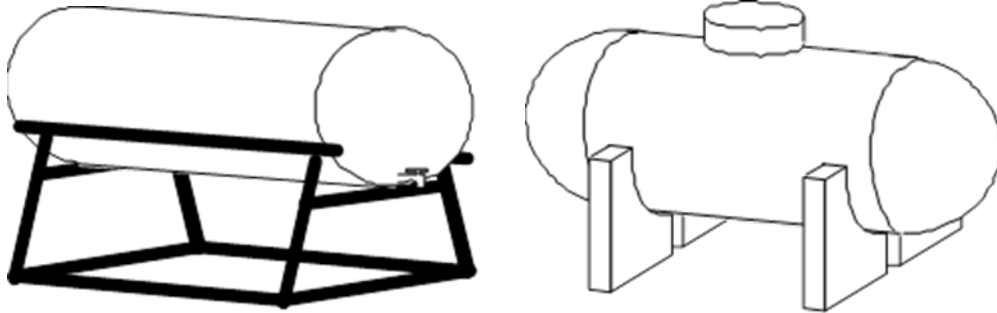


- The flat roof floats up and down on the liquid in the tank
- Normally store petroleum products such as crude oil or condensate
- Roof floating on the liquid reduces release of vapors and prevents vapor build-up and rim-space fire hazard
- Snow and rain can accumulate on the roof. Weather can speed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



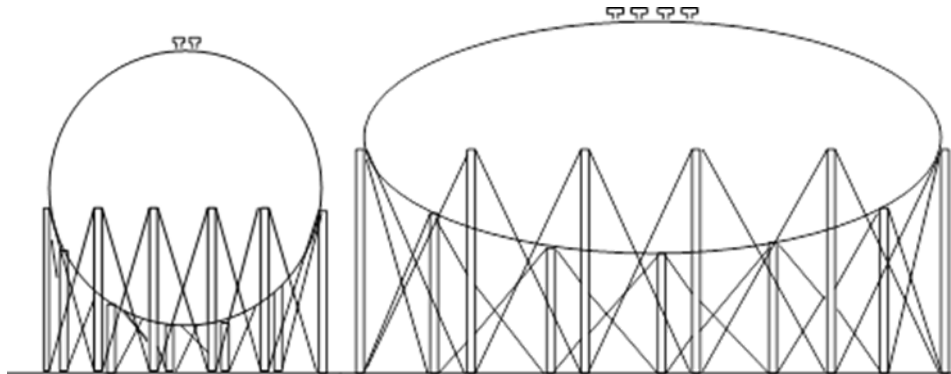
### Horizontal Storage Tanks

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



### Sphere Storage Tanks

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



### Underground Storage Tanks (USTs)

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

## Drums

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

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

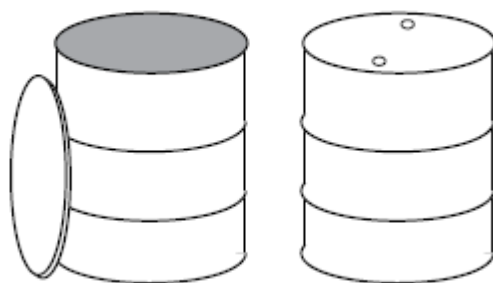
Closed-top metal drums normally contain non-corrosive products in liquid form

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

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

Open-top plastic drums usually contain corrosive solids or sludges

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



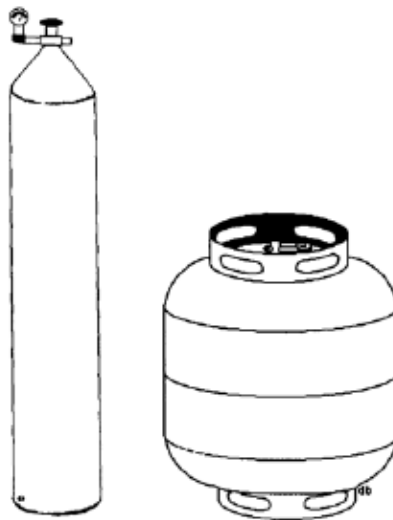
**Open-Top (Left) and Closed-Top (Right) Drums**

### Cylinders

The emergency responder needs to be aware of the potential danger posed by the presence of cylinders in an emergency.

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

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



### Bulk Containers or Totes

Bulk containers are designed to hold up to several hundred gallons of liquid or solid raw material, intermediate or product that may be hazardous or non-hazardous.

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



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

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



Flexible Intermediate Bulk container being off-loaded for shipment.

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

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

**It is important that you report unlabeled containers discovered during a response.**

Note any container that appears to be constructed from “special” materials.

**Chemical container checklist**What information should I observe about the container?

## Location

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

## Shape

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

## Material

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

How do I observe them?

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

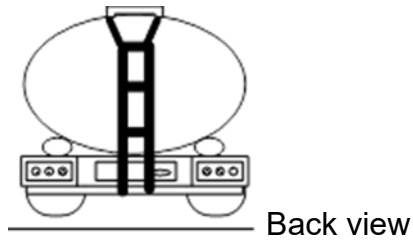
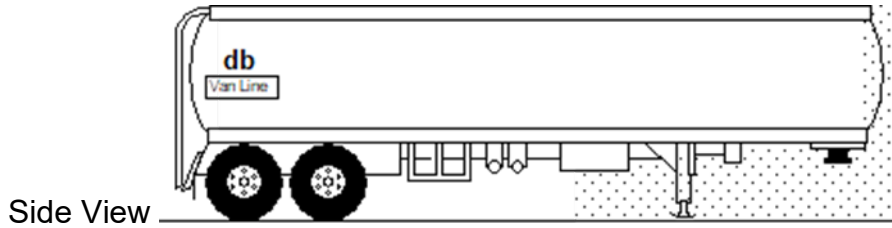
Report any suspect container to your supervisor or the person designated in the ERP.

**Exercise - Container Shapes and Sizes**

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The class will be divided into groups. Working with your group, describe the containers shown on the following pages as you would if reporting an incident involving these containers.

**Container Shape I**



Description: \_\_\_\_\_

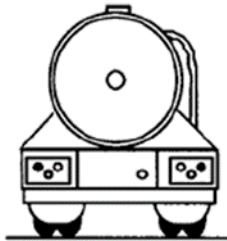
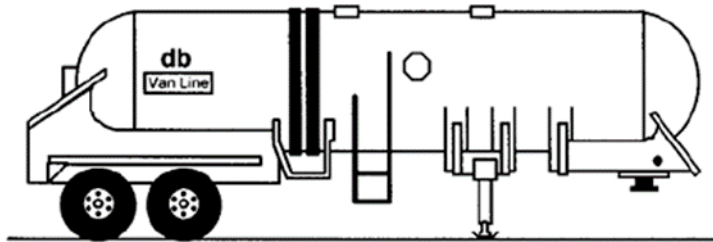
\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

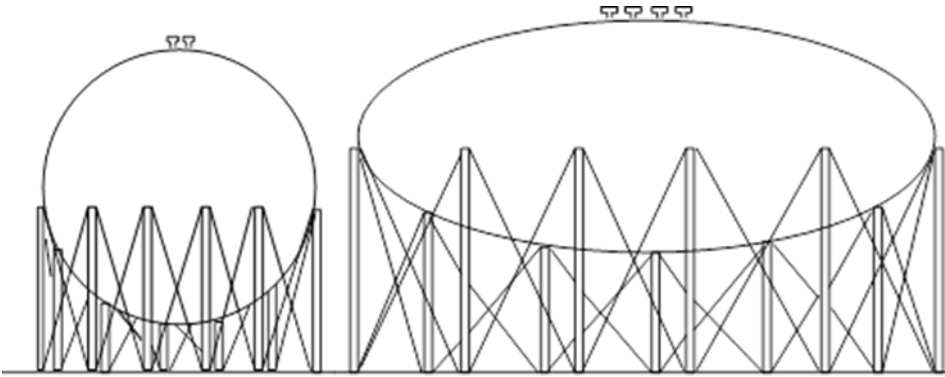
**Container Shape II**



Description: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

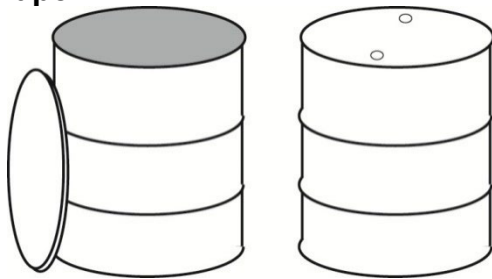


**Container Shape III**



Description: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Container Shape IV**



Description: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Shipping Papers and Safety Data Sheets (SDSs)

Written documents are available describing the hazardous chemicals and wastes. Two important sources are shipping papers and Safety Data Sheets (SDSs). It is important to know where these resources are kept and the types of information each contains.

### Shipping Papers

Each shipment of hazardous materials must have paperwork documenting the specific contents of the shipment and relevant information. This paperwork has different names, depending on the type of transportation vehicle.

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

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

When a shipment arrives at a plant, a copy of the shipping papers is given to plant personnel.

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

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

The basic description should include:

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

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

The shipper must provide a certification statement, certifying that the shipment complies with the HMR. The shipping papers must also contain an emergency response telephone number, unless exempted. This number must be monitored by a knowledgeable person at all times while the shipment is underway.

### **Safety Data Sheets (SDSs)**

SDSs are required by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

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



## Hazard Communication Safety Data Sheets

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

**Section 1, Identification** includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

**Section 2, Hazard(s) identification** includes all hazards regarding the chemical; required label elements.

**Section 3, Composition/information on ingredients** includes information on chemical ingredients; trade secret claims.

**Section 4, First-aid measures** includes important symptoms/ effects, acute, delayed; required treatment.

**Section 5, Fire-fighting measures** lists suitable extinguishing techniques, equipment; chemical hazards from fire.

**Section 6, Accidental release measures** lists emergency procedures; protective equipment; proper methods of containment and cleanup.

**Section 7, Handling and storage** lists precautions for safe handling and storage, including incompatibilities.

**Section 8, Exposure controls/personal protection** lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).

**Section 9, Physical and chemical properties** lists the chemical's characteristics.

**Section 10, Stability and reactivity** lists chemical stability and possibility of hazardous reactions.

**Section 11, Toxicological information** includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

**Section 12, Ecological information\***

**Section 13, Disposal considerations\***

**Section 14, Transport information\***

**Section 15, Regulatory information\***

**Section 16, Other information**, includes the date of preparation or last revision.

\*Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15(29 CFR 1910.1200(g)(2)).

**Employers must ensure that SDSs are readily accessible to employees.**

See Appendix D of 1910.1200 for a detailed description of SDS contents.

For more information: [www.osha.gov](http://www.osha.gov)



(800) 321-OSHA (6742)

U.S. Department of Labor

Preplanning must include a review of SDSs. This review will provide information about the properties of each material used on-site and how responders should react to each during an emergency.

SDSs and other resources provide important information during preplanning activities.

Workers must be trained to use SDSs and how to work with materials that are routinely used. At a manufacturing plant, the SDSs must be available to employees during all shifts. A full HCS training is outside the scope of this program.

What information does the SDS provide to emergency responders?

Preventive measures

- Precautions for safe material handling and use
- Storage instructions
- Protective clothing and equipment needed

*Emergency preplanning*

- Fire and explosion hazards
- Spill or leak procedures
- Special protection information
- Health hazards
- First aid information

The supplier/manufacturer should be contacted for additional information as soon as a substance arrives at a work site. The SDS will include information about how to contact the supplier for information.

### Limitations of SDSs and Shipping Papers

Although SDSs and shipping papers contain important information, there are a number of limitations to their use during an emergency. Some of these limitations are listed below.

- Limited information
  - The information may be incomplete or inaccurate
  - Space on the form may be inadequate
  - The information may not be relevant for the facility
- Insufficient time to read the information
- Insufficient time to call the manufacturer's/supplier's contact person
- Not immediately available
  - Shipping papers may be damaged or not easily removed from where they are kept
  - SDSs may not be located right at the spill or release site

### Senses

Your eyes and ears are important to gather information as part of emergency response at the scene of a release or other potential hazardous material incident.

Use your eyes to gather information to describe:

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

Use your ears to gather information to describe:

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

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

- Burn, tingle

Caution regarding relying on your nose:

- Many hazards (e.g., carbon monoxide, radiation) have no warning properties by smell.

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

Caution regarding relying on your eyes:

- Some people have difficulty distinguishing colors

### Recognizing Biological Hazards

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Responders may also be exposed to biological hazards such as bacteria, viruses, certain parasites, mold and animal/bird droppings. Specialized training and equipment are needed to detect or measure these biological hazards and is not usually available at a response. The visual identification of possible mold and bird/animal droppings may be considered 'positive' for a hazard.

#### Infectious wastes

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



**Infectious  
Materials Symbol**

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

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

### **Poisonous plants**

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

### **Fungi and yeasts**

Mold (a fungus) may be present in storage areas that have been wet.

Bird droppings on the support beams of storage buildings (fungus or yeasts cause lung disease). Look for deposits on the highest structures. Disturbing droppings can result in airborne exposure.

### **Insects**

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

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

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

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

### **Snakes**

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

### **Animals**

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

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



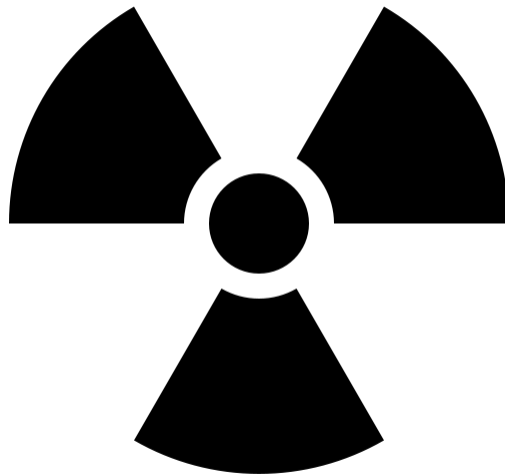
## **Recognizing Physical Hazards**

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Physical hazards include a wide range of potential exposures. Examples include radiation and noise and hazards such as slips or trips or falls. The potential for injury from these hazards may increase during an emergency due to poor visibility and the tendency to rush.

### **Radiation**

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



**Radiation Symbol**

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

**Noise**

The usual definition of 'noise' is 'unwanted sound'. At a response there are many sounds that may be considered noise. Some areas in an industrial facility may be marked with signage alerting workers to high noise levels and the need for hearing protection. Noise from mobile sources such as emergency response vehicles at a response is recognized as a potential hazard.

**Slips, Trips and Falls**

Slips, trips and falls occur due to unstable footing or unstable surfaces. Avoid any unstable steps or walkways. Avoid steep slopes, walking through puddles or climbing over equipment or obstructions. If you fall while responding to a chemical spill and must be rescued, response to the incident will be delayed and exposure to a toxic material may be increased for you and the rescuers.

**Electricity**

Downed power lines represent a major risk of electrocution. Other risks of electrical and hazardous material exposure may be present at transformers and circuit boxes.

The presence of water will increase the hazard. Maintain a safe distance, and keep others out of the area. See 29 CFR 1910.147 for regulations concerning the control of hazardous energy (lock-out/ tag-out).

**Heat and Cold**

Responding on days when the temperatures are extreme, using protective equipment that decreases heat loss or responding in areas that are heated or cooled for the production process puts extra physical stress on the body. Long periods of exposure to heat may cause illness, particularly if an employee is not accustomed to working in hot areas. Cold stress is less common, but may occur if work is required outdoors in winter months or in cold storage/freezer compartments.

**Steam**

Any 'cloud' seen at a response site should be reported to the designated person while maintaining a safe distance. Steam from ruptured lines can cause severe burns. The steam, or the heat from it, may also react with other materials to compound the hazards at a hazardous materials incident scene. Some chemicals may appear as clouds that look like steam.

Steam or other rising 'cloud' will be carried by the wind. Stay upwind to further reduce the possibility of contact.

### **Confined Spaces**

Confined spaces are areas like ditches, stream beds, trailers, tanks, rail cars, basements, and storage closets. Entry into confined spaces poses many dangers. Accumulations of chemical vapors can overcome an entrant and prove deadly. Emergency responders must only enter confined spaces if properly trained.

See 29 CFR 1910.146 for regulations concerning permit-required confined spaces.

An operations-level emergency responder is not trained to do everything and should not attempt any task for which training has not been completed.



**Safety Data Sheet**

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

**1. PRODUCT AND COMPANY IDENTIFICATION**

- *Product identifier*
- *Trade name:* **REMOVER/THINNER 911**
- *Article number:* 911-1
- *CAS Number:*  
107-98-2
- *EC number:*  
203-539-1
- *Index number:*  
603-064-00-3
- *Relevant identified uses of the substance or mixture and uses advised against*  
No further relevant information available.
- *Application of the substance / the preparation* Laboratory chemicals
- *Details of the supplier of the safety data sheet*
- *Manufacturer/Supplier:*  
  
: Chemco  
  
909 Chemway Ct.  
Montgomery, AL  
USA  
Telephone : +1 800-999-9999  
Fax : +1 800-888-8888  
Emergency Phone # (For : (314) 776-6555  
both supplier and  
manufacturer)  
Preparation Information : Chemco  
Product Safety – North America  
1-800-777-7777

**2. HAZARDS IDENTIFICATION**

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



GHS02 Flame

Flam. Liq. 3 H226 Flammable liquid and vapour.



GHS08 Health hazard

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



GHS07

*Acute Tox. 4 H312 Harmful in contact with skin.*

*Acute Tox. 4 H332 Harmful if inhaled.*

*Skin Irrit. 2 H315 Causes skin irritation.*

*STOT SE 3 H336 May cause drowsiness or dizziness.*

### GHS Label elements, including precautionary statements

#### · Hazard pictograms



#### · Signal word *Warning*

#### · Hazard statements

*H312 Harmful in contact with skin.*

*H332 Harmful if inhaled.*

*H315 Causes skin irritation.*

*H336 May cause drowsiness or dizziness.*

#### · Precautionary statements

*P261 Avoid breathing dust/fume/gas/mist/vapours/spray.*

*P280 Wear protective gloves/protective clothing/eye protection/face protection.*

*P321 Specific treatment (see on this label).*

*P322 Specific measures (see on this label).*

*P405 Store locked up.*

*P501 Dispose of contents/container in accordance with local/regional/national/international regulations.*

#### · Classification system:

#### · NFPA ratings (scale 0 - 4)

*Health = 2*

*Fire = 1*

*Reactivity = 0*

#### · HMIS-ratings (scale 0 - 4)

*Health = 2*

*Fire = 1*

*Reactivity = 0*

---

### 3. COMPOSITION/INFORMATION ON INGREDIENTS

#### · Chemical characterization: *Substances*

#### · CAS No. *Description*

*107-98-2 1-methoxy-2-propanol*

#### · Identification number(s)

*· EC number: 203-539-1*

*· Index number: 603-064-00-3*

#### · Dangerous components:

*1589-47-5 2-methoxypropanol ≤ 2.5%*

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### 4. FIRST AID MEASURES

#### · Description of first aid measures

#### · General information:

*Symptoms of poisoning may even occur after several hours; therefore medical observation for at least 48 hours after the accident.*

· **After inhalation:**

*Supply fresh air. If required, provide artificial respiration. Keep patient warm. Consult doctor if symptoms persist.*

*In case of unconsciousness place patient stably in side position for transportation.*

· **After skin contact:** *Immediately wash with water and soap and rinse thoroughly.*

· **After eye contact:** *Rinse opened eye for several minutes under running water.*

· **After swallowing:** *If symptoms persist consult doctor.*

· **Information for doctor:**

· **Most important symptoms and effects, both acute and delayed** *No further relevant information available.*

· **Indication of any immediate medical attention and special treatment needed**

*No further relevant information available.*

---

### 5. FIREFIGHTING MEASURES

· **Extinguishing media**

· **Suitable extinguishing agents:** *Use fire fighting measures that suit the environment.*

· **Special hazards arising from the substance or mixture** *No further relevant information available.*

· **Advice for firefighters**

· **Protective equipment:** *Mouth respiratory protective device.*

---

### 6. ACCIDENTAL RELEASE MEASURES

· **Personal precautions, protective equipment and emergency procedures** *Not required.*

· **Environmental precautions:** *Do not allow to enter sewers/ surface or ground water.*

· **Methods and material for containment and cleaning up:**

*Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).*

*Dispose contaminated material as waste according to item 13.*

*Ensure adequate ventilation.*

· **Reference to other sections**

*See Section 7 for information on safe handling.*

*See Section 8 for information on personal protection equipment.*

*See Section 13 for disposal information.*

---

### 7. HANDLING AND STORAGE

· **Handling:**

· **Precautions for safe handling**

*Ensure good ventilation/exhaust at the workplace.*

*Prevent formation of aerosols.*

· **Information about protection against explosions and fires:**

*Protect from heat.*

*Protect against electrostatic charges.*

· **Conditions for safe storage, including any incompatibilities**

· **Storage:**

· **Requirements to be met by storerooms and receptacles:** *No special requirements.*

· **Information about storage in one common storage facility:** *Not required.*

· **Further information about storage conditions:**

*Keep receptacle tightly sealed.*

*Protect from heat and direct sunlight.*

· **Specific end use(s)** *No further relevant information available.*

---

**8. EXPOSURE CONTROLS/PERSONAL PROTECTION**

· **Additional information about design of technical systems:** No further data; see item 7.

· **Control parameters**

· **Components with limit values that require monitoring at the workplace:**

**107-98-2 1-methoxy-2-propanol**

REL ST: 540 mg/m<sup>3</sup>, 150 ppm

TWA: 360 mg/m<sup>3</sup>, 100 ppm

TLV STEL: 360 mg/m<sup>3</sup>, 100 ppm

TWA: 180 mg/m<sup>3</sup>, 50 ppm

· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**

· **Personal protective equipment:**

· **General protective and hygienic measures:**

Keep away from foodstuffs, beverages and feed.

Immediately remove all soiled and contaminated clothing.

Wash hands before breaks and at the end of work.

Avoid contact with the skin.

Avoid contact with the eyes and skin.

· **Breathing equipment:**

In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.

· **Protection of hands:**

Protective gloves:

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.

Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.

Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.

· **Material of gloves**

The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.

· **Penetration time of glove material**

The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.

· **Eye protection:** Goggles recommended during refilling.

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**9. PHYSICAL AND CHEMICAL PROPERTIES**

· **Information on basic physical and chemical properties**

· **General Information**

· **Appearance:**

**Form:** Fluid

**Color:** Colorless

· **Odor:** Alcohol-like

· **Odour threshold:** Not determined.

· **pH-value at 20 °C (68 °F):** 4-7

· **Change in condition**

**Melting point/Melting range:** -96.7 °C (-142 °F)

**Boiling point/Boiling range:** 80 °C (176 °F)

· **Flash point:** 110 °C (230 °F)

· **Flammability (solid, gaseous):** Not flammable.

· **Ignition temperature:** 270 °C (518 °F)

· **Decomposition temperature:** Not determined.



- **Auto igniting:** Not determined.
- **Danger of explosion:** Product does not present an explosion hazard.
- **Explosion limits:**  
**Lower:** 2.3 Vol %  
**Upper:** ~ 20 Vol %
- **Vapor pressure at 20 °C (68 °F):** 12 hPa (9 mm Hg)
- **Density at 20 °C (68 °F):** 0.962 g/cm<sup>3</sup> (8.028 lbs/gal)
- **Relative density** Not determined.
- **Vapour density** Not determined.
- **Evaporation rate** Not determined.
- **Solubility in / Miscibility with Water:** Not miscible or difficult to mix.
- **Partition coefficient (n-octanol/water):** Not determined.
- **Viscosity:**  
**Dynamic:** Not determined.  
**Kinematic:** Not determined.
- **Organic solvents:** 34.0 %
- **VOC content:** 34.0 %
- **Density:** 997.9 g/l / 8.33 lb/gl
- **Solids content:** 66.0 %
- **Other information** No further relevant information available.

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## 10. STABILITY AND REACTIVITY

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

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## 11. TOXICOLOGICAL INFORMATION

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

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**12. ECOLOGICAL INFORMATION**

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

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**13. DISPOSAL CONSIDERATIONS**

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

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**14. TRANSPORT INFORMATION**

- **UN-Number**
- **DOT, ADR, IMDG, IATA** UN3092
- **UN proper shipping name**
- **DOT, IMDG, IATA** 1-METHOXY-2-PROPANOL
- **ADR 3092** 1-METHOXY-2-PROPANOL
- **Transport hazard class(es)**
- **DOT**
- **Class 3** Flammable liquids.
- **ADR, IMDG, IATA**
- **Class 3** Flammable liquids
- **Packing group**
- **DOT, ADR, IMDG, IATA** III
- **Environmental hazards:**
- **Marine pollutant:** No
- **Special precautions for user** Warning: Flammable liquids
- **Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code** Not applicable.
- **UN "Model Regulation":** UN3092, -METHOXY-2-PROPANOL, 3, III

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**15. REGULATORY INFORMATION**

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

*Substance is not listed.*

· **Chemicals known to cause reproductive toxicity for females:**

*Substance is not listed.*

· **Chemicals known to cause reproductive toxicity for males:**

*Substance is not listed.*

· **Chemicals known to cause developmental toxicity:**

*Substance is not listed.*

· **Carcinogenic categories**

· **EPA (Environmental Protection Agency)**

*Substance is not listed.*

· **TLV (Threshold Limit Value established by ACGIH)**

*Substance is not listed.*

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**

*Substance is not listed.*

· **OSHA-Ca (Occupational Safety & Health Administration)**

*Substance is not listed.*

· **Product related hazard information:**

*The product has been classified and marked in accordance with directives on hazardous materials.*

· **Chemical safety assessment:** *A Chemical Safety Assessment has not been carried out.*

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## 16. OTHER INFORMATION

*This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.*

· **Department issuing SDS:** *Safety Data Sheet Department*

· **Contact:** *Safety Department*

· **Abbreviations and acronyms:**

*ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)*

*IMDG: International Maritime Code for Dangerous Goods*

*DOT: US Department of Transportation*

*IATA: International Air Transport Association*

*ACGIH: American Conference of Governmental Industrial Hygienists*

*EINECS: European Inventory of Existing Commercial Chemical Substances*

*CAS: Chemical Abstracts Service (division of the American Chemical Society)*

*NFPA: National Fire Protection Association (USA)*

*HMIS: Hazardous Materials Identification System (USA)*

*VOC: Volatile Organic Compounds (USA, EU)*

*LC50: Lethal concentration, 50 percent*

*LD50: Lethal dose, 50 percent*

*Revision: 06.21.2013*

## **Summary – Hazard Recognition**

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

### **Chemical**

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

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

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

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

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

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

### **Biological**

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

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

### Physical

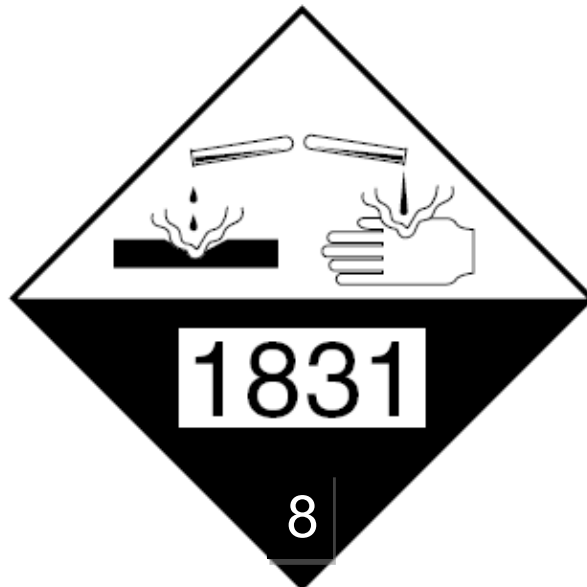
- Radiation
- Noise
- Slips, trips, falls
- Electricity
- Heat and cold
- Steam
- Confined spaces

Signage may alert you to physical hazards, especially radiation, noise, electrical or confined space; however do not rely on signage. Be alert for wet, uneven or unstable walking surfaces and emissions that may appear to be steam. Heat and cold from weather or production processes pose additional stresses when working in protective gear during an emergency.

**Review Questions**

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1. List major types of health and safety hazards.
  
  
  
  
  
  
  
  
  
  
2. On the placard provided, what information is shown?



3. What do the following pictograms mean?



\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. What do the following symbols indicate?



\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5. Why is a container shape important?

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





## **HEALTH HAZARD RECOGNITION**

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First responders need to be aware of potential hazards to their health. By understanding the hazards which may be present during emergency response, the responder can learn to protect himself or herself from them.

### **Chapter Objectives**

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

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

### Chemical Reactions

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

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

- Toxic gases
- Large amounts of heat/cold
- Fire or explosion

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

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

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

## **Chemical and Physical Characteristics**

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Understanding the way chemicals behave can help the first responder anticipate the hazards a substance might present in an emergency. Scientists have developed many terms to describe the chemical and physical properties of substances. It is not important for the first responder to memorize these terms, but a general understanding of their meanings may be helpful. Many are defined below, and examples given:

### **Freezing Point (FRZ)**

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

### **Melting Point (MP)**

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

### **Boiling Point (BP)**

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

Water.....	212° (100C°)	Cadmium.....	1,409°F
Acetone.....	133°F	Chlorine.....	-29°F
- **Importance** Determines whether a substance will be a liquid or gas at the temperature of the air.

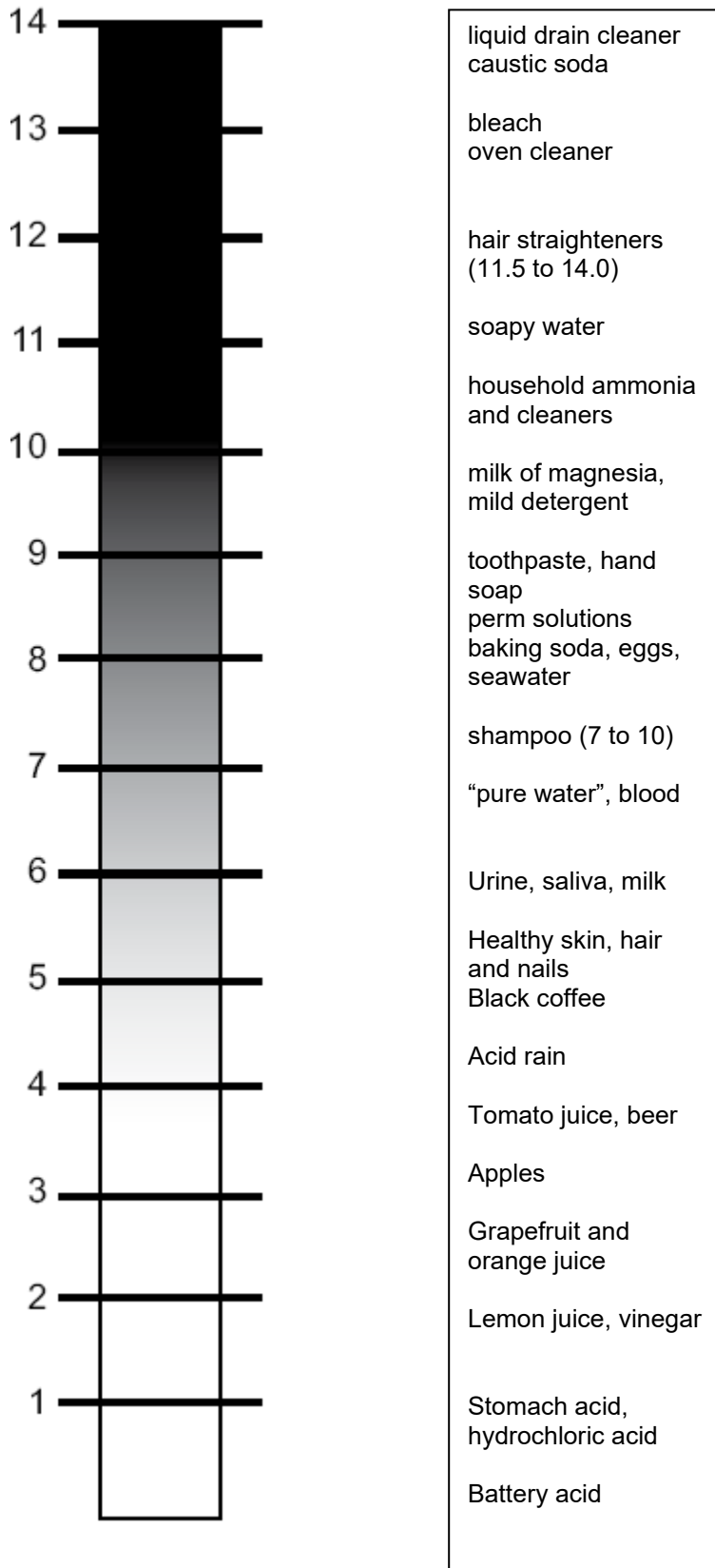
### pH

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

**Example** See scale.

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

## Health Hazard Recognition



### Corrosive

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

### Examples

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

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

### Flash Point (Fl. P.)

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

### Examples in degrees Fahrenheit (°F)

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

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

**Flammable, Combustible, Ignitable**

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

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

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

**Autoignition Temperature**

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

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

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

### Oxidizer

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

### Examples

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

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

### Solubility in Water (Sol)

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

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

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



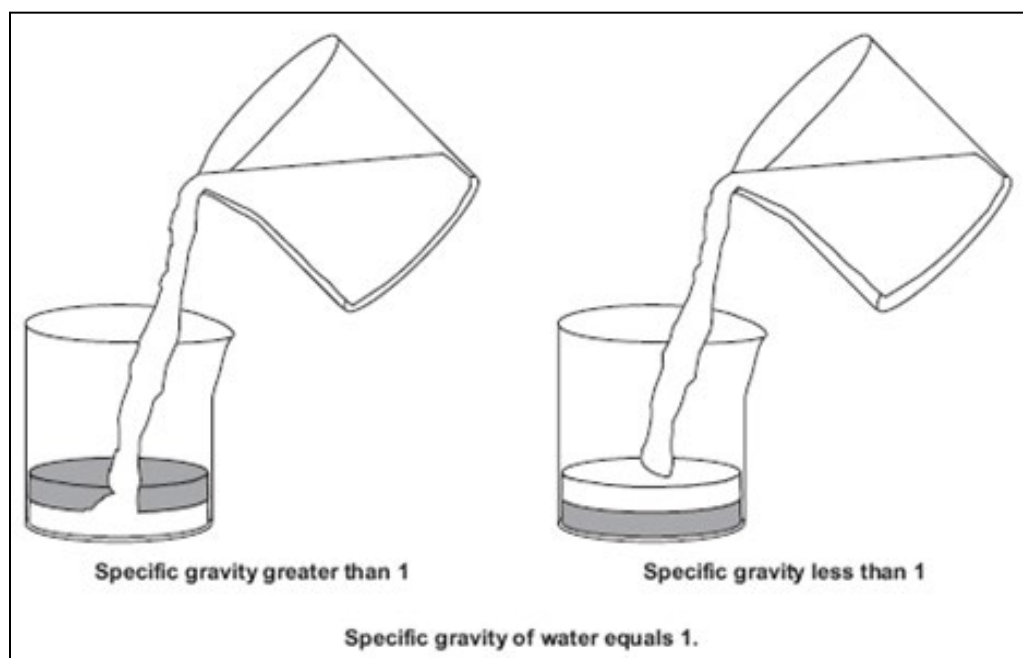
## Specific Gravity (Sp. Gr./S.G.)

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

**Examples**

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

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



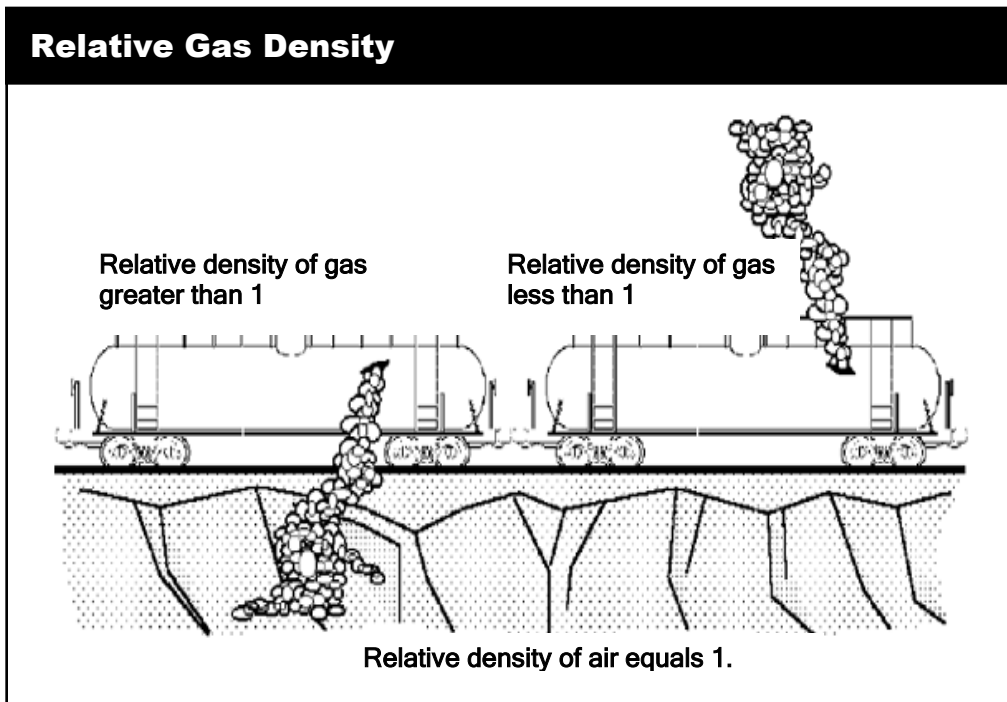
**Relative Gas Density (RGasD)**

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

**Examples**

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

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

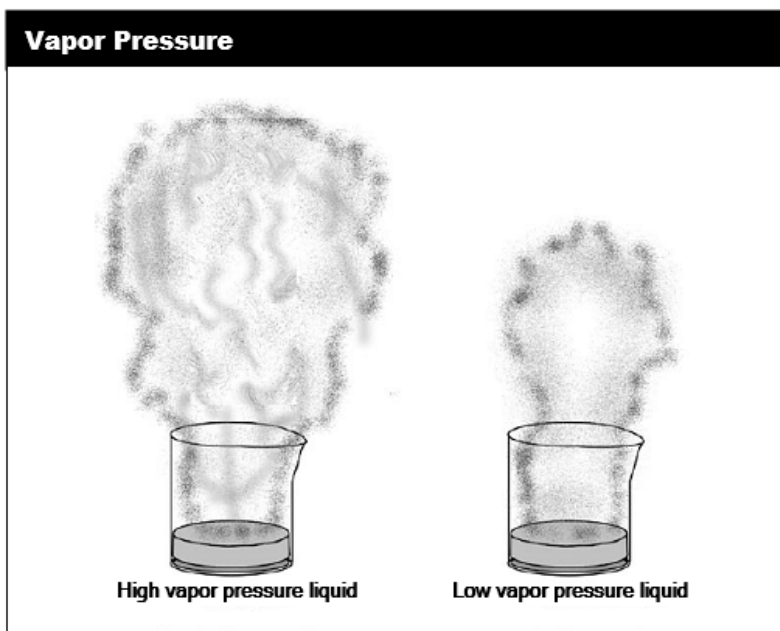


## Vapor Pressure (VP)

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

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

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



### Viscosity

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

**Examples** Water has a low viscosity  
Molasses has a high viscosity

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

### Volatility

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

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

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

### Toxicity

**Definition** The types and level of harm caused by exposure.

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

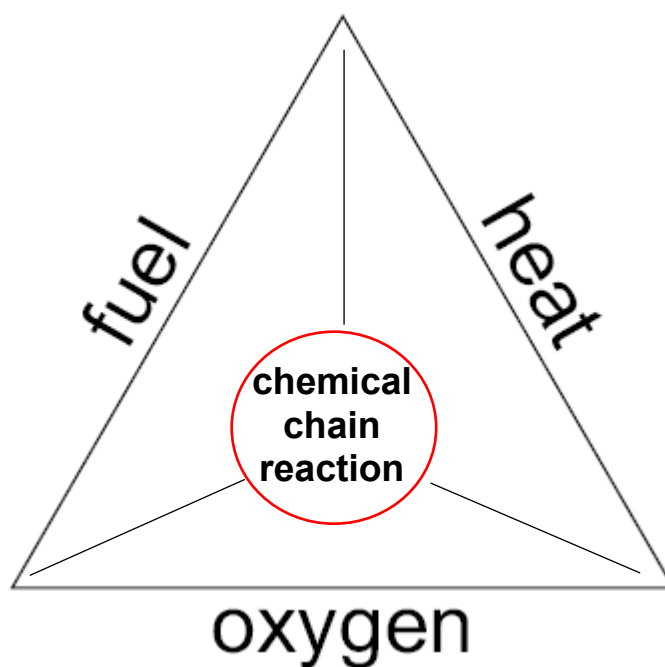
**Importance** The risk of a health effect depends on the toxicity of the chemical and many other factors, including level of exposure, duration of exposure and exposures to other toxic compounds.

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

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

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



**For example:**

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

## **Explosive Limits**

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

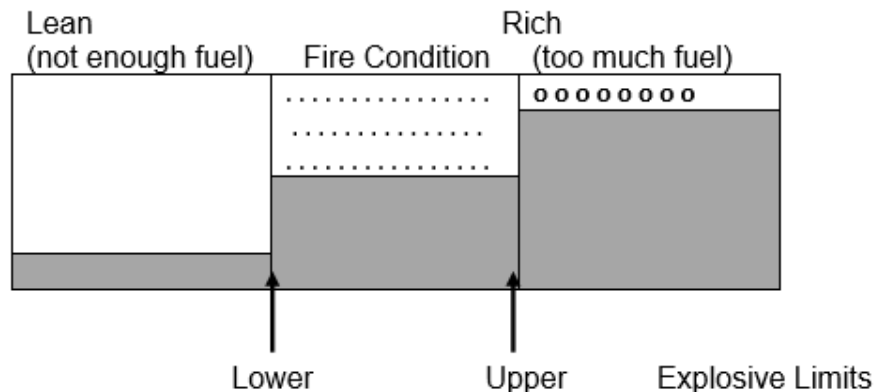
Compare these explosive limits to the operation of a car engine. When the mixture is too lean (not enough gas), the engine will not run. The gas vapor is below the LEL, and the engine will not run. If the engine floods (too much gas), then the UEL has been exceeded and the car will not run. When the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

During an emergency involving flammable/explosive gases or vapors, constant air monitoring is essential, because the concentration of the gas can rapidly change. The air also needs to be monitored throughout the site, not just in the immediate area of the release.

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

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

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



## **Chemicals and the Body**

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### **Introduction**

How does the body react to exposure?

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

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

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

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

### **Some Basic Principles of Toxicology**

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

### **Acute Effects or Acute Toxicity**

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

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

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

You may move away from an acute exposure if you experience a warning property. Warning properties may be reactions such as:

- Irritation to the skin, eyes, or respiratory tract (upper airways or lungs)

## Health Hazard Recognition

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

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

Pictograms in the 2012 update to the Hazard Communication standard (29 CFR 1910.1200) indicate the potential for an acute effect. For example, the following Hazards:

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

are linked to the "Exclamation Mark" Pictogram on labels.



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

Acute toxicity (fatal or toxic).





### Chronic Effects or Chronic Toxicity

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

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

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

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



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

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

## Routes of Entry

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

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

### Inhalation

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

### Skin Absorption/Contact; eye contact

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

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

### Ingestion

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

### **Injection**

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

### **Multiple Routes of Entry**

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

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

### **Be alert for secondary sources of exposure**

Hand contamination can contribute to ingestion and inhalation!

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

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

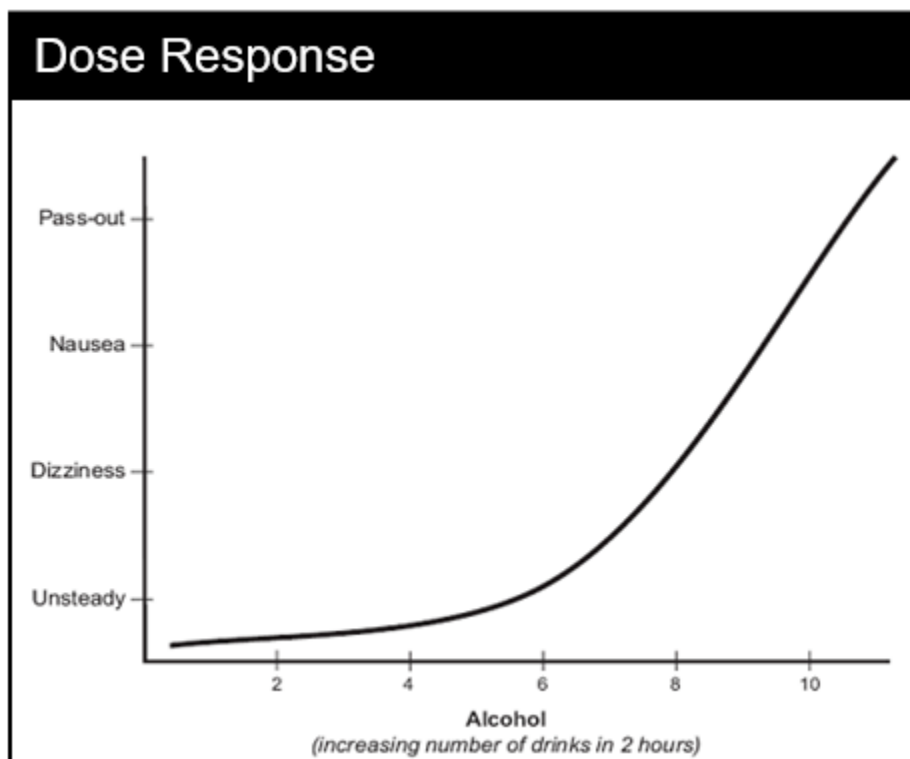
Example: Put your hands on back of a chair where someone with dusty shirt has been sitting and transfer to your hands and then ingested.

## Factors That Influence the Body's Response to Exposure

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

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



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

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

Exposure or Dose?

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

### Exposure Interactions

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

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

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

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

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

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

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

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

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

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

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

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

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

Carcinogenic effects may be local or systemic.

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

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

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

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

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

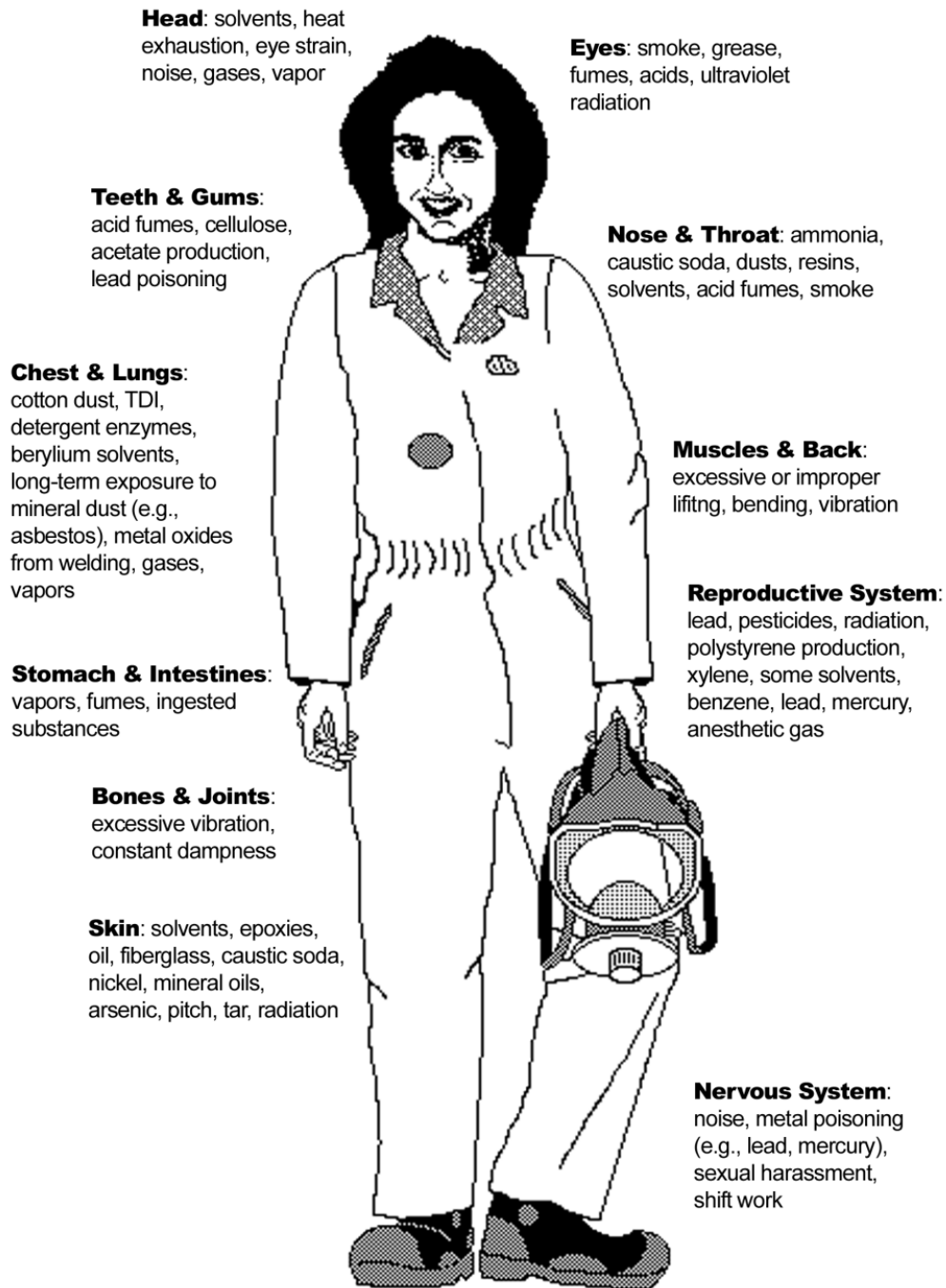
**Aspiration** is the entry of a liquid or solid chemical directly through the oral or nasal cavity (or indirectly during vomiting) into the trachea and lower respiratory system. Aspiration toxicity includes chemical pneumonia, other pulmonary injury or death. Petroleum distillates and chlorinated solvents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

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

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

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

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



Adapted from the International Metal Worker's Union



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

**Head:** dizziness, headache

**Teeth & Gums:** corrosion of tooth enamel, blue gums

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

**Stomach & Intestines:** Vomiting, diarrhea

**Bones & Joints:** arthritis.

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



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

**Ears:** ringing, temporary deafness, hearing loss

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

**Muscles & Back:** soreness, strain

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

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

Adapted from the International Metalworker's Union

**Exercise – Information Sources**

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

1. What is the name of the chemical or hazardous waste?
2. What does the placard or label tell you about the chemical?
3. What are the physical hazards of the substance—explosion, fire, reactive, oxidizing material, etc.?
4. What are the health hazards?
5. What target organs does this chemical affect?
6. What are the safe handling recommendations?
7. What personal protective equipment is recommended to limit worker exposure?
8. Is First Aid information given? What is it?
9. Is the chemical volatile? What is the vapor pressure and vapor density?

## **Heat and Cold**

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Wearing protective gear adds to the risk of heat stress. Temperature puts extra physical stress on the body. Long periods of exposure to heat may cause illness, particularly if a responder is not accustomed to working with a high heat load. Heat builds up inside protective clothing, so there is a risk of heat stress even if outside temperatures are moderate.

Regular monitoring, observation and other protective measures such as rest breaks and adequate fluids are vital to prevent heat stress. Individuals react to heat in different ways. Some factors that add to the risk of heat stress include lack of physical fitness, age, low fluid intake, alcohol or drug use, sunburn, diarrhea, and infection.

### **Signs and Symptoms of Heat Stress**

#### **Heat Rash or Prickly Heat**

Symptoms: Little bumps that look like blisters on the skin surrounded by reddened skin

Cause: Increased sweating causes pores to be blocked causing irritation

Treatment: Remove or loosen clothing; topical creams may help relieve itching.

#### **Heat Cramps**

Symptoms: Painful muscle spasms

Cause: Profuse sweating and drinking large amounts of water

Treatment: Provide liquids with electrolytes (sodium, potassium) like diluted Gatorade™

#### **Heat Exhaustion**

Symptoms: Weakness; fatigue; dizziness; pale, cool, moist skin; heavy sweating; headache; nausea; and fainting

Cause: Reduced blood volume resulting from dehydration from profuse sweating and insufficient replacement of water and salts

Treatment: If worker is conscious, rest in a cool place is recommended. Replace water and electrolytes lost in sweat. If worker is unconscious, get medical help immediately. Do not give liquids if the person is unconscious.

### Heat Stroke

Symptoms: Very dry, hot skin with red, mottled or bluish appearance; confusion; convulsions; unconsciousness; rapidly rising temperature

Cause: Body becomes overheated because the worker does not sweat. Can be fatal.

Treatment: Call for medical help immediately. Move person to a cool place. Remove PPE. Use wet towels or water and fan to cool while waiting for help.

Heat stroke is a life-threatening emergency. Medical attention is required.

Cold stress is less common but may occur outdoors in winter months or in responses that involve cryogenic materials or cold storage areas.

### Signs and Symptoms of Cold Exposure

#### Frostbite

Symptoms: Numbness of hands, feet, or face.

Cause: Prolonged exposure to cold environments.

Treatment: Frostbitten tissue should be gently warmed and not exposed to further cold.

#### Hypothermia

Symptoms: Lowered body temperature, shivering, or drowsiness. If body temperature is reduced to 80°F (or below), unconsciousness is often followed by death.

Cause: Wet, cold, exhaustion; body's response to minimize heat loss becomes ineffective when body temperature goes below 86°F

Treatment: Warm the body. Get medical assistance.

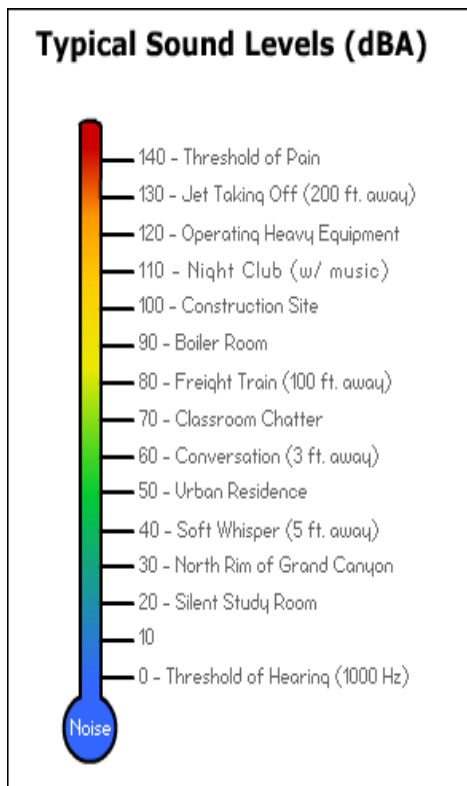
## Noise

During a response, noise levels from alerting signals and other sources may be very high. Short exposures to high noise levels can cause a temporary change in hearing or the sound of ringing in your ears. Repeated exposures over longer periods of time to noise can lead to permanent effects, including hearing loss. Exposure to high noise levels is also linked to high blood pressure, insomnia, headaches and psychological stress.

Loud noise during a response can interfere with communication and concentration resulting in slower or inappropriate actions, accidents and injuries.

See noise exposure levels in the figure, below.

Source: <https://www.osha.gov/SLTC/noisehearingconservation/loud.html>



Notice that the values are shown in dBA, or decibels (dB) measured on the A-weighting scale. This scale mimics the human ear response to sound; it does not measure some of the low frequency sound, as the human ear does not pick up all low frequency sound.

Occupational exposure to noise is measured on this scale. dB and dBA cannot be compared easily.

Other useful noise levels are:

Forklift	90 dBA
Ambulance siren	120 dBA
Air horn alert system	130 dBA

Over an 8-hour shift, OSHA allows a TWA exposure of 90 dBA. If the sound is louder, less time is allowed; for example, 4 hours is allowed at a TWA of 95 and 2 hours is allowed

at a TWA of 100. If the TWA exceeds 85 dBA, a Hearing Conservation Program is required to monitor hearing, provide training and hearing protection. See 29 CFR 1910.95.

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

## **Radiation**

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When a material is radioactive, it sends small parts of its atoms or energy through the air. There are three forms of ionizing radiation: Alpha, Beta, and Gamma. All of these forms are serious health hazards.

### **Alpha Radiation:**

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

### **Beta Radiation:**

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

### **Gamma Radiation:**

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

### **Neutrons:**

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

### **For Protection from Radiation:**

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

## **Medical Surveillance Program**

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

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

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

Medical exams should be conducted:

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

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

The content of the examination or consultations made will be determined by the physician. The physician may not understand the details of the

employee's work. Therefore, before the examination, it is important to explain to the physician the type of work, potential health risks, and the type of protective equipment which may be worn for the response. Materials provided may include but may not be limited to:

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

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

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

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

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

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



### Exposure Records

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

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

### Things the Responder Should Do

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

## Summary – Health Hazard Recognition

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

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

Chemical terms used to describe the chemical and physical properties of substances help the first responder anticipate the hazards that may be present during an incident. Commonly used terms include:

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

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

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

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

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

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

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

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

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

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

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

Responders should:

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

### Review Questions

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1. Describe the importance of the following terms:

Boiling Point

Flammability

Flash Point

Relative gas density

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

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

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

5. When should medical examinations be performed?

# MONITORING

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Monitoring the environment for hazardous substances is an important part of size-up. First responders need to know as much as possible about what hazards are present before response actions are taken. This section will review techniques to monitor the environment, focusing on the types which will most likely be used during a response to a hazardous materials incident.

## Chapter Objectives

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

- Identify why and how the work environment is monitored
- Identify some hazards that can be monitored
- Identify steps taken to monitor at the scene of a hazardous materials emergency
- Identify the uses of different types of monitoring equipment during a response
- Demonstrate the use of a monitoring device and record the results

## The Importance of Monitoring

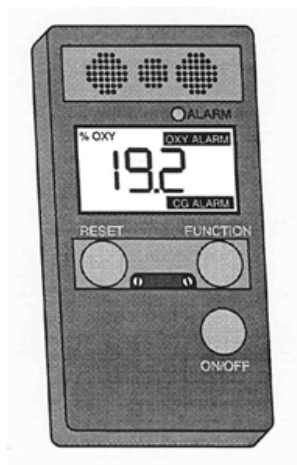
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Monitoring helps the operations-level first responder by providing vital information about the hazards present at the site. Usually readings or samples with air monitors will be taken of the atmosphere surrounding the incident. Although no single instrument can detect all hazards, using air-monitoring equipment properly can provide information which is needed to protect life and property. However, using the wrong instrument or one that isn't working properly may endanger life and property by indicating conditions as not hazardous when, in fact, they are.

Reasons for monitoring are:

- *To detect whether potential hazardous conditions exist*
- *To measure the concentration of hazardous substances*

Oxygen meter to MEASURE oxygen 19.2% displayed



Monitoring will generally be conducted as part of risk assessment (size-up of the scene), as well as during response activities. Continuous monitoring helps the responder be aware of the concentrations of hazards and changes that may occur as a result of the response itself or the wind or ventilation changes.

## **Uses for Monitoring Data**

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Detect potential hazards to:

- Determine possible immediate effects of hazards, especially conditions which are Immediately Dangerous to Life and Health (IDLH) before and during response actions
- Monitor for sudden release of toxic materials that would require new emergency action during the response
- Determine that no hazardous exposures are present when the response has ended

Measure concentrations to:

- Determine the extent of hazardous conditions
- Assist in planning response actions
- Provide records of exposure for medical purposes
- Provide a historical record to submit to regulatory agencies

Responders with more advanced training will be involved in other monitoring activities, such as identifying specific compounds, if the substance(s) is unknown. This information will:

- Assist in the selection of respiratory protection and ensure that it remains effective during the period in which work is performed.
- Assist in the selection of chemical-protective clothing
- Help determine whether there is a need for medical monitoring
- Verify chemical(s) and help determine the response

## **Monitoring at an Emergency**

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### **General considerations**

It is important to carefully monitor the atmosphere during a response to an unexpected release. Failure to recognize toxic, explosive, oxygen-deficient or oxygen-enriched atmospheres could result in serious damage to life and property. The ERP provides a plan for monitoring as part of the emergency response.

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

Air monitoring will usually be conducted as part of initial actions and throughout the response to ensure that the proper level of PPE is used by the responders. In addition, it is often necessary to document concentrations at the perimeter or in other locations near or adjacent to the response such as downwind, where contaminants may be transported. Specific SOPs developed in advance and included in the ERP are followed. Where monitoring will not be conducted, the reasons must be listed in response documentation.

Monitoring data will be used for specific purposes before and throughout the response and may include:

### **Pre-Emergency**

Establishing background or usual levels may available from routine monitoring or might be determined in advance as a training exercise

### **Emergency**

- Determining whether entry can be made
- Providing information for the response strategy
- Determining level of PPE protection
- Monitoring conditions, in case of change

### **Post-Emergency**

- Establishing levels after containment/confinement
- Documenting perimeter levels
- Identify post-emergency response needs during termination
- Completing termination documents



## What Can Be Monitored in the Air?

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

1. Oxygen Deficiency/Enrichment
2. Fire and Explosion Hazards
3. Toxic Chemicals
4. Corrosivity
5. Radiation

### Oxygen-Deficient/-Enriched

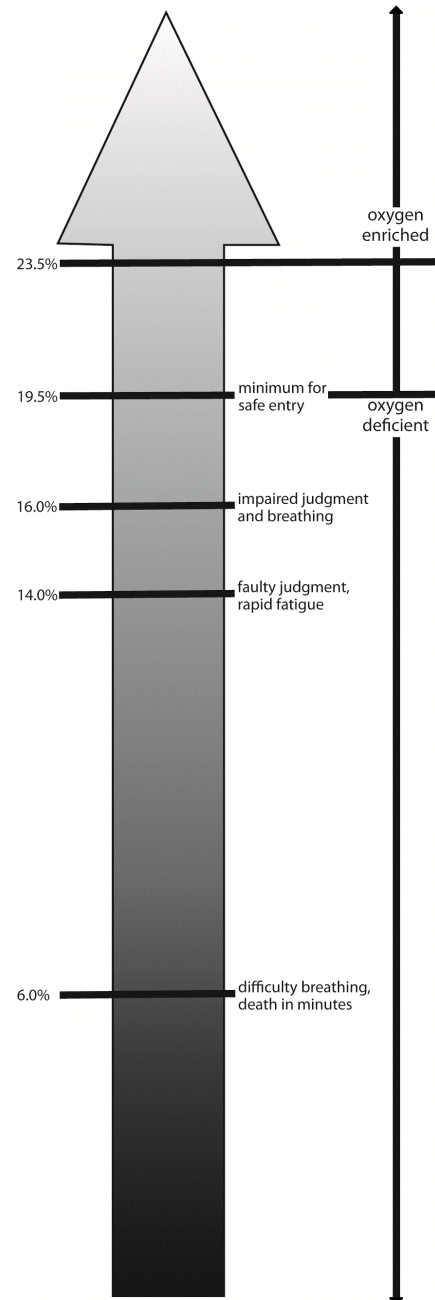
#### Oxygen-Deficient

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

#### Oxygen-Enriched

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

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



## Fire and Explosion Hazards

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

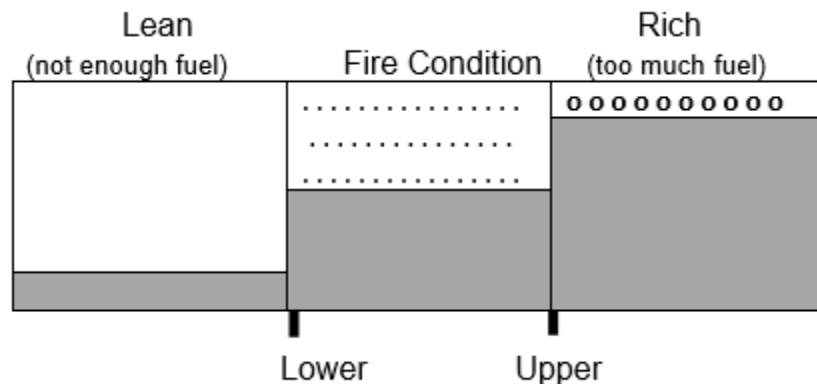
### Explosive Limits

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

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

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

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



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

**Toxic Chemicals**

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

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

**Corrosivity**

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

There are chemical-specific monitors for some acids such as hydrochloric acid.

**Radiation from radioactive substances**

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

## **Measures of Concentration**

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

1 ppm, 1 mg/m<sup>3</sup>, or 1 f/cc are very dilute concentrations. Some chemicals are hazardous even at these low concentrations.

Percent is used for higher concentrations; a concentration of 1% is 10,000 ppm.

Concentrations of particulates, dusts, and mists are usually measured in milligrams per cubic meter of air (mg/m<sup>3</sup>).

- There are about 400,000 milligrams in one pound.
- There are about 35 cubic feet in one cubic meter. (A meter is about 40 inches.)

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

## Exposure Limits and Guidelines

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

### Permissible Exposure Limits (PELs)

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

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

### Threshold Limit Values (TLVs)

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

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

### Recommended Exposure Levels (RELs)

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

### Short-Term Exposure Limits (STELs)

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

### Ceiling Limits (C)

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

### Skin, Sensitizer, and Carcinogen Notations

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

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

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

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

### Time-Weighted Averages (TWAs)

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

#### Time-Weighted Averages Calculated

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

$$\text{TWA} = \frac{(\text{Exposure}_1 \times \text{Time}_1) + (\text{Exposure}_2 \times \text{Time}_2) + \dots}{(\text{Time}_1 + \text{Time}_2 + \dots)}$$

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

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

$$\text{TWA} = 48 \text{ ppm}$$

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

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

#### Important Points to Remember About Exposure Limits and Guidelines

*The following considerations are important when thinking about exposure limits.*

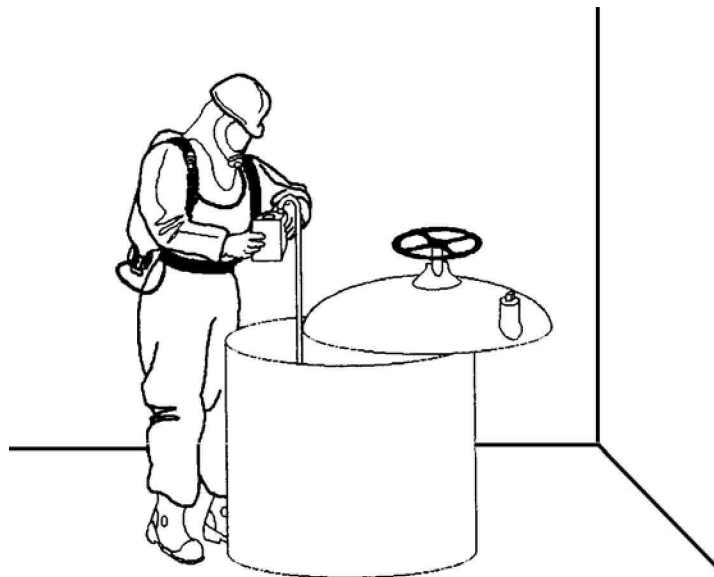
- Most PELs and TLVs are 8-hour average work exposures; however, most emergencies don't last this long.
- STELs are set for very few compounds
- Measuring exposure during an emergency requires preplanning so emergency equipment is available and ready for use.
- Results of exposure monitoring can be requested under the OSHA standard on access employee exposure and medical records (29 CFR 1910.120).

## **Types of Air Monitoring**

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Air samples may be collected by placing monitoring devices directly on the worker (personal monitoring) or by placing a monitoring device in the area where people may work (area monitoring). Monitors (personal or area) with alarms can be set up to alert workers to unusual or unexpected concentrations of substances in the air.

Real-time monitoring is a type of area monitoring which provides a direct reading of air contamination at the moment it is being used. Other types of area monitors collect samples which are sent away for analysis by a lab.



**Real-Time, Area Monitoring at a Process Tank**



## Personal Monitoring

Personal monitoring is done to determine the quality of the air the worker is breathing or would breathe if not protected. Personal air samples are usually collected by placing a battery-operated air pump on the wearer's belt and clipping a collection tube or filter on his/ her collar near the nose, an area known as the breathing zone. Air from the environment is pulled into the collection tube or filter where the contaminants are trapped. The collection tube or filter is sent to a laboratory for analysis.

Another method of collecting personal air samples is through the use of a passive dosimeter. This device is a chemically sensitive badge clipped to the work's collar which collects a sample without using a pump.

Advantages of personal air monitoring include:

- It provides the most accurate measurement of a worker's actual exposure
- The results can be converted to a TWA and compared with the OSHA PEL and ACGIH TLV levels
- It can be used during an emergency response to document exposure throughout the event

Disadvantages of personal air monitoring include:

- It requires laboratory analysis of the sample, which may take 1–14 days
- It provides no data concerning peak or ceiling exposures if collected over several hours
- It generally requires that the exact chemical in the air be known
- It requires preparation so the equipment is ready at any time to be used for monitoring during an emergency response

### Wearing a Sampling Device

- The monitor should be worn according to the instructions that are given
- Wearer should request the results of the test using the OSHA Access to Employee Exposure and Medical Records Standard, 1910.1020. (Management must provide these results, if requested.)
- Results can be compared with PELs and TLVs
- The wearer should keep the results and/or give them to a physician and/or his or her union

## Real-time Monitoring

Real-time monitoring provides an immediate measurement of substance in the air. It can be done with a variety of equipment. The equipment selected at any facility will normally depend upon the potential hazards present. The real-time monitors are often referred to as direct-reading instruments. Various types can detect gases, vapors, dusts, flammable atmospheres, oxygen, radiation, heat, and noise.

Advantages of real-time monitoring include:

- It allows information to be immediately available at the scene
- It is available for a wide range of potential hazards
- It measures chemicals that might cause acute health effects and IDLH situations
- It allows response teams to identify potentially high levels of toxic and flammable materials
- It helps determine whether the atmosphere within a confined space is safe for entry (not oxygen- deficient, flammable, or toxic)

Disadvantages of real-time monitoring include:

- It may not be sensitive enough to detect low levels of contaminants. (A reading of *zero* may mean contaminants are present but at levels below the detection level of the instrument.)
- Most of these instruments cannot identify a specific contaminant or distinguish one contaminant from another
- Those instruments equipped with alarms may give a false alarm. (Note: Any alarm should be considered real until further investigation is conducted.)
- It may give an inaccurate reading because of background levels or the presence of chemicals other than the one being sampled
- Instruments may require factory maintenance

## Monitoring Instruments

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Emergency responders frequently use real-time monitors. Instruments are selected to measure the specific potential hazards at each facility. This section outlines the general uses of some commonly used instruments. Management should assure that responders are trained to use the equipment available at the plant.

### pH paper

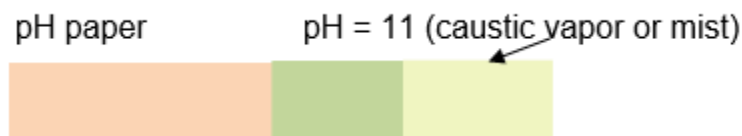
When exposed to a chemical, pH paper changes color.

Use:

Measure presence of corrosive substance

Read-out:

#### Observed color matched to chart



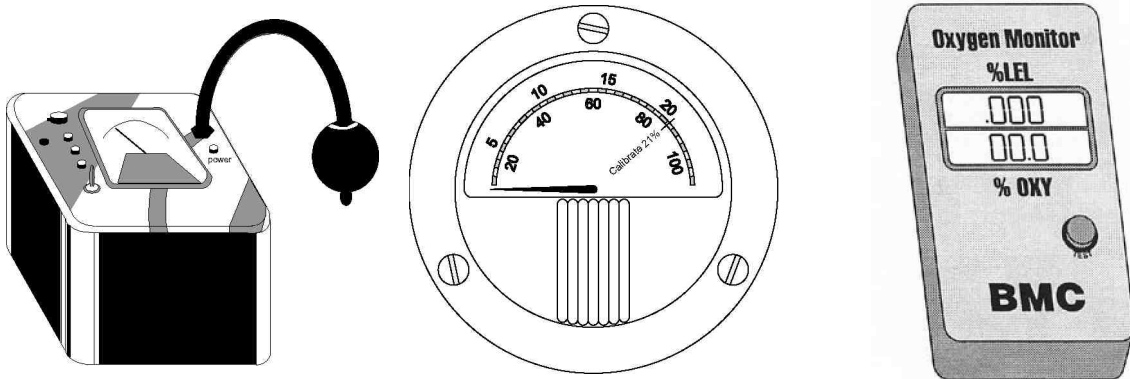
Notes:

- When pH paper changes color in the presence of corrosive vapors, the color change is easy to interpret. The color change may be harder to interpret when testing liquids.
- Hydrocarbons, which are neutral, may appear to change the color of the paper. In this case, the border between the wet and dry sides of the paper will be straight. If the border is jagged, multicolored, and the liquid seems to be wicking through the pH paper, the liquid is actually corrosive.
- The result may be difficult to interpret depending on the chemicals that are present; for example, in the presence of hydrocarbons, use of pH paper may provide an inaccurate result.
- When using the wetted pH paper for corrosive vapor detection, a neutral reading should not give you a sense of security. Other hazards may be present.
- pH paper can be attached to a stick or an extension tool when approaching an unknown environment, such as during hazard assessment.
- Utilize two pieces of pH paper (one wetted and one dry). The wetted paper reacts more quickly than the dry paper especially for low levels of a

chemical in the air. The wetted pH paper is used for detecting corrosive vapor and dry is used to dip into liquids.

NOTE: The presence of strong oxidizers may change the colors and give false results.

### Oxygen Meter



Use:

- To sample oxygen concentration, particularly near and in confined spaces

Read-out:

- Usually 0%–25% or 0%–100% oxygen concentration
- At greater than 23.5% oxygen, the explosion hazard increases
- At less than 19.5%, do not enter without a self-contained breathing apparatus (SCBA) or a supplied-air respirator (SAR)

Precautions:

- Affected by temperature and pressure
- Carbon dioxide levels may affect reading
- Must be calibrated before each use
- Maintenance Required
- User must be trained

## Combustible-Gas Indicator

(CGI)/LEL Meter/Explosion Meter

Use:

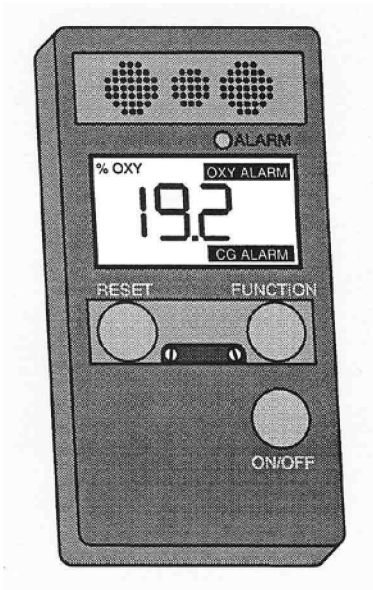
- To sample flammable vapor concentration, particularly near and in confined spaces

Read-out:

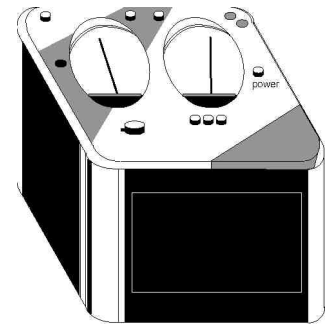
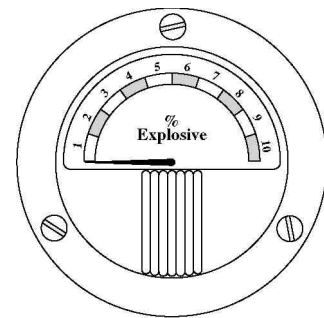
- % LEL (same as Lower Flammable Limit)
- A reading above 10% should be considered a potentially explosive atmosphere. For added safety, many companies use lower values such as 1% or 5%

Precautions:

- Requires periodic factory calibrations
- Does not respond the same to all vapors
- Oxygen must be measured first. Many combustible-gas instruments require sufficient oxygen to operate properly to determine the LEL



- Models with a needle indicator require constant observation during use, as the needle may peg out (swing far to the right and back to 0 and then be misread as 0)
- User must be trained
- Must be field-calibrated by trained personnel before and after each use



## Colorimetric Detector Tubes (Drager, MSA, Sensidyne, RAE)

## Use:

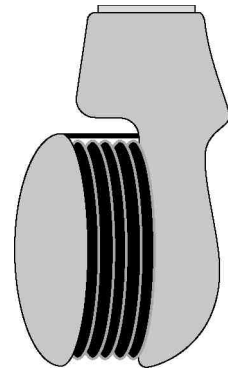
- To sample gas or vapor concentration in any workspace

## Read-out:

- Percent concentration is indicated by color change or length of color stain

## Precautions:

- Not very accurate - within 25% of the real value at best
- Pump must be checked for leaks and calibrated
- Tubes have a limited lifetime, so the expiration date on the container should be checked before use
- Results may be affected by temperature and humidity
- User must be trained in reading the scales on the tubes used
- User must follow specific pump-stroke requirements



A colorimetric detector tube is a glass tube filled with a solid material, gel, or reactant tape/strip that has been impregnated with an indicator chemical. When the detector tube is used, the ends are broken off and the tube is inserted into a bellows or piston pump. An arrow on the tube indicates which end of the tube to insert into the pump orifice. A predetermined volume of air is pulled through the pump. The contaminant of interest reacts with the chemical in the tube. This reaction produces a color change, with the length of the change proportional to the concentration of the contaminant.

## Personal Alarm Systems to notify wearer of exposure

Use:

- To sample gas or vapor concentration in any work space
- Battery-operated, worn on belt
- Alert workers to levels of contaminants to which they should not be exposed

Read-out:

- Audible alarm and sometimes a measure of concentration (examples: ppm or %)

Precautions:

- Inaccurate readings may be given if there are interferences
- Wearers must be trained in actions to take if the alarm sounds

## Other Monitoring Instruments

There are other, more specialized direct-reading sampling instruments, such as photo ionization detectors. These instruments require detailed training for operation and use.

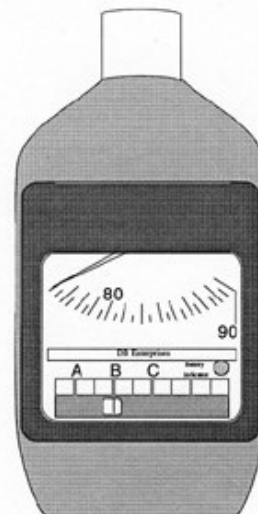
## Radiation Exposure Monitoring

No single instrument is appropriate for measuring all forms of radiation. In facilities where radiation sources are present, a specific program should be in place. This program will detail how monitoring devices were selected, the type of hazard, and control methods. Area monitors (for example, the Geiger-Mueller tube and Cutie pie) are available. Personal monitors include the film badge and thermo luminescence detectors.

## Noise Monitoring

A Sound Level Meter (SLM) is a direct-reading instrument. Some models have additional features such as:

- measure sound in small bands across the entire spectrum of sound, called octave bands
- data-logging for future analysis



**Use:**

To monitor noise exposure in the area

**Read-out:**

Decibels (dB) usually on the A scale (dBA)

**Notes:**

- A-Scale used for occupational exposure
- A-Scale developed to mimic the way the human ear responds to noise
- Requires calibration before and after each use
- Some instruments require manually changing the range of noise that can be measured
- Battery must be checked before use
- General-purpose meters are designed to measure continuous noise only (sounds which last at least 1 second)
- Personnel must be trained to use the instrument



## Monitoring at an Emergency - Review

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Detailed information on air monitoring must be included in the company ERP to ensure adequate training, appropriate use, and proper storage and maintenance of equipment. Before you conduct monitoring:

- Receive training in use of instrument and procedure
- Follow the procedure
  - Where to sample
  - Record keeping
  - Report results
  - Report unexpected events

### Selecting Monitoring Equipment

Site management is responsible for selecting equipment appropriate for routine sampling and anticipated emergencies. Manufacturers should provide information about the uses and limitation of their equipment. NIOSH (National Institute of Occupational Safety and Health) and the EPA (Environmental Protection Agency) also can provide information about equipment.

Some general considerations when selecting monitoring equipment follow:

- The unit should be intrinsically safe. (That is, it will not produce sparks that could trigger an explosion.) Check the label and the manufacturer's guide to make sure.
- Most instruments are designed to sample only one contaminant. There are no instruments which can monitor all toxic substances.
- Equipment should be easy to operate in the field under changing conditions
- Instruments should operate properly at temperatures which are anticipated during response activities.
- Training should be available which gives responders a routine chance to practice with the equipment "hands-on."

Some general considerations during various phases of planning or response follow.

**Preplanning**

- Monitoring equipment appropriate for anticipated hazards should be selected by plant management
- Members of the emergency response team who are expected to use the equipment must be trained in its use
- Emergency response team members should practice using the equipment during emergency response drills
- Equipment must be properly maintained and stored so it is ready for use during an emergency
- Spare parts should be available to repair the equipment in case it is damaged during response activities
- Someone on each shift should be trained to make emergency repairs

**During an Emergency Response**

Before use:

- Allow adequate warm-up time as appropriate
- Calibrate equipment as appropriate
- Cover with plastic to prevent contamination as appropriate

During size-up (risk assessment):

- Enter upwind from the spill or release
- Begin monitoring at a distance where no contamination is expected
- Monitor for oxygen first, then flammable/explosive limits and toxic substances
- Continue to take readings as the spill or release is approached
- Take readings at ground level, a few feet from the ground, and higher in the air
- Take readings at the entry and throughout a confined space. Do not enter if there is inadequate oxygen or an explosive or toxic atmosphere
- Leave the area immediately if readings indicate that PPE is inadequate

During response actions:

- Continuously monitor all areas near the source of the spill where response activities are occurring; conditions can change rapidly
- Retreat immediately if readings indicate that PPE is inadequate
- Decontaminate the equipment properly

After response (termination):

- Recharge power sources and replace any damaged or expended parts
- Store monitors properly to be ready for any future use
- Reorder any needed disposable supplies or damaged parts

## What Can Be Monitored in the Environment?

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Trained Operations-level first responders may perform basic air monitoring as a part of risk assessment as specified in a SOP (Standard Operating Procedure). With specific training, the first responder may perform or assist with various types of environmental monitoring.

Monitoring of the water may occasionally be done during or after an emergency response. For example, the water used during an emergency may require testing in order to determine proper disposal. Sampling from sewers, wells, ponds, streams, and groundwater may be done during the emergency and periodically after an emergency to determine if any of the hazardous materials have migrated off-site.

Soil at the facility or on neighboring property may be tested to determine if hazardous materials have migrated. Soil testing will indicate how much, if any, contamination there is, how deep it is, and the geographical limits of the contaminated area.

Surfaces may be tested by wipe testing (swipe testing) to determine if any contaminants are present. It is done by wiping a surface with a piece of cloth or other material according to a special procedure and then submitting it for analysis.

**Exercise - Monitoring**

---

For one or more of the instruments described above that may be used during an emergency response, you will demonstrate use and complete Performance Checklist (s). Be prepared to discuss findings and ask any questions about the instruments used.

**Monitoring Lab Data Sheet**

Name \_\_\_\_\_

Type of equipment \_\_\_\_\_

Brand of equipment \_\_\_\_\_

Purpose of equipment \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

What are the limitations of this equipment?

Date \_\_\_\_\_ Instructor's Signature \_\_\_\_\_

**Monitoring Lab Data Sheet**

Name \_\_\_\_\_

Type of equipment \_\_\_\_\_

Brand of equipment \_\_\_\_\_

Purpose of equipment \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

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Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

What are the limitations of this equipment?

Date \_\_\_\_\_

Instructor's Signature \_\_\_\_\_

**Monitoring Lab Data Sheet**

Name \_\_\_\_\_

Type of equipment \_\_\_\_\_

Brand of equipment \_\_\_\_\_

Purpose of equipment \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

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Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

Sample No. \_\_\_\_\_ Reading (in units) \_\_\_\_\_ Distance (in units) \_\_\_\_\_

What are the limitations of this equipment?

Date \_\_\_\_\_ Instructor's Signature \_\_\_\_\_



## Summary - Monitoring

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Reasons for monitoring are:

- *To detect whether potential hazardous conditions exist*
- *To measure the concentration of hazardous substances*

Monitoring may be conducted at various times:

### Pre-Emergency

- Establish background or usual levels
- Skill development training

### Emergency Response Actions

- Determine whether entry can be made
- Provide information for the response strategy
- Determine level of PPE protection
- Monitor conditions to detect any change

### Termination

- Establish levels after containment/confinement
- Document perimeter levels
- Identify post-emergency response needs during termination
- Complete termination documents

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

1. Oxygen Deficiency/Enrichment
2. Fire and Explosion Hazards
3. Toxic Chemicals
4. Corrosivity
5. Radioactivity

Terms to know: PEL, TLV, REL, STEL, ceiling limit, TWA

Full-shift monitoring results are averaged out over an 8-hour work day. This is called a time-weighted average (TWA). Time-weighted averages do not give

information on peak exposure. OSHA requires employers to keep air contaminants at or below the Permissible Exposure Limits (PELs). Results of personal monitoring can be compared with OSHA's PELs or recommendations for exposure (such as those set by ACGIH).

There are two types of air monitoring:

- **Personal monitoring** is used to measure the amount of a toxic chemical in the air to which a worker is exposed. This type of monitoring may be done at a response, but often is not feasible.
- **Real-time monitoring** gives you a direct reading of air contamination at the time of use. Direct-reading instruments may be used to detect IDLH conditions, flammable vapors, oxygen, and other toxic materials. This type of monitoring is most frequently used during emergencies as information is needed immediately.

Gases and vapors are generally measured in ppm; mists and dusts are measured in mg/m<sup>3</sup>, and fibers in f/cc. Personal sampling (when a worker wears a small pump all day and the sample is taken in the breathing zone) gives the best information on a worker's exposure.

## Review Questions

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1. What are two reasons to conduct monitoring during an emergency response?

2. Is a STEL or a TWA generally more applicable to emergency responder exposures? Why?

3. Match the following.

gas/vapor

fiber

dust/mist

f/cc

mg/m<sup>3</sup>

ppm

4. What instruments are used to test air where solvents have been spilled?

5. Imagine that a combustible-gas indicator gives a reading of 0%. What are the possible reasons for this reading?

# **Personal Protective Equipment (PPE)**

## **Introduction**

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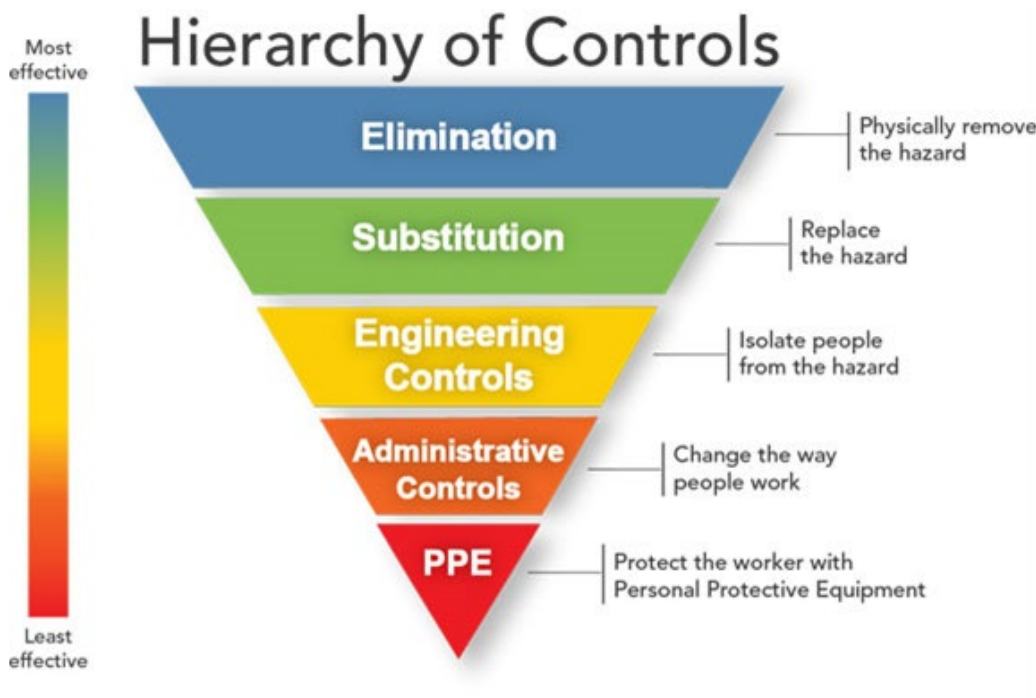
The purpose of PPE is to shield or isolate responders from the chemical, physical, and biological hazards that may be encountered at a response.

Careful selection and use of adequate PPE should protect the respiratory system, skin, eyes, ears, face, hands, feet, and head. OSHA requires that the selected personal protective equipment must fit the responder who is utilizing it; this can be accomplished by having several sizes. For example, not everyone can wear the same size of gloves; different sizes of coveralls are needed for a person who is 6 feet tall and a person who is 5 feet tall, even if the waist sizes are the same.

In those cases where it is required, the employer must provide and pay for personal protective equipment. The exception is that the employer is not required to pay for PPE that can be used away from the worksite, such as prescription safety glasses and some safety shoes.

In this chapter, respiratory protection, chemical protective clothing and other PPE are covered.

Personal protective equipment is the last choice in the Hierarchy of Controls to prevent exposure.



Source: <https://www.cdc.gov/niosh/topics/hierarchy/default.html> .

This scheme illustrates that the best and surest approaches to control hazards is to eliminate the exposure or substitute a less toxic material or hazardous process.

The prevention strategies rely on modifying the process (use a robot to explore a possible hazard), contain (build a box), removing through ventilation, a change in work practice that must be done diligently (day after day by everyone) or use of personal protective equipment (may not be 100% effective even when used diligently; requires proper selection, training, cleaning and maintenance).

Work practice controls are often described in written procedures (called administrative controls and include Standard Operating Procedures) that detail how work is to be done or the duration that someone can work in a particular area. For example, an administrative control for emergency response is an Emergency Response Plan that details the various procedures needed from initial assessment to response to termination; confined space entry permitting is a specific administrative control that might be used during a response.

**What part of the Hierarchy of Controls is illustrated by the following?**

Closing a lab where there has been a spill to the floor  
Buddy system  
Fire suppression

## **Respiratory Protection**

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Respiratory protection is vital for the first responder's health during a spill response. This section includes a discussion of the different levels of respiratory protection and information on how to use the different levels. At the end of this section you will have an opportunity to put on, wear, remove, and inspect respiratory protection.

### **Chapter Objectives**

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

- Identify situations where respiratory protection is needed
- Identify types and features of respirators used to protect against exposure to hazardous materials
- Identify limitations of different types of respirators
- Demonstrate the inspection, donning and doffing of an APR or SCBA
- Demonstrate respirator cleaning procedures
- Identify the key components of a respiratory protection program

## **Use of Respirators for Emergency Response**

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Respirators provide vital protection against chemicals and oxygen-deficient atmospheres. Employers must provide workers with appropriate respirators and training for their use if respirators are needed for usual work tasks or for emergency-response activities. OSHA Standard, 29 CFR 1910.134 requires that a written respiratory protection program be developed by the employer if workers may be required to wear respirators, or if respirators are available for voluntary use.

Respirators are used to help protect the workers' health. Respirators help to prevent toxic chemicals or dusts from entering the lungs. Some types of respirators provide air so that workers can survive in hazardous atmospheres. Different types of hazards require different types of respirators. A number of factors should be considered when selecting a respirator. Consideration of the following questions during preplanning and risk assessment will lead to answers that are useful for respiratory selection.

- Is there enough oxygen in the atmosphere (19.5% to 23.5%)?
- What are the hazardous substances to which the worker may be exposed?
- Is the atmosphere immediately dangerous to life and health (IDLH)?
- What is the concentration of the substance in the air?
- What is the maximum permissible exposure limit (PEL or STEL) for the substance?

Other considerations for selecting respirators for emergency response include:

- Communication needs
- Use in confined space
- Use in extreme temperatures
- Skin/eye contact hazards

## **Types of Respirators**

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Two basic types of respiratory protection are:

**Air-Purifying Respirator (APR)** protects against toxic dusts, gases, and vapors by removing the contaminant from the air before it enters the lungs. APRs include negative pressure and Powered Air Purifying Respirators (PAPR).

**Atmosphere-Supplying Respirator (ASR)** provides breathing air from a source independent of the work environment. ASRs include supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA).

## **Air-Purifying Respirators**

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**Air-Purifying Respirators (APRs)** are used to protect against specific dusts and toxic chemicals. They work by removing the contaminant by filtering, adsorbing, or reacting with the airborne contaminant air before it is inhaled. If APRs are used:

- all toxic substances must be identified
- the concentration must be known throughout the response by monitoring
- the respirator and cartridge must be selected to protect against those specific chemicals
- the oxygen concentration must be greater than or equal to 19.5%
- APRs are not used in atmospheres Immediately Dangerous to Life and Health (IDLH)

APRs can be reusable or single use. Reusable APRs consist of a facepiece with an exhalation valve and one or two filtering cartridges through which the air enters. The most widely used facepieces are full-face or half-mask. Full-face and half-mask respirators are illustrated below. Single-use types are typically filtering-facepiece respirators, often known as dust masks.

APRs cannot be used in an IDLH atmosphere.



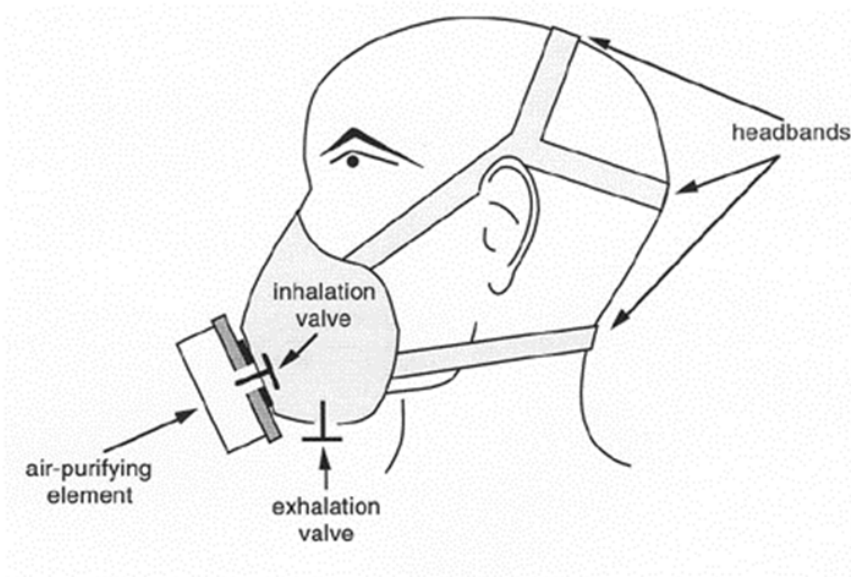


Full-face Air Purifying Respirator



Half-face Air Purifying Respirator

## Operation of a Reusable Air-Purifying Respirator



Air enters through the cartridges and exits through an exhalation valve. Below, note the proper placement of the headbands for a half-mask respirator. Reusable half-mask respirators without the head harness (only two single straps) must not be used.

## Cartridges and filters for protection from chemical and particle exposure

Two types of air-purifying elements are used with APRs:

## Respiratory Protection

- **Chemical cartridges** are used to protect against certain vapors and gases.
- **Particulate cartridge filters** are used to protect against dusts, mists, and fumes.

*Cartridges are selected for specific exposures which are expected. Factors that affect APR use include the size of the particles, concentration of the substance, and type of filter used. There is no appropriate protective cartridge filter for some environments; examples include oxygen displacement, or the concentration exceeds APR guidance. APRs are not recommended by NIOSH for known or suspected carcinogens.*

Cartridge colors designate what type of particulates or chemicals are filtered. OSHA regulation 29 CFR 1910.134 dictates the colors that may be used. The table below lists OSHA-approved color and protection combinations.

Contaminants to be Protected Against	Color Assigned <sup>1</sup>
Acid gases	White
Hydrocyanic acid gas	White with 1/2-inch green stripe completely around the canister near the bottom
Chlorine gas	White with 1/2-inch yellow stripe completely around the canister near the bottom
Organic vapors	Black
Ammonia gas	Green
Acid gases and ammonia gas	Green with 1/2-inch white stripe completely around the canister near the bottom
Carbon monoxide	Blue
Acid gases and organic vapors	Yellow
Hydrocyanic acid gas and chloropicrin vapor	Yellow with 1/2-inch blue stripe completely around the canister near the bottom
Acid gases, organic vapors, and ammonia gases	Brown
Radioactive materials, except tritium & noble gases	Purple (magenta)
Pesticides	Organic vapor canister & a particulate filter
Multi-Contaminant and CBRN agent	Olive
Any particulates - P100	Purple
Any particulates - P95, P99, R95, R99, R100	Orange <sup>2</sup>
Any particulates free of oil - N95, N99, or N100	Teal

<sup>1</sup>Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

<sup>2</sup>Orange shall be used as a complete body or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

### Chemical Cartridges

How do you tell if the cartridge needs to be changed? The respirator standard, 1910.134(d)(3), requires that respirators used to prevent gas or vapor exposures be equipped with an indicator showing that the cartridge (certified by NIOSH for the

contaminant) has expired; this is called an End-of-Service-Life Indicator (ESLI). It is rare to find an ESLI on a cartridge. If the cartridge approved for a specific gas/vapor exposure has no ESLI, then the employer must use objective data to determine a change schedule and describe it in the written respiratory protection program; expected concentration, humidity, temperature and work rate are important inputs to calculation of a breakthrough time. Should you detect the contaminant before the time that the cartridge is expected to reach breakthrough, notify the supervisor immediately and change the cartridge. For dust, a wearer may also notice that it is more difficult to breathe as the filter becomes loaded.

The person responsible for establishing a change-out schedule for chemical cartridges shall consider temperature, humidity, contaminate concentration, and work rate. For some chemicals at high concentrations, the change-out schedule may be so frequent as to make the use of air purifying respirators impractical.

### **Particulate Cartridges/Filters**

There are nine classes of particulate filters which are broken down into three series: N, R, and P. Each series (N, R, and P) is available at three levels, based on their efficiency for filtering out the most difficult size of particulate: 95%, 99%, and 99.97%.

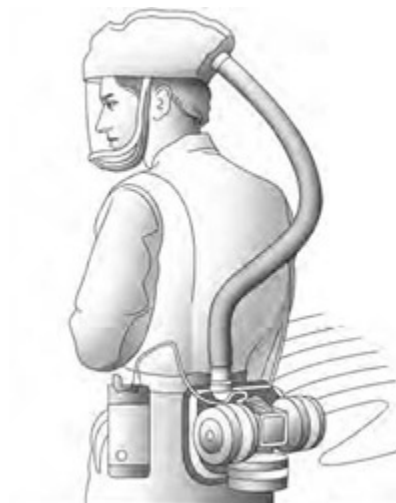
N series	No oil
R series	Oil resistant, one shift only
P series	Oil proof, reusable

The filters should be changed when the breathing resistance increases, or the filter is dirty, wet or damaged. Employer guidelines may be more specific.

### Other Reusable APRs

**Gas masks** are a special type of APR that consists of a full-facepiece and a canister containing sorbent material. These units typically protect against organic vapors, acid gases, ammonia, and certain combinations. Gas masks usually have more purifying elements in the canister than the chemical cartridges described above.

Another special type of APR is a **Powered Air-Purifying Respirator (PAPR)**; air is pulled through the chemical cartridges or filters and blown into the facepiece, as shown on the right. The units use a powered fan to achieve the airflow through filters or cartridges to the facepiece. The type of air purifying element must match the contaminant(s) to which the workers are being exposed. PAPRs consist of a hood or helmet, or tight-fitting facepiece, filter and/or cartridge, and power source.



PAPR selection includes special consideration of the atmosphere where it will be used. As an air-purifying respirator, the oxygen concentration must be at least 19.5%; however, due to the power source, it is necessary to consider whether the atmosphere is combustible or flammable due to oxygen concentration (not greater than 23.5%) or the presence of a flammable chemical. Consult the supplier regarding planned use and guidance on the need for intrinsically safe units.

Limitations for are shown in the written respiratory protection program.

PAPRs cannot be used in an IDLH atmosphere.

### Atmosphere-Supplying Respirators (ASR)

ASRs may have air supplied from a remote source (supplied air) or from a bottle or tank carried by the user (self-contained) as described below.

#### Supplied-Air Respirators (SAR)

A supplied-air respirator (SAR) provides at a minimum Grade D breathing air to the worker from a stationary tank or other source through a supply line that cannot exceed 300 feet in length. When using an SAR, the worker must wear (not carry) an escape bottle containing a minimum of 5 minutes of air. This escape bottle, or egress unit, is required to allow time to escape if the air supply is interrupted.

There are three classifications of supplied air respirators:

- Hose mask with blower (Type A)
- Hose mask without blower (Type B)
- Airline respirators (Type C)

Types A and B do not meet the requirements for emergency response and cannot be used; therefore these units are not covered in this training.

Airline respirators must operate in either **continuous-flow** or **pressure-demand** mode. In continuous-flow mode, air is always flowing, even when the wearer is not inhaling. In pressure-demand mode, a constant positive pressure is maintained inside the facepiece; air flows when the positive pressure in the facepiece is reduced as the wearer inhales. A third mode of operation is **demand mode**, in which air only flows when the pressure inside the facepiece becomes negative due to the wearer inhaling. Demand mode provides the least protection, because contaminants can leak into a poorly sealed facepiece when the pressure becomes negative. NOTE: Not allowed when the concentration is unknown or IDLH conditions.

Compressors used to supply air must meet special requirements. Compressor exhaust and lubricants must not contaminate the air supplied. Compressor air intakes must be located in a contaminant-free area.

### Self-Contained Breathing Apparatus (SCBA)

A self-contained breathing apparatus is an atmosphere-supplying respirator where the breathing air is designed to be carried by the user. A self-contained breathing apparatus is used when extremely toxic chemicals are present, in an oxygen-deficient atmosphere, or when the contaminant or concentration is not known. SCBAs are typically used in emergency response situations.

SCBAs consist of:

- **Bottle (tank or cylinder)** contains compressed breathing air (2216 psi-5500 psi)
- **Harness** secures cylinder and connects user to apparatus
- **Gauge** displays current cylinder pressure
- **Safety/by-pass valve** by-passes the regulator in case of malfunction of the regulator. The by-pass valve should be open only when needed
- **Pressure regulator(s)** provide reduced pressure air during inhalation
- **Full facepiece** isolates user's face from exterior environment

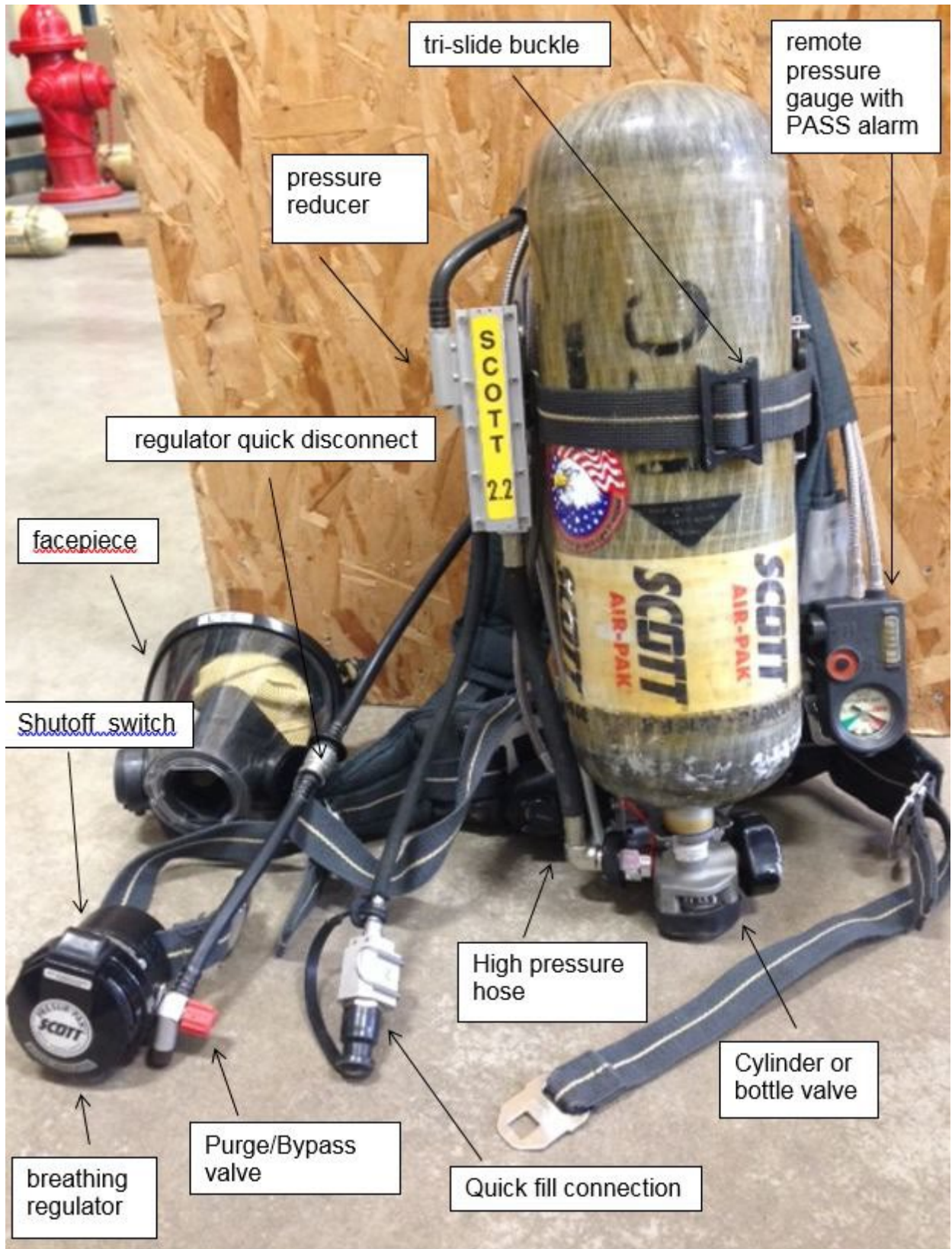
The SCBA is equipped with an alarm to warn the wearer when air in the tank falls below a specified capacity (note that the 2013 edition of NFPA 1981 specifies a 33% capacity alarm; NIOSH specifies 25%). Most SCBAs operate in an open-circuit mode; that is, the exhaled air is vented to the atmosphere and not re-breathed.

SCBAs and cylinders differ by manufacturer and type. You must be trained in the manufacturer's instructions and checkout procedures before using any SCBA. These units should be NIOSH certified for IDLH, full facepiece and with a minimum duration of 30 minutes or combined with SAR with auxiliary SCBA escape bottle. An SCBA can operate in either demand mode (less protective) or pressure-demand mode. SCBA cylinders may be constructed of steel, aluminum, or composite materials. These have varying service lives and hydrostatic testing requirements. Users should familiarize themselves with their specific cylinders. A positive-pressure SCBA or positive-pressure airline respirator equipped with an escape air supply must be used when exposure levels are likely to present an IDLH situation or impair the ability to escape.

The equipment should be donned according to the manufacturer's recommended procedures. Periodic training and practice are especially important for workers who may use this equipment infrequently.

When the contaminant is unknown, wear a pressure-demand SCBA with a full-facepiece, or a pressure-demand SAR with a full-facepiece in combination with an auxiliary pressure-demand SCBA or 5-minute escape bottle. Auxiliary SCBA must provide air for sufficient time to permit escape to safety if needed.

# Respiratory Protection



### Rebreather

A rebreather apparatus may be used in specialized applications by responders. These units are useful because in each breath, only about 4 percent of the oxygen in inhaled air is used.

### Single Use Particulate Respirators (Also referred to as Filtering Facepiece Respirators)

A single use particulate respirator is a paper filter that is held to the face by two straps and fit to the nose by a self-molding metal strip. These may have an exhalation valve but do not use filter cartridges. They do not provide a high level of protection, but will decrease the inhalation of dusts and mists. They generally provide no protection against gases or vapor exposures. (Some specialized single-use respirators have been approved by NIOSH to remove “nuisance” or very low levels of organic vapors or acid gases.)

An example of a single use respirator is the N95:

- N→ not resistant to oil
- 95→removes 95% of airborne particulate

The percent of particulate removed assumes a very good seal between the face and the mask.



## Respirator Fit

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A respirator is effective only if there is a good seal between the facepiece and the wearer's face. Therefore, all persons wearing respirators must first be fit tested. Fit testing includes qualitative or quantitative testing, as well as routine positive- and negative-pressure fit checks.

Because human faces come in many different shapes and sizes, each manufacturer has several facepiece sizes. The purpose of fit testing is to find the manufacturer/size combination which offers adequate protection. Factors such as weight loss or gain, dentures, dental work, or facial injury can change the shape of the face, thus potentially changing the fit and efficiency of the respirator. If any of these factors exist, retesting is required.

### Annual Fit Tests

Two types of fit testing, **qualitative** and **quantitative**, may be used to determine the size and model of respirator that an individual should wear as well as how good the face-to-facepiece seal is. These tests must be repeated annually to document respirator effectiveness. Fit tests **shall not** be performed if facial hair is present in the seal area of the respirator. (OSHA 29 CFR 1910.134)

### Qualitative Testing

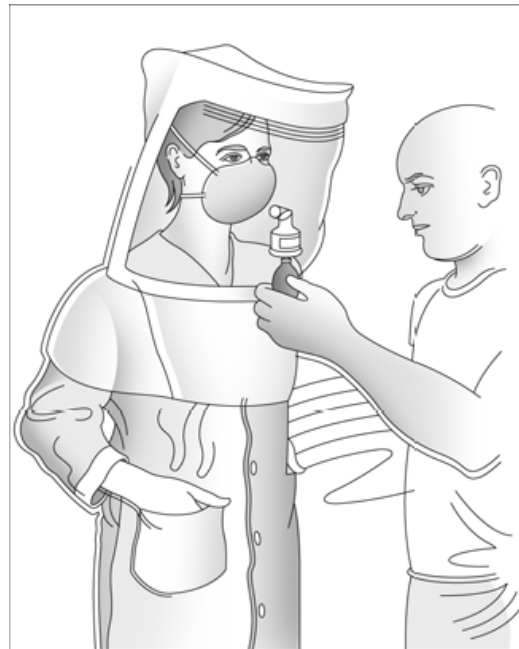
**Purpose:** Checks effectiveness of preventing substances from entering the facepiece.

**Method:** While the individual is wearing a respirator, a test substance is released, as shown on the right. The test substance could be smelly (banana oil), sweet (saccharin), bitter (Bitrex) or an irritant (special smoke tube). The wearer should not be able to detect the substance while performing a series of prescribed tasks.

**Requirements:** This test or its equivalent is required by OSHA at least once a year.

There are several important cautions to qualitative fit testing:

- Some of the test substances may irritate the eyes or cause coughing
- A sensitivity test is first performed to determine the individual is capable of sensing the test solution



- Fit testing is often done in “ideal” environments. The fit may change after wearing the respirator several hours or during strenuous activity. Must be used only when the ratio of the concentration outside to the concentration inside the facepiece is less than or equal to 100; this is called the Fit Factor

### Quantitative (Numerical) Testing

This test measures the fit factor (FF), a comparison of the concentration of a substance outside of the mask to the concentration of a substance inside of the mask, or a loss of vacuum between the outside and inside of the mask. The FF is useful in determining whether the respirator will effectively protect the wearer from exposure. A disadvantage to this test is that special equipment and specially trained personnel are needed to administer it.

**Purpose:** Measures effectiveness of the respirator in preventing a substance from entering the facepiece.

**Methods:** There are two methods for quantitative fit testing based on the fit testing device.

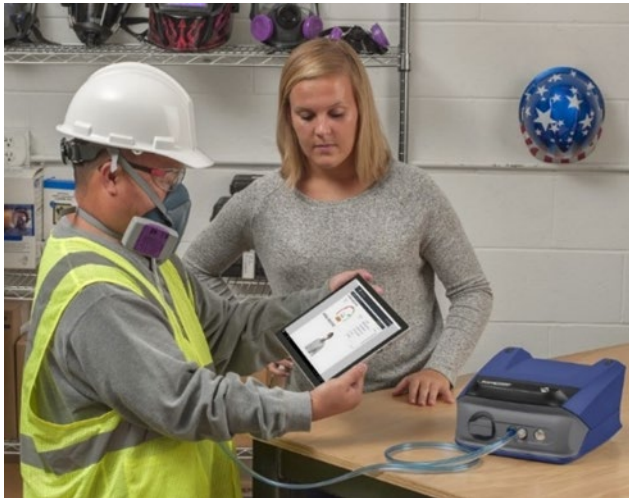


Photo courtesy of TSI Inc. to MWC

1. While an individual wears a respirator modified with a probe, the concentrations of particulates in the air inside and outside of the respirator are measured, as shown above. The test is repeated while the person performs specific tasks (speaking, running in place, etc.) that may affect fit.

2. While an individual wears a respirator connected to a fit testing device, a vacuum is drawn in the mask to assess the seal for leaks. Then the user removes and re-dons the mask and the test is repeated twice.

**Requirement:** This test is mandated when a fit factor of 500 is required.

### Routine User Checks

Two types of checks, **positive-** and **negative-**pressure checks, should be done each time a respirator is donned and before each use in the field to check the seal of the respirator. They do not replace yearly fitting but provide a routine assessment as to whether the fit is still adequate.

### Positive-Pressure Check

**Purpose:** Checks the facepiece components for leaks at valves or other points.

**NOTE:** Not all respirators allow easy access to the exhalation valve for this test.

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

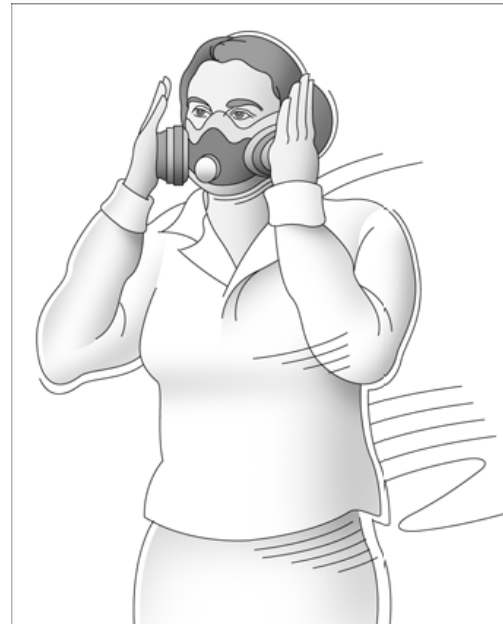
**Requirement:** Shall be done before each use.

### Negative-Pressure Check

**Purpose:** Checks the facepiece-to-face seal.

**Method:** SCBA wearer disconnects the regulator and places hands over the hole for the regulator connection and inhales. APR wearer places hands over cartridges and inhales, as shown on the right. No outside air should be felt leaking into the facepiece.

**Requirement:** Shall be done each time the respirator is donned (first use, break, lunch).



Positive- and negative-pressure checks can be done quickly and easily in the field. If the wearer is unable to block the holes or cartridges with their hands, additional measures may need to be performed to accomplish the blocking requirement to detect the leaks.

### Assigned Protection Factors

Respirators are selected by using Assigned Protection Factors (APFs). The higher the APF, the more protective the respirator is. A protection factor has been determined in the laboratory at NIOSH for each type of respirator (APR, PAPR, SCBA, etc.) and mask (half- or full-face). Protection factors also exist for combinations of the above respirators. For example, an SAR with a full-face mask and an auxiliary SCBA equals 10,000.

The following table shows Assigned Protection Factors (APFs):

Type of Respirator	Quarter mask*	Half mask	Full facepiece	Helmet/Hood	Loose-fitting facepiece
1. Air-purifying Respirator	5	10	50	-	-
2. Powered Air-purifying Respirator (PAPR)	-	50	1,000	25/1,000	25
3. Supplied-air Respirator (SAR) or Airline Respirator					
• Demand mode	-	10	50	-	-
• Continuous flow mode	-	50	1,000	25/1,000	25
• Pressure-demand or other positive-pressure mode	-	50	1,000	-	-
4. Self-contained Breathing Apparatus (SCBA)					
• Demand mode	-	10	50	50	-
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)	-	-	10,000	10,000	-

\*Quarter masks are rarely used and are not presented here.

See <https://www.osha.gov/laws-regs/standardinterpretations/2002-05-30> for additional information about this table.

Never assume you will get this much protection. Quantitative fit testing provides a measure of the maximum protection you can expect. Less protection may occur during actual work activities.

The use of these APFs presumes that the facepiece has been properly selected to provide the best possible fit. These factors do not apply for persons with facial hair as

it interferes with the seal of the facepiece. A person with facial hair that interferes with the fit is required to utilize a hood type system and the APF for that is low (see table).

### Fit Factor Calculation

Selection of respirators includes calculation of the fit factor by dividing the known chemical concentration by the APF. The resulting value is compared with the occupational exposure guideline used by your employer.

$$\frac{\text{measured chemical concentration (ppm)}}{APF} = \text{parts per million (ppm)}$$

If the calculated ppm is higher than the exposure guideline, then that type of respiratory protection would be inadequate. If the calculated ppm is lower than the exposure guideline, then that type of respiratory protection should be sufficient, provided that the measured concentration will not increase, and provided that the measured chemical concentration is below the IDLH concentration, if using an APR.

### Sample Fit Factor Calculation:

Cyclohexene released from a faulty valve has resulted in a loss of about 480 gallons in the transfer building. The first entry team wore SCBAs and stopped the release. The safety and health officer monitored the concentration and found 400 ppm at the entrance. This is not a TWA, but a single measurement on a direct-reading instrument. The OSHA PEL is 300 ppm for an 8-hour work shift; it is expected that the cleanup by the responders will take four hours. Because engineering controls cannot be implemented, respiratory protection must continue to be used. What type of respiratory protection would provide adequate protection against this contaminant?

Formula:  $\frac{\text{measured chemical concentration (ppm)}}{APF} = ppm$

First, use the table of APFs to see if a half-face APR can be used:

$$\frac{400 \text{ ppm}}{10} = 40 \text{ ppm}$$

*The resulting answer is 40 ppm, which means that 40 ppm of cyclohexene could be present inside the facepiece of a properly fitted respirator. A concentration of 40 ppm is less than the OSHA 300 ppm PEL, so this type of respiratory protection would be adequate, especially since the duration of work is less than eight hours. However, the*

*safety and health supervisor questions the fit for all responders as it is very hot in the transfer building. Does a full-face APR provide better protection?*

$$\frac{400 \text{ ppm}}{50} = 8 \text{ ppm}$$

The resulting answer is 8 ppm. A properly fitted full-face APR would protect better than the half-face APR.

NOTE: This solvent is an eye irritant. How does this affect respirator selection? What protection is needed to prevent eye irritation? How does the temperature affect selection?

If the concentration of the contaminant in the workplace changes, another calculation of fit factor would need to be done to see if the respirator is still protective at the new concentration (if higher) or the cartridge change-out schedule is altered (lower).

**Respiratory Protection Factor Exercise**

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Protection Factors:

1/2 face APR	=	10
full-face APR	=	50
SAR	=	1,000
SCBA	=	10,000

1. You are working where the industrial hygienist has been sampling a spill of chlorobenzene. The results indicate exposure to 1,500 ppm. The PEL for chlorobenzene is 75 ppm. What is the minimum type of respiratory protection that can safely be used?

2. You are working when a leak occurs which has a concentration of ammonia consisting of 3,500 ppm. The PEL for ammonia is 50 ppm. What is the minimum type of respiratory protection that can safely be used?

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

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Before a responder receives clearance to wear a respirator, a medical evaluation must be performed by a physician or other licensed health care professional (PLHCP). The evaluation helps ensure that the employee is physically capable of working with the added stress of a respirator. Any follow-up evaluations and testing will be determined by the PLHCP.

Some medical conditions which may prevent respirator usage include:

- Lung disease
- Claustrophobia
- Severe high blood pressure
- Heart disease

Other conditions that should be considered when wearing a specific type of respirator include:

- Contact lenses
- Eyeglasses
- Moustache that may interfere with fit
- Perforated tympanic membrane (ruptured eardrum)

Changes in weight or dental work may alter the fit of a respirator and require a new fit test.

Special eyeglass kits are available for use with full-facepiece respirators.



## **Cleaning, Storage, Inspection and Maintenance of Respirators**

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Proper inspection, maintenance, and storage are essential to ensure that the respirator is always ready for use. The OSHA respirator standard requires employers to provide for the cleaning and disinfection, storage, inspection and repair of respirators used by employees. Always consult manufacturers' recommendations for use, care and maintenance as well.

### Cleaning respirators

Appendix B-2 to 29 CFR 1910.134 requires the following respirator cleaning procedures. Manufacturers' recommendations may be used as an alternative, if they are at least as effective as those specified here:

- A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure- demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.
- B. Wash components in warm (43 deg. C [110 deg. F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.
- C. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain.
- D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:
  - 1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter (approximately 20 drops) of laundry bleach to one liter of water (about a 1000:1 dilution) at 43 deg. C (110 deg. F); or,
  - 2. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters (about 16 drops) of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45% alcohol) to one liter of water (about a 1250:1 dilution) at 43 deg. C (110 deg. F); or,
  - 3. Other commercially available cleansers of equivalent disinfectant quality when used as directed if their use is recommended or approved by the respirator manufacturer.
- E. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in

dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

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

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

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

Respirators must be cleaned and disinfected after each use, unless they are being used routinely and exclusively by the same employee. In that case, they must be cleaned and disinfected as often as needed to be sanitary.

### Respirator Storage

OSHA requires that all respirators be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and that they must be packed or stored to prevent deformation of the facepiece and exhalation valve.

### Inspection

Respirators must be inspected before and after each use and checked at least monthly, even if the respirator has not been used. A company policy may include more frequent inspections. OSHA requires that inspections include:

- A check of respirator function
- Tightness of connections
- The condition of the various parts including, but not limited to, the facepiece, head straps, valves, connecting tube, and cartridges, and canisters or filters
- A check of elastomeric parts for pliability and signs of deterioration.
- In addition to the above, self-contained breathing apparatus must be inspected monthly

Air cylinders must be maintained in a fully charged state and be recharged when the pressure falls to 90% of the manufacturer's recommended pressure level. The employer must determine that the regulator and warning devices function properly.

NOTE: Cold temperatures may result in pressure below 90%, even if the cylinder is full.

### Maintenance

OSHA requires that defective respirators be removed immediately from service and repaired/adjusted or discarded.

Repair program guidance follows:

- Repairs or adjustments must be made only by trained persons using the manufacturer's NIOSH-approved parts.
- Repairs must be made according to the manufacturer's recommendations and specifications.

Critical parts including reducing and admission valves, regulators and alarms may only be adjusted or repaired by the manufacturer or a technician trained by the manufacturer.

Consult the site-specific respiratory protection program for detailed requirements.

### **Minimum Requirements for a Respiratory Protection Program**

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OSHA requires that employers who make respirators available to their employees have a written respiratory protection program with work-specific procedures. The program must be evaluated and updated as necessary. Programs shall be updated as requirements change and/or modifications occur that reflect changes in the workplace. OSHA requires the use of NIOSH-approved respirators. Approval numbers will be clearly written on all approved equipment, as shown on the next page, or on written materials shipped with the respirator. Respirators manufactured after 2008 are marked with an approval designation known as a "TC" number. [Example: TC #XXX-XXXX].

A respiratory protection program must include the following points:

- Medical evaluations of employees required to use respirators
- Fit testing procedures for tight-fitting respirators
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators
- Training of responders in the respiratory hazards to which they may be potentially exposed during routine and emergency situations
- Training of responders in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance
- Procedures for regularly evaluating the effectiveness of the program

The employer must designate a program administrator who is qualified to oversee the respiratory protection program and to conduct the required evaluations of its effectiveness. Respirator training and the required medical evaluations are provided to the employee at no cost. The respiratory protection program also may include:

- Provision for corrective lenses in full-facepiece respirators using a spectacle kit that clips into the facepiece or is permanently mounted in the facepiece
- Restriction of use of contact lenses. (See ANSI Z87.1)
- Communication needs
- Guidelines for use in dangerous atmospheres, including confined spaces
- Guidelines for use in extreme temperatures

The respiratory protection program will include a description of who is responsible for the various aspects of the program including selection, periodic and routine fit testing, inspection, cleaning, repair, and maintenance. Persons using respirators under unusual conditions (e.g., a high concentration of acid vapor) should review special requirements with supervisors or the employee safety and health representatives. For a sample respiratory protection program, see:

[http://www.osha.gov/dcsp/compliance\\_assistance/sampleprograms.html#Respiratory Protection](http://www.osha.gov/dcsp/compliance_assistance/sampleprograms.html#RespiratoryProtection).

Effective training must be provided at least annually by the employer for all employees who are required to use respirators (see 1910.134(k)). This training must be understandable to the participant.

Based on the training, the employer shall ensure that each employee can demonstrate knowledge of at least the following:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator
- Limitations and capabilities of the respirator
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the seals of the respirator
- The procedures are for maintenance and storage of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- The general requirements of the respiratory protection standard

## **Respiratory Protection Lab**

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The purpose of this laboratory is to give you the opportunity to wear and become familiar with SCBAs, egress units, air-purifying respirators (APRs), equipment cleaning, and inspection procedures. This lab is broken down into four rotating stations:

- Donning and doffing an SCBA
- User check of an APR
- Inspecting and cleaning respirators
- Wearing an airline with escape unit

Copies of lab Performance Checklists for this exercise are provided in this student manual on the following pages. However, the instructor will hand out duplicates of these checklists which you will complete, have signed by the instructor, and turn in at the end of the lab. The training center retains this information with your other training records. Therefore, you may want to record your lab results in your manual for your personal records.

Name \_\_\_\_\_

**Respiratory Protection Lab Performance Checklist Station 1:  
Donning and Doffing an SCBA**

1. What brand of SCBA and size did you wear?                      Size

Brand \_\_\_\_\_

2. Please list the brands and sizes you tried that could not pass the negative-pressure user check.

Brand \_\_\_\_\_                      Size

Brand \_\_\_\_\_                      Size

Brand \_\_\_\_\_                      Size

3. Before donning the SCBA, did you check your:

a. Straps?.....  Yes     No

b. Cylinders?.....  Yes     No

c. Alarms?.....  Yes     No

d. Regulator Range?.....  Yes     No

4. Did you don the SCBA as you were instructed?.....  Yes     No

5. While wearing the SCBA, did you:

a. Check the bypass valve?.....  Yes     No

b. Wear the SCBA for at least 7 minutes?.....  Yes     No

c. Communicate with your buddy?.....  Yes     No

6. While wearing the SCBA, did you do an assigned task?.....  Yes  No

If yes, describe the task:

\_\_\_\_\_

7. After doffing the SCBA, did you:

a. Extend the straps?.....  Yes  No

b. Extend the facepiece straps?.....  Yes  No

c. Clean the facepiece?.....  Yes  No

d. Check the cylinder?.....  Yes  No

i. Did the cylinder need to be charged?.....  Yes  No

ii. If yes, did you tag it to be charged?.....  Yes  No

8. How long did you stay in all protective gear? \_\_\_\_\_ minutes

Date \_\_\_\_\_ Instructor's Signature \_\_\_\_\_

Name \_\_\_\_\_

**Respiratory Protection Lab Performance Checklist Station 2:  
User Check of an APR**

1. Please check any of the following items that you wear.

- Prescription glasses
- Dentures
- A beard
- Contact lenses
- Hairstyle that prohibits a good face seal

2. Did you do a negative-pressure user check? .....  Yes  No

3. Did you do a positive-pressure user check? .....  Yes  No

4. What brand and size of air-purifying respirator did you wear for this lab?

Brand _____	Size
_____	
Full-face _____	Half-face
_____	



5. Please list the brands and sizes of respirators you tried that could not pass the user checks

Brand \_\_\_\_\_ Size

Brand \_\_\_\_\_ Size

Brand \_\_\_\_\_ Size

Brand \_\_\_\_\_ Size

6. How long did you wear the respirator? \_\_\_\_\_ minutes

Date \_\_\_\_\_ Instructor's Signature \_\_\_\_\_

Name \_\_\_\_\_

**Respiratory Protection Lab Performance Checklist Station 3:  
Inspecting and Cleaning Respirators**

**Routine Maintenance of Your Respirator:**

- 1. Did the instructor tell you how to wash your respirator? .....  Yes  No
- 2. Did you clean your respirator? .....  Yes  No
- 3. Did you see a disassembled respirator and all its parts? .....  Yes  No  
If yes, did someone in the lab reassemble the respirator? .....  Yes  No
- 4. Did someone in your lab inspect a respirator? .....  Yes  No
- 5. Were defects found during the inspection? .....  Yes  No

If yes, describe the defects: \_\_\_\_\_

**OSHA Required Inspections of SCBA:**

- 6. Was the inspection procedure which must be done at least once per month described?  
 Yes  No
- 7. Were you shown the hydrostatic test date?  Yes  No
- 8. Did you see someone demonstrate inspection of an SCBA according to the manufacturer guidelines?  Yes  No

Date \_\_\_\_\_ Instructor signature \_\_\_\_\_

Name \_\_\_\_\_

**Respiratory Protection Lab Performance Checklist Station 4:  
Wearing an Air Line with Egress Bottle**

1. Did the station leader demonstrate how to hook up and use the unit?     Yes     No
  
2. Did the station leader demonstrate how to switch to the 5-minute egress bottle?  
 Yes     No
  
3. Did one of the trainees in the lab wear an egress unit     Yes     No
  
4. Did you wear the unit?     Yes     No
  
5. Did a trainee who wore the egress unit switch to the 5-minute egress bottle?  
 Yes     No

Date \_\_\_\_\_ Instructor's Signature \_\_\_\_\_

## **Summary – Respiratory Protection**

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Different types of hazards require different types of respirators. A number of factors should be considered when selecting a respirator. Situations which may require the use of respiratory protection include:

- Oxygen deficiency
- Hazardous substances in the air
- Atmosphere immediately dangerous to life and health (IDLH)
- Confined space entry
- Skin/eye contact hazard

Air-purifying respirators (APR) and self-contained breathing apparatus (SCBA) may be used by operations-level emergency responders to prevent toxic materials from entering the body.

APRs consist of a facepiece with exhalation valve and one or two filtering units through which the air enters.

SCBAs consist of a facepiece and supply of air, gauge, and safety valve. If air-line respirators are used during an emergency, an escape unit must also be worn.

A respirator should be selected for use after either qualitative or quantitative fit testing. Before each use, positive- and negative-pressure user checks are done by the wearer. Persons assigned to wear a respirator must be examined by a physician to ensure fitness. Care of respirators includes diligent cleaning, disinfecting, and storing. Units should be inspected before and after each use, or monthly if not used routinely. A written program is required in any workplace where respirators are or may be used. Special considerations in use of respirators include the need for corrective lenses, communication requirements, and use in dangerous atmospheres.

Important acronyms include:

- APR - Air-Purifying Respirator
- SCBA - Self-Contained Breathing Apparatus
- ASR - Atmosphere Supplying Respirator
- PAPR - Powered Air-Purifying Respirator
- IDLH - Immediately Dangerous to Life and Health





## **Chemical Protective Clothing**

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Chemical-protective clothing (CPC) includes suits, aprons, gloves, safety goggles, and face shields. This provides an important barrier between chemicals or other hazards in the environment and your body. Although CPC and respirators cannot provide protection from all exposures, when properly selected and worn, the combination can limit harmful exposures. This section includes the use, selection and application of levels of protection as designated by EPA and OSHA.

You will don and doff PPE.

### **Chapter Objectives**

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

- Identify general types, uses and limitations of chemical-protective clothing
- Identify the EPA/OSHA levels of personal protective equipment (PPE)
- Identify the general guidelines for selection of CPC and demonstrate selection for a scenario
- Demonstrate the donning and doffing of CPC provided
- Identify the procedures for inspection, maintenance, and storage of CPC

## **Personal Protective Equipment**

---

Personal protective equipment (PPE) includes respirators, chemical protective clothing, boots, gloves and hearing protection; the full ensemble of PPE is selected to protect emergency responders from a number of hazards including

- Chemical contact with skin and eye
- Physical hazards
- Respiratory hazards

PPE is effective only when properly selected, maintained, and worn during emergency response activities. The Emergency Response Plan (ERP), required by HAZWOPER, must include a description of PPE (chemical-protective clothing and emergency equipment).

OSHA standards specifically for PPE include:

- 1910.95      Hearing Protection
- 1910.132    General Requirements—Full-Body Protection
- 1910.133    Eye and Face Protection
- 1910.134    Respiratory Protection
- 1910.135    Head Protection
- 1910.136    Foot Protection
- 1910.138    Hand Protection



## **Chemical-Protective Clothing**

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Chemical-Protective Clothing (CPC) consists of special clothing worn to prevent chemicals from contacting the body. CPC generally includes eye/face protection, aprons, boots, gloves, and suits/coveralls. CPC is used to protect responders from both chemical and physical hazards. The proper use of CPC can prevent or reduce exposure to a hazard. CPC is an important part of an emergency responder's personal protective equipment (PPE).

The materials used to construct CPC are chemical-resistant, which means they act as a barrier to keep chemicals from coming in contact with the wearer's skin. Different materials provide protection from different types of chemicals. It is important to select CPC which is designed to protect against the specific chemical or type of chemical that may be encountered during an emergency response. Otherwise, you might not be protected, even when you think you are.

### **Personal Protective Equipment Program**

A written personal protective equipment program is required by OSHA as part of the employer's Emergency Response Plan. PPE must be selected to protect employees from known or likely potential hazards. The proper selection of PPE is based on many factors, including potential hazards, layout of the scene and surrounding activities.

### **PPE must be properly selected and used to be effective.**

#### Examples of improper selection

- Goggles, when whole body splash is likely
- Gloves known to swell when wetted with solvent that must be cleaned up

#### Examples of improper use

- Respirator 'stored' below the chin
- Continuing to work with a tear in CPC suit

What examples of improper selection or use have you seen?

The PPE program must address:

- Selection, based upon anticipated hazards (See 29 CFR 1910.132 Appendix B for guidance)
- Use and limitations
- Work task duration
- Maintenance and storage
- Decontamination and disposal
- Training and proper fitting
- Donning and doffing procedures prior to, during, and after use
- Inspection procedures
- Evaluation of program effectiveness
- Special limitations during temperature extremes, heat stress, and other appropriate medical considerations

When model procedure descriptions provided by the manufacturer will be followed exactly, they may be incorporated into the PPE Program as is.

Appropriate PPE must be purchased as part of preplanning, and it must be selected and properly used during initial size-up and response activities. The size-up should provide sufficient information to select PPE to protect personnel from overexposures to chemicals. During size up and other initial actions, responders may a high level of protection. With the information gathered, including air monitoring, a decreased level of respiratory protection may be ordered by the person in charge and following the ERP for the response activities. All PPE selected and used must meet OSHA requirements where applicable (1910, Subpart I and 1910.120).

### Types of Chemical-Protective Suits

Chemical-protective suits are of two general types: totally encapsulating and partially encapsulating.

**Totally Encapsulating Chemical-Protective Suit (TECP):** Provides head-to-toe coverage to protect the wearer from chemicals. These suits have special seams and zippers to prevent chemicals from leaking into the suit. These suits have a face shield which is made as part of the hood. They are very bulky to wear, and the wearer can become very hot while working. TECPs are the only vapor-resistant suits. TECP suits protect workers from hazards which are identified during initial hazards and risk

assessment. TECP suits must pass specific positive-air pressure tests and be capable of preventing inward test gas leakage of more than 0.5%. Specific information about pressure tests can be found in OSHA 1910.120, Appendix A.

**Partially Encapsulating Chemical-Protective Suit (PECP):** Provides less protection from chemicals and may or may not have face shields. These suits are used when less skin protection is needed. The hood can either be part of the suit or detached. This type of CPC may include suits which look like totally encapsulating suits but will not pass a pressure test. A large variety of PECP designs is available.

Disposable suits that provide limited protection from chemicals can be used in conjunction with these chemical-protective suits. These disposable suits can be worn either on top of other suits to protect them or inside protective suits to protect the wearer from chafing, to limit contamination of personal clothing or to provide added protection during decon.

### Selection of CPC and other PPE

Generally, one person or the health and safety group is responsible for the selection and purchase of protective equipment; however, it is important for everyone to understand the considerations which go into the selection. The selection process should be detailed in the employer's PPE plan. Questions about PPE selection should be addressed to the person responsible for the selection.

A hazard assessment with a survey of the facility is part of pre-emergency planning at fixed sites and will include a list of potential emergency releases or events. This list is used in planning for required PPE. Hazards to take into consideration include:

- Impact
- Compression (roll-over)
- Heat/cold
- Light (optical) radiation
- Sources of electricity
- High temperatures
- Fire
- Penetration/ puncture hazards
- Combustible/Harmful dust
- Biologic agents
- Sources of motion or impact
- Chemicals

The type of chemical-protective suits selected will depend on the type and nature of potential exposure. For example, totally encapsulating suits may be required for persons approaching a perc release at a faulty valve; less protection is required for those involved in maintaining site security during the response. Generally, the level of protection provided will be re-evaluated as additional information is gained. Guidelines for selection of PPE, including CPC suits, are presented in the following table.

### **CPC Selection Guidelines - Always follow manufacturer's recommendations**

**Chemical resistance:** Different materials are resistant to different chemicals.

Management should provide CPC which will provide protection against the chemicals likely to be encountered. This rule is true for whole-body as well as hand and foot protection.

**Physical integrity:** Construction of the suit is important for the proper functioning of the CPC. Seams and zippers should provide solid barriers to chemicals and should be constructed to prevent seam tears and rips during use

**Resistance to temperature extremes:** Heat and cold can adversely affect CPC.

Clothing which will be worn in cold temperatures could crack or become ineffective against chemicals. Likewise, heat can destroy the chemical resistance of clothing or even melt it.

**Ability to be cleaned:** Clothing must be able to be cleaned and decontaminated after each use. If this is not possible, the clothing must be disposed of after use.

**Cost:** Initial and ongoing costs of purchasing PPE can be important considerations for management. However, buying less expensive, inferior products that do not adequately protect the wearer can be more expensive in the long run due to medical costs, lost work time, or, at worst, loss of human life.

**Flexibility:** Materials need to be flexible enough for the wearer to move and work safely. Overly rigid suits can result in unnecessary accidents from slips, trips, and falls. Gloves which are too rigid may create gripping problems that may lead to other hazards.

**Size:** CPC should be available in a variety of sizes to accommodate the height and weight of the worker. Suits that are too small will tear easily and provide no protection. Suits that are too large will make walking and/or working difficult. Safety boots that are too big will create both tripping and comfort problems.

**Design:** CPC should be designed so that all required respiratory PPE can be used at the same time. Some styles/designs require assistance to don/doff.

Levels of PPE (see 29 CFR 1910.120, Appendix B)

### Level A

Level A is the highest level of protection which can be worn.

#### What Is Level A Protection?

The following list constitutes Level A equipment; it may be used as appropriate:

- Positive-pressure, pressure-demand, full-facepiece SCBA or positive-pressure, supplied-air to full-facepiece with escape SCBA (NIOSH-approved)
- Totally encapsulating chemical-protective suit (TECP) (gas tight or vapor tight)
- Inner and outer chemical-resistant gloves
- Disposable protective suit, gloves, and boots (depending on suit construction, may be worn over totally encapsulating suit)
- Coveralls\*
- Long underwear\*
- Hard hat (under suit)\*
- Chemical-resistant boots with steel toe and shank.
- Cooling system (ice vest, water/air circulation)\*

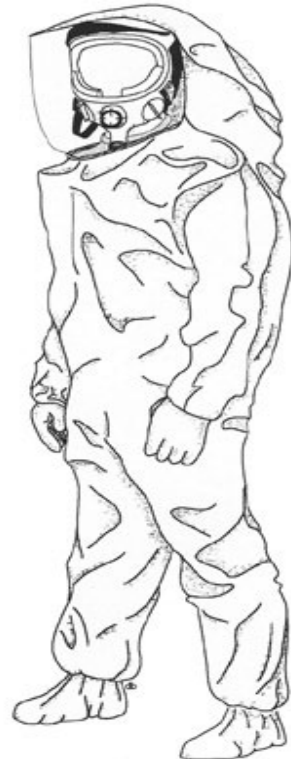
\*Optional as applicable

Note: Suit must be properly equipped with a pass-through airline connection, referred to as an airline egress if using an SAR.

#### When Is Level A Protection Needed?

Level A protection is required when:

- The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and respiratory system.
- There is potential for splash, immersion, or exposure to vapors, particulates, or gases that are harmful to the skin or may be absorbed through the skin.
- Confined space entry may be involved and the need for Level A cannot be ruled out (but explosion hazard has been ruled out).
- The skin absorption hazard may likely result in immediate death or serious illness/injury or impair the ability to escape.



### Level B

Level B is used when maximum respiratory protection is desired, but the skin/eye hazards do not require Level A.

#### What Is Level B Protection?

The following constitutes Level B equipment; it may be used as appropriate.

- Positive-pressure, full-facepiece SCBA or positive-pressure, pressure-demand, supplied-air to full-facepiece with escape SCBA (NIOSH approved)
- Hooded chemical-resistant clothing OR total encapsulating chemical suit (not gas tight or vapor tight)
- Inner and outer chemical-resistant gloves
- Outer chemical-resistant boots with steel toe and shank
- Boot covers: outer, chemical-resistant (disposable)\*
- Hard hat\*
- Face shield\*
- Cooling system (ice vest, water/air circulation)\*



New Level B chemical-resistant clothing is designed to go over the SCBA. If appropriate for the potential exposures, this CPC should be used to protect the SCBA and prevent its contamination. In this case, the Level B ensemble will resemble a Level A ensemble, but the suit is not vapor-tight.

\*Optional as applicable

#### When Is Level B Protection Needed?

Level B protection is required when:

- The highest level of respiratory protection is needed but a lower level of skin protection (than Level A) is acceptable
- The substances have been identified
- A SCBA is required
- Less skin protection is needed. (Vapor and gases are not believed to be present at high levels harmful to skin or capable of being absorbed through intact skin)

### Level C

Level C provides less skin and respiratory protection than Level A or B.

#### What Is Level C Protection?

The following list constitutes Level C equipment; it may be used as appropriate.

- A full-face or half-face air-purifying respirator (NIOSH-approved)
- Hooded chemical-resistant clothing
- Inner and outer chemical-resistant gloves
- Coveralls\*
- Boots (outer), chemical-resistant steel toe and shank\*
- Boot covers: outer, chemical-resistant (disposable)\*
- Hard hat\*
- Escape mask\*
- Face shield\*

\*Optional as applicable

#### When Is Level C Protection Needed?

Level C provides protection when:

- The concentration(s) and type(s) of airborne substance(s) are known and the criteria for using an air-purifying respirator are met.
- Direct contact with the hazardous substance will not harm the skin or the substance will not be absorbed through any exposed skin.
- Air contaminants have been identified, concentrations measured, and an air-purifying respirator is available with an acceptable protection factor
- An adequate level of oxygen ( $\geq 19.5\%$ ) is available and all other criteria for the safe use of air-purifying respirators are met.



### Level D

This level offers no respiratory protection and low skin protection.

#### What Is Level D Protection?

The following list constitutes Level D equipment; it may be used as appropriate:

- Coveralls (work uniform)
- Chemical-resistant boots or shoes with steel toe and shank
- Hard hat\*
- Gloves\*
- Outer, chemical-resistant boots (disposable)\*
- Safety glasses or chemical splash goggles\*
- Escape mask\*
- Face shield\*

\*Optional as applicable

#### When Is Level D Protection Needed?

Level D is required when:

- Minimal protection from chemical exposure is needed. It is worn to prevent nuisance contamination only
- The atmosphere contains no known hazards that require skin or respiratory protection
- Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals

#### Typical Uses of Level D Equipment

Level D protection is worn by personnel who may be exposed only to nuisance contamination while working with hazardous materials. Typically, workers involved with support activities such as equipment supply, maintenance, off-site vehicle operation, or supervision/management will wear Level D.

Level D may appear similar to “typical work clothes.” Differences include the chemical-resistant boots with steel shanks.



A general rule for which level of protection to use is:

“The less you know, the higher you go.”

### **Remembering Levels of Protection**

A helpful way to remember the levels of protection is:

Level A - "A"ll Covered, gas/mist tight

Level B - "B"reathing Air, splash protection

Level C - "C"artridge Respirator or air purifying respirator

Level D – "D"on't Expect Protection", regular work clothes

Note: Levels A and B suits must be tested. See:

- 29 CFR 1910.120, Appendix A - PPE Test Methods
- ASTM F23.50.01, Practice for Pressure Testing of TECP
- NFPA 1991, Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies (EPA Level A)
- NFPA 1992, Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies (EPA Level B)
- ANSI/ISEA-101-1996, Limited-Use and Disposable Coveralls - Size and Labeling Requirements
- Chemical-Resistant Clothing: ASTM F739, Permeation; ASTM F903, Penetration

## Characteristics and Properties of CPC

PPE is effective only if it is properly selected, worn, and maintained. Standard Operating Procedures (SOPs) for PPE are included in the ERP. SOPs are employer-specific versions of the more general Standard Operating Guides (SOGs) often used in training. SOGs are written instructions and are a form of administrative control.

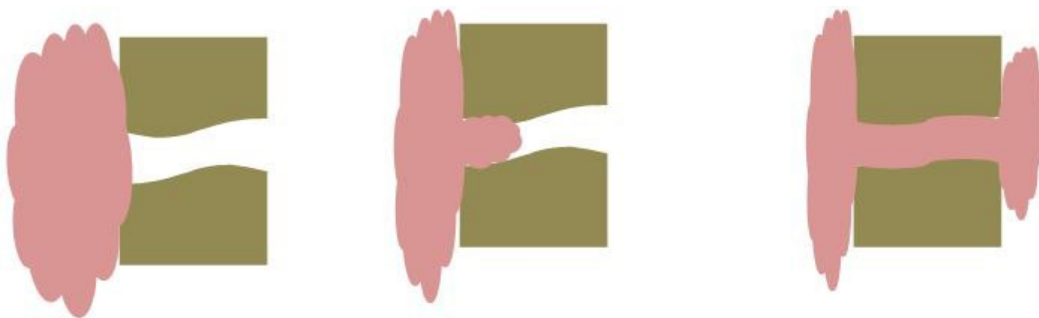
- Whenever possible, a variety of suit sizes should be on hand to fit the various sizes of personnel
- Adhesive on tape not approved by the manufacturer may cause degradation of the suit and the warranty may be voided
- Materials used to make most suits do not “breathe.” Rapid heat and moisture build-up will occur in the suit during use
- All suits have limits as to the temperature at which they can be worn without damage. This information may be particularly important for emergency response activities. Check the manufacturer’s data.
- Most suits offer no fire protection and in some cases increase the possibility of injury because they will melt and may burn

### Penetration, Degradation, Permeation

Chemicals can reduce the effectiveness of CPC garments through penetration, degradation, or permeation.

NOTE: Mixtures of chemicals may behave differently from the components.

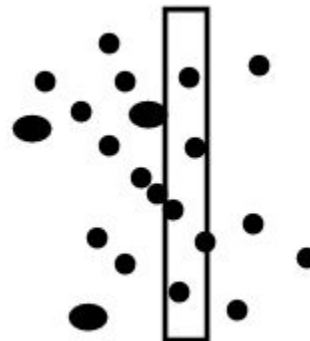
**Penetration** is the flow of a chemical through zippers, stitched seams, or imperfections in the material.



**Degradation** is a reduction in one or more physical properties of a protective material due to contact with a chemical, use or ambient conditions such as sunlight or cold. This may be seen by swelling or ‘gumminess’ of the material, discoloration or loss of strength.

**Permeation** is the process by which a chemical moves through a material on a molecular level. The rate of permeation is dependent on six major factors:

- Contact time
- Material thickness
- Concentration
- Temperature
- Physical state of chemicals
- Size of the contaminant molecules and pore space



A general rule of thumb is that the permeation rate is inversely proportional to the thickness ( $2 \times \text{thickness} = 1/2 \times \text{permeation rate}$ ). Other important factors are chemical concentration, contact time, temperature, material grade, humidity, and solubility of the material in the chemical. Consult the manufacturer for more information.

### Chemical-Resistant Materials

The following is a list of some commonly used chemical-resistant materials and their advantages and disadvantages. Materials for chemical protection may be blended or laminated and require manufacturer's data when determining proper selection(s). This list should not be used to select materials; manufacturer's guidelines and other references should be consulted.

#### Butyl Rubber

**Use** Mainly in encapsulating suit, but some gloves, boots, and splash gear.

**Advantages** Good for bases and many organics. Very resistant to gas/vapor permeation. Readily releases contamination. Good heat and ozone resistance.

**Disadvantages** Poor for aliphatic and aromatic hydrocarbons, gasoline, halogenated hydrocarbons, and abrasion resistance. More expensive than PVC or neoprene.

#### Chlorinated Polyethylene (CPE)

**Use** Only in fully encapsulating suits

**Advantages** Good for aliphatic hydrocarbons, acids and bases, alcohols, and phenols. Resists abrasion and ozone.

**Disadvantages** Poor for amines, esters, ketones, and halogenated hydrocarbons. Becomes very rigid when cold.

### Natural Rubber

**Use** For boot covers because of durability and for disposable inner and outer gloves.

**Advantages** Good for bases, alcohols, and dilute acids. Inexpensive. Flexible.

**Disadvantages** Poor for organic chemicals. Ages (affected by ozone).

### Neoprene

**Use** In all types of protective clothing.

**Advantages** Better than polyvinyl chloride (PVC) for organics. Durable. Abrasion- and cut-resistant.

**Disadvantages** Not as good as PVC for acids and bases. Poor for chlorinated aromatic solvents, phenols, and ketones. More expensive than PVC.

### Nitrile Rubber

**Use** In gloves and boots and one encapsulating suit.

**Advantages** Made specifically for petroleum products. Abrasion- and cut-resistant. Flexible. Good for bases, peroxides, PCBs, phenols, and alcohol.

**Disadvantages** Poor for aromatic and halogenated hydrocarbons, amines, ketones, and esters. Loses flexibility in cold weather.

### Polyurethane

**Use** In boots and splash gear.

**Advantages** Good for bases and organic acids, oils, and alcohols. Abrasion-resistant. Flexible (especially in cold weather).

**Disadvantages** Poor for inorganic acids and other organic solvents.

### Polyvinyl Alcohol (PVA)

**Use** For gloves only.

**Advantages** Excellent (the best) for oils, aromatic solvents, and chlorinated hydrocarbons. Ozone-resistant.

**Disadvantages** Degraded by water. Not flexible. Expensive.

### Polyvinyl Chloride (PVC)

**Use** All types of protective clothing.

**Advantages** Excellent for acids and bases. Very durable. Relatively inexpensive.

**Disadvantages** Poor for chlorinated and aromatic solvents. Difficult to decontaminate.

### Viton

**Use** In fully encapsulating suits and gloves.

**Advantages** Good for most organics including chlorinated hydrocarbons. Fair durability. Good for acids. Good for decontamination. Good for physical properties.

**Disadvantages** Poor for oxygenated solvents—aldehydes, ketones, esters, and ethers. Expensive.

### Teflon

**Use** In fully encapsulating suits.

**Advantages** Excellent chemical resistance against most chemicals.

**Disadvantages** Limited permeation test data. Expensive.

### Nomex

**Use** For flame retardant PPE and a base fabric for some suits.

**Advantages** Fire-resistant. Durable.

**Disadvantages** Readily penetrated.

### Tyvek®

**Use** Predominantly for coveralls.

**Advantages** Dry particulate and dust protection. Disposable, lightweight, and inexpensive.

**Disadvantages** Penetrable if not chemically treated. Poor durability.

### Polyethylene (coated Tyvek®)

**Use** Predominantly for coveralls, but also gloves and booties. It can be worn over CPC to prevent gross contamination of non-disposables.

**Advantages** Good for acids and bases, alcohols, phenols, and aldehydes. Good for decontamination (disposable) and lightweight.

**Disadvantages** Poor for halogenated hydrocarbons, aliphatic and aromatic hydrocarbons. Not very durable. Easily penetrated (stitched seams).

### Polyethylene/Ethylene vinyl alcohol (PE/EVAL) – 4H® or Silvershield®

**Use** Gloves, aprons, sleeves and booties

**Advantages** Good for alcohols, aliphatics, aromatics, chlorines, ketones and esters, economical

**Disadvantages** Poor fit of gloves impacts dexterity, easily punctured.

### Trellchem®

**Use** Fully encapsulating and partially encapsulating suits

**Advantages** Resistant to a wide range of chemicals, some models also including chemical warfare agents, abrasion resistance and flame resistance.

**Disadvantages** Stiff and bulky, expensive

### Tychem®

**Use** Fully encapsulating and partially encapsulating suits, coveralls and hoods

**Advantages** Resistant to a wide range of chemicals. Some models also resist chemical warfare agents, puncture and abrasion, heat, arc flash and flame.

**Disadvantages** Expensive, stiff and bulky

See resources from manufacturers when selecting CPC. The rating for a material does not necessarily predict performance of a garment; thickness, formulation, substrate and manufacturing process can all affect the product performance.

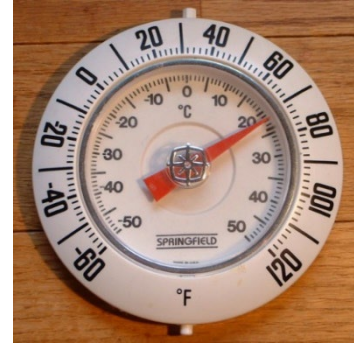
## Precautions When Wearing CPC

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Every level of chemical-protective clothing has limitations. The following precautions should be considered:

- Hearing and speaking to be heard may be difficult in CPC with respiratory protection. It is important to establish other ways to communicate with each other. Hand signals or audio signals such as horns, sirens, and whistles can be used to communicate. Communication can also be improved by using two-way radios, such as a portable radio with microphone or radio with a microphone and speaker combination attached to the full-face respirator. Remember, any radio must be intrinsically safe to prevent an ignition hazard. Be aware of potential traffic areas.
- Due to the size, weight and design of some suits, motion is restricted, especially when climbing, working in tight areas, or using hand tools.

- Look for signs of heat stress (dizziness, headache, nausea, perspiration ceases), especially at temperatures over 70°F.
- Always wear the correct size of footwear in order to prevent accidents. You should also make certain that the soles provide a proper grip for the surfaces that you will be encountering. Steel shanks, toes, and shin guards help to prevent puncture wounds and/or crushing injuries.



- Disposable booties may be slippery. Use caution when walking to prevent slips and falls.
- Care should be taken when donning and doffing inner and outer gloves. When donning gloves, make sure that no cracks or tears are present. When doffing gloves, take care not to spread contamination.
- All joints such as suit-to-boots and suit-to-gloves in Levels B and C protection should be secured with tape that is compatible with the CPC; see manufacturer recommendations. Fold the end of the tape back under to make a tab for easy removal. Use special care when removing tape.
- Goggles and eye/face protection may become clouded due to moisture condensation during use. Follow manufacturer recommendation regarding use of products such as anti-fog film or spray on protective eye/face gear. Similarly, follow manufacturer instructions regarding clearing away any fog that may form on the inside of the face shield of a fully encapsulating suit.
- Be sure you are adequately hydrated prior to and after use of CPC.
- Avoid placing your hands or knees on the ground when in the Hot Zone to prevent contamination by chemicals and abrasion to the suit material. Avoid sitting on anything sharp in suits.
- When removing a suit, open and fold down onto itself as it is removed to prevent contamination of internal clothing.
- Suits have weak seams, especially if they are disposable. Be careful not to strain and split them. If splitting occurs, report it and follow the appropriate SOP (standard operating procedure).
- Use caution when suits are used in potential fire areas. If fire occurs, get out of the area.



- When dressing out with a team be careful to coordinate your dressout at the same speed and level as your team/buddy. The longer you are dressed out, the more stress is being put on your body.
- Completion of dressout should be delayed until ready to conduct your assigned duty/response activity.

### **Inspection, Maintenance, and Storage of CPC**

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It is important to inspect CPC, for evidence of chemical damage. CPC that is torn, degraded, or otherwise non-functional will not offer adequate protection to the wearer. The PPE program should describe or reference SOPs for CPC inspection, maintenance, and storage. The inspection SOP is used when CPC is:

- Received from the distributor
- Issued to responders
- Put into storage
- Taken out of storage
- Used for training
- Used for an emergency response
- Sent for maintenance
- Returned from repair or service

An inspection checklist should be developed for each item. Factors to consider are:

- Cuts, holes, tears, swelling, and abrasions in seams of fabric
- Weakness in zipper or valve seals
- Signs of contamination such as discolorations or visible chemical residues
- Signs of malfunctioning exhaust valves

Note: CPC may be contaminated or degraded even though there are no visible signs.

Proper maintenance can prevent CPC deficiencies and prolong its life. A detailed SOP must be developed by the employer and followed rigorously. All maintenance must be performed by trained personnel.

Proper storage is important in order to prevent CPC failures. The written SOP should describe storage before the CPC is issued to the responder, as well as storage after use. Check the manufacturer data for specific temperature and humidity storage requirements, shelf life and any expiration date.



## **Exercise - Levels of PPE**

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This exercise will allow you to apply knowledge gained from this section to a “real-life” situation. The exercise involves determining what level of PPE would be required for different situations. Although the operations-level first responder will usually be provided specific PPE selected by the team leader, this exercise gives the responder an opportunity to determine the basic level of protection which is needed. For each situation, state the appropriate level of PPE and the reason for your decision.

1. At a paved storage area on the plant grounds, a truck has overturned, spilling unknown materials onto the ground. The material is vaporizing. You do not have any monitoring equipment. What level of protection should you wear upwind to size up the scene?
  
2. A tank containing ammonia has a minor leak. The ammonia level is measured about 247 ppm (300 ppm is IDLH for ammonia). What level of PPE should you wear?
  
3. A cylinder of chlorine has ruptured. Level A is required for the HazMat Technicians who have gone in to patch the leak. You will be assisting in the perimeter of the hot zone where the concentration is less than 10 ppm. What level of protection should you be wearing?



## **Summary – Chemical Protective Clothing**

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PPE includes respirators, chemical-resistant suits, boots, gloves, chemical goggles and face shields and hearing protection. PPE is required by OSHA regulations and protects emergency responders from:

- Chemical contact with skin and eyes
- Physical hazards
- Respiratory hazards

Level A provides the most protection and includes:

- A positive-pressure, full-facepiece SCBA or supplied-air respirator with an escape unit
- A totally encapsulating chemical-resistant suit
- Inner and outer chemical-resistant gloves
- Chemical-resistant boots with steel toe and shank

Level B includes:

- A positive-pressure, full-facepiece SCBA or supplied-air respirator with an escape unit
- Hooded, chemical-resistant clothing or TECP non gas-tight suit
- Inner and outer chemical-resistant gloves

Level C includes:

- Full- or half-face air-purifying respirator (APR)
- Hooded, chemical-resistant clothing
- Inner and outer chemical-resistant gloves
- Chemical-resistant boots with steel toe and shank

Level D includes:

- Coveralls
- Chemical-resistant boots with steel toe and shank

PPE must be properly cared for and maintained. Wearers should know the requirements of PPE. Written programs about selection, care, and use of PPE should be included or references in the Emergency Response Plan.



## **PPE - Other Protective Gear**

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PPE for hazardous materials responders includes respirators, chemical-resistant suits, boots, gloves, eye protection and hand protection.

PPE is required by OSHA regulations for protection from:

- Chemical contact with skin and eyes. (suits, aprons, gloves, goggles, face shield)
- Respiratory hazards.(respirator)
- Physical hazards. (boots, hard hat, gloves, sleeves, thermal protection, hearing protection)

### **Chapter Objectives**

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

- Identify OSHA requirements and other guidelines for hearing, eye/face, head and foot, hand/arm protection
- Describe special protective clothing

In addition to RPE and CPC, other types of PPE may be required in an emergency response. OSHA standards for additional PPE include:

- 1910.95 Hearing Protection (fire truck siren can exceed 100 dB)
- 1910.132 General Requirements: Personal Protective Equipment
- 1910.133 Eye and Face Protection
- 1910.135 Head Protection
- 1910.136 Foot Protection
- 1910.137 Electrical Protective (gloves and sleeves)
- 1910.138 Hand Protection

With the exceptions of hearing protection and electrical protection, these protective devices are required in one or more of the Levels of Protection (A, B, C, D).

Specialized clothing to protect against high temperatures or arc flash is available. Training in the selection and use is outside the scope of this program.

While OSHA provides testing requirements for hazardous materials suits, the testing protocols for head, shoe and eye/face protection are published by independent groups.

The selection and training of hearing protection is detailed by OSHA in 29 CFR 1910.95. When needed, several choices must be available to workers.

### **Summary – Other Protective Gear**

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Eye, face, hand, head and hearing protection are covered by specific OSHA regulations.

### **Review Question**

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Other than RPE and CPC, what other protective gear is required in one or more of the levels of protection?

## **DECONTAMINATION**

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Decontamination is an important set of procedures designed to protect emergency responders, other people, and the environment from exposures or contamination resulting from a hazardous materials incident. This section covers the principles of decontamination and the establishment of zones at hazardous materials emergencies.

### **Chapter Objectives**

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

- Identify steps in pre-planning decontamination
- Identify methods to prevent contamination of personnel, PPE, equipment and the environment
- Identify the purpose of each of the work zones put in place during a hazardous materials emergency response
- Identify basic decontamination methods
- Demonstrate setting up a decontamination line, using supplies provided

## **Introduction**

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Decontamination (decon) is the process of removing and/or neutralizing contaminants from PPE, personnel and equipment to prevent exposure that may cause a health effect to the responder or others. If decon cannot be accomplished, then proper disposal is required. The need for and methods and procedures to accomplish decon is detailed in the decon SOP in the ERP.

Adequate decon may be as simple as thorough hand washing or may require scrubbing of PPE prior to removal in a specific sequence followed by a shower for the responder. For most chemicals, soap and water washing is sufficient to decontaminate PPE.

## **Pre-Planning for Decontamination**

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Decontamination is the process of removing and/or neutralizing contaminants that may have accumulated on PPE and equipment. Proper decontamination or replacement of protective clothing or equipment is critical in controlling hazards and ensuring the health and safety of responders. The need for decontamination is documented in the employer's emergency response plan (ERP) as required in 1910.120(q) (2)(vii). The detailed plan is developed, communicated to responders and other workers, and implemented before responders or equipment enter the hazmat area.

The plan must be monitored by the incident commander or a designee.

Decontamination plans include the following:

- A description of the location and layout of potential decontamination stations for the response
- A list of the decontamination equipment needed for the possible hazards (for example, water for removal and brushes for scrubbing)
- The appropriate PPE for persons assisting with decontamination
- Specific procedures for decontamination of substances that may be encountered during the response
- Methods and procedures for preventing contamination of clean areas
- Methods and procedures for minimizing contact with contaminants during removal of PPE
- Safe disposal methods for clothing and equipment that are not completely decontaminated
- Revisions whenever the type of personal protective clothing or equipment changes, the conditions change, or the hazards are reassessed based on new information



If commercial laundries or cleaning establishments receive contaminated clothing or equipment, they must be informed of potential harmful effects of exposure to the contaminant(s).

Where the decontamination procedure specifies regular showers and change rooms outside of a contaminated area, they must be provided according to the requirements of 29 CFR 1910.141. If water cannot be used due to temperature conditions, then other effective cleansing means must be provided and used.

Following the plan results in these outcomes:

- Protects responders from exposure to hazardous substances and contaminated equipment
- Prevents continued permeation of the hazardous substance into PPE
- Contamination of other PPE, equipment or tools
- Limits transfer of harmful substances to employees in clean areas
- Prevents the mixing of incompatible substances during decon
- Prevents the transfer of contaminants outside the response area
- Ensures routine critique and revised as necessary

The following examples illustrate situations when decontamination should be utilized:

- When PPE becomes contaminated
- Before responders go from a “dirty” to “clean” work area
- Before responders, eat or drink, smoke, or use restroom facilities
- Before contaminated response emergency vehicles or equipment leave the response site
- Before process equipment in the area of the response is put back into service

### **Limiting Contamination**

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The primary goal is to avoid employee contamination by minimizing contact with hazardous materials.

Specific procedures are used to prevent personal contamination. For example, procedures during donning PPE will minimize the potential for contact with a hazardous material, such as:

- Inspecting PPE before each use to ensure it is in proper condition
- Closing zippers, buttons, and snaps fully
- Tucking gloves over or under the sleeves will be specified in the SOP for any task where gloves and sleeves are overlaid to prevent contaminants entering

between the two

- Wearing a third pair of tough outer gloves
- Putting legs of outer clothing over boot tops
- Place any head covering that is not attached to a suit, outside the collar
- Taping all junctures with tape adhesive compatible with suit materials to help prevent contaminants from entering inside gloves, boots, and zippers

Other precautionary measures can help reduce the amount of contamination during response activities, such as:

- Using work practices that minimize contact with hazardous substances
- Avoiding puddles, plumes, or areas of obvious contamination
- Minimizing contact with surfaces potentially contaminated with hazardous substances
- Using remote devices such as robots and cameras
- Covering monitoring and sampling instruments (plastic bags with openings for sensors or intake ports), following manufacturer recommendations for preventing contamination to instruments and decontaminating those instruments after use
- Covering equipment and tools with a coating which can be stripped away as one step in decontamination
- Wearing disposable outer garments
- Using disposable equipment where appropriate

The spread of contamination after the response is limited by actions including:

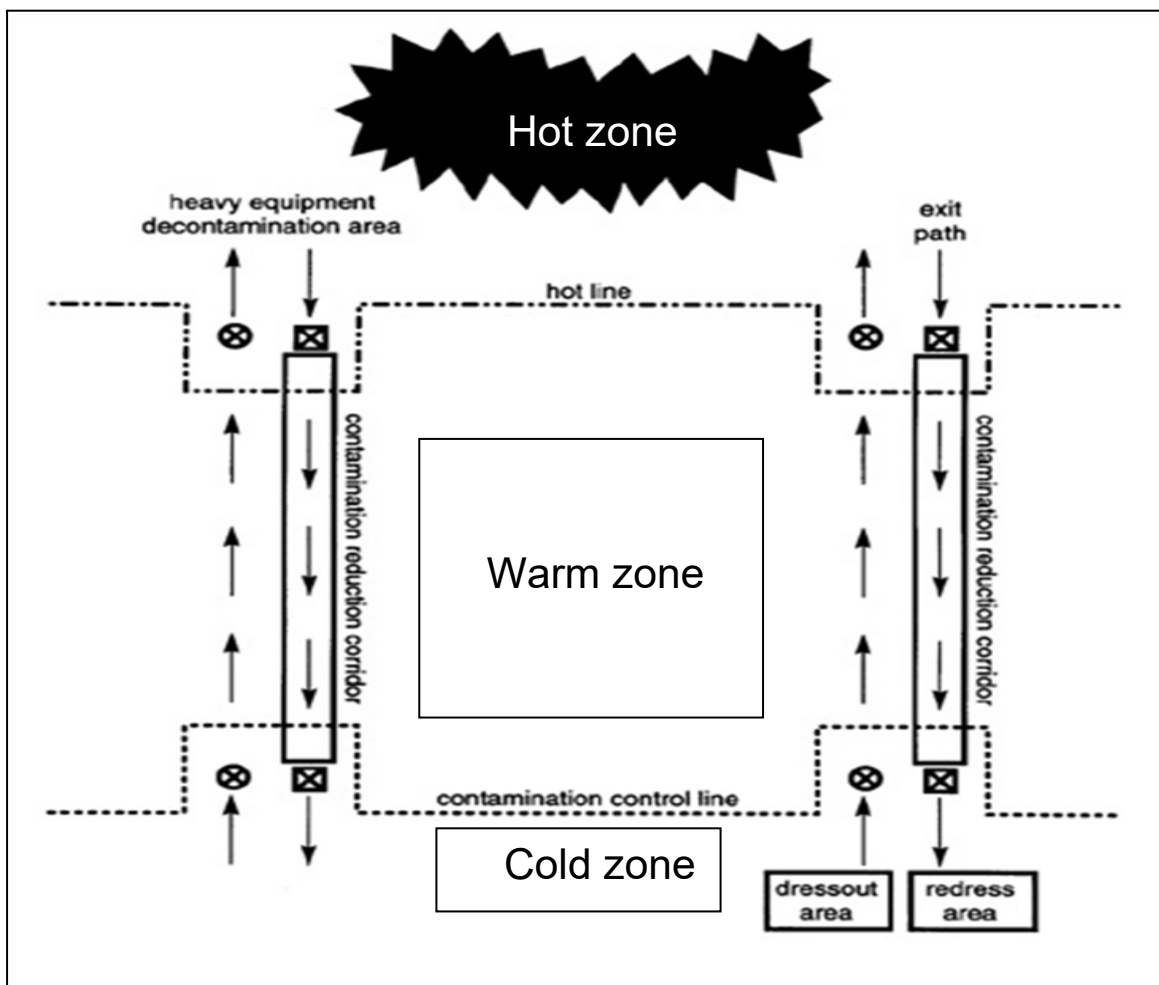
- Using methods to verify effectiveness of decon
- Decon containers and supplies that will be re-stowed
- Proper disposal of all wastes - tools, disposables, solutions

## Work Zones

Zones are established to limit movement of contamination and contaminated materials. Three work zones are:

- The **Hot Zone**, or **Exclusion Zone**, which is the area of highest contamination.
- The **Warm Zone**, or **Contamination Reduction Zone (CRZ)**, which is the area surrounding the hot zone, where decontamination occurs.
- The **Cold Zone**, or **Support Zone**, which is the area free of contamination, where support activities occur.

These zones are shown in the figure below:



## Primary Activities in Each Work Zone

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Different activities are performed by authorized employees in each zone. Movement of personnel and equipment between zones occurs at specific access control points.

**Hot Zone/Exclusion Zone/Danger Zone:** This zone refers to the area where the hazard is being assessed or controlled. Primary activities in this zone include emergency response hazard assessment (mapping, photographing and sampling) and spill containment and control.

The size of the zone is determined by the characteristics of the area where the hazmat emergency has occurred and access points. The “Hot line” is the outer boundary and should be clearly marked with hazard tape, lines, signs, or ropes. Further subdivision of the area may be necessary depending on the hazard and activities being conducted. The level of PPE necessary will be determined by the hazard, monitoring results, and the ERP. It will usually be Level A or Level B; Level C may be used when the hazard is identified and the situation meets the criteria shown in the ERP.

**Warm Zone/Contamination Reduction Zone/Decontamination Zone:**

Decontamination takes place in a designated area called the Contamination Reduction Zone (CRZ) and is the primary activity in the Warm Zone. The boundary of this zone is called the Contamination Control Line.

The degree of contamination decreases along the CRZ, from the Hot Zone to the Cold Zone. Tools are dropped and clothing and protective gear are removed step-by-step to prevent the transfer of hazardous substances to cleaner areas. PPE for responders in this zone is usually one level lower than that used in the Hot Zone. Depending on the hazard and the ERP, the same level of PPE may be required.

**Cold Zone/Support Zone/Clean Zone:** The Cold Zone is free of known contamination. Here, responders exiting the Hot Zone have removed all PPE. Final determinations should be made here about the effectiveness of the decontamination procedures by visual examination and other methods shown in the ERP.

This zone also contains the administrative and other support functions that keep the response running smoothly.

### Decontamination Line

Decontamination must occur before responders re-enter any clean areas. Decontamination procedures will vary depending on the nature and extent of contamination. Procedures must be specified in the ERP.

The decontamination line is an organized series of procedures performed in a specific sequence to reduce levels of contamination on personnel, PPE, and equipment until no contaminant is present. Each procedure is performed at a separate station. The stations are arranged in order of decreasing contamination, preferably in a straight line. All decontamination activities are located in the Contamination Reduction Zone (CRZ). Outer, more heavily contaminated items such as boots, gloves, and suit should be decontaminated and removed first, followed by the decontamination and removal of inner, less-contaminated items (inner boots and gloves). The graphics on the following pages show selected, generic decontamination layouts taken from <https://www.osha.gov/SLTC/hazardouswaste/training/decon.html>. Additional layouts are shown in this resource. Each of those shown below is labeled.

Some important observations:

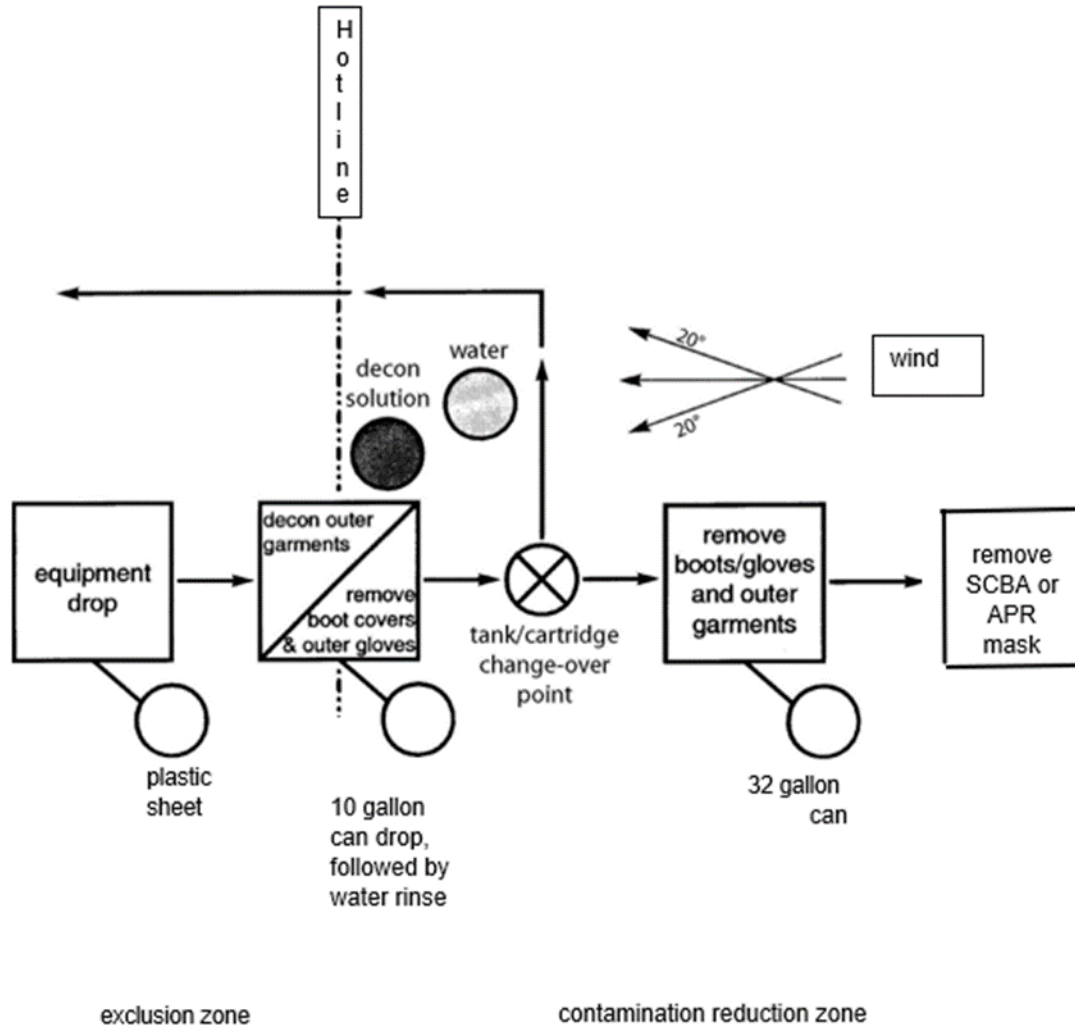
- Each procedure is performed at a separate station. The stations are arranged in order of decreasing contamination, preferably in a straight line
- Tools and equipment are dropped at specified locations
- First, outer more heavily contaminated items such as boots, gloves, and suits are decontaminated and then removed
- Next, inner, less-contaminated clothing (inner boots and gloves) is decontaminated and removed
- Facepieces are removed near the end of the line
- Materials that cannot be decontaminated are discarded

Notes: Complete decontamination of protective clothing may not be possible if the contaminant has permeated into the CPC. If permeation has occurred, the CPC should be discarded.

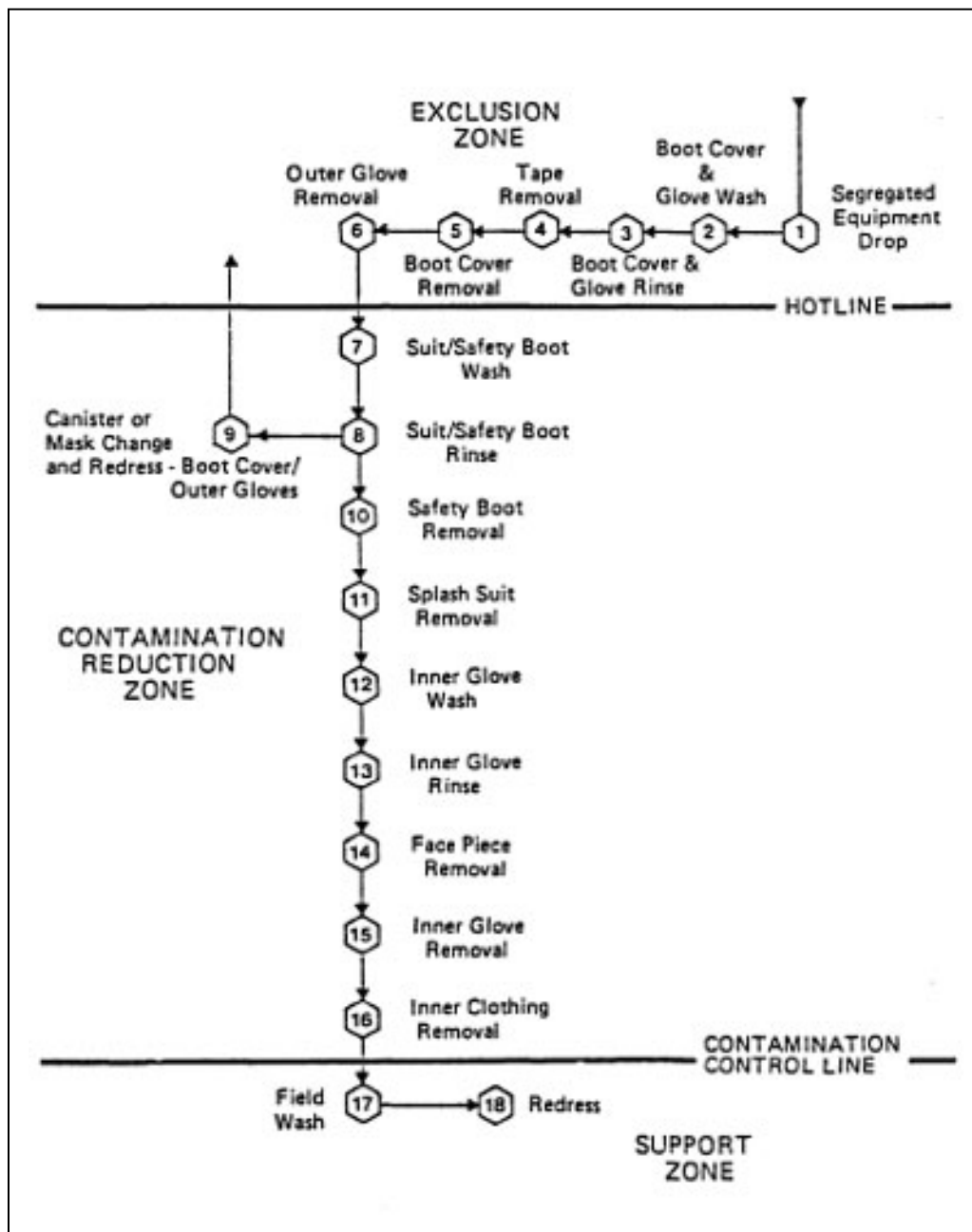
As a general guideline, if a team of responders comes to the decontamination area at the same time, the least contaminated individuals should be decontaminated first. Exceptions to this guideline are medical emergencies and responders who are low on air or who have damage to PPE that might result in direct contamination to inner clothing or skin.

Decontamination layouts are designed to meet the needs of the response. Two additional layouts are illustrated on the following pages.

Minimum Decontamination Layout Level A, B and C



Level C Maximum Decontamination Line Layout



## Decontamination Procedures and Follow up Steps

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All responders and workers, clothing, equipment, and sample containers leaving contaminated areas must be decontaminated to remove any hazardous materials that may have adhered to them.

Decontamination can be accomplished by:

- Physically removing contaminants
- Chemically removing contaminants
- Rinsing off contaminants
- Disinfecting and sterilizing (infectious materials)
- Combining the above methods

The selection of method(s) is based on the contaminants, the materials to be decontaminated and other factors, and is described in the ERP. Manufacturer recommendations for decontamination methods and materials should be consulted during the process of developing the Decontamination SOP and the follow up actions needed to support decontamination.

### Physical Removal

Some contaminants stick to the surface of PPE and equipment and can be removed by scraping, brushing or wiping, adsorbing or absorbing, vacuuming, or use of pressurized air jets. These methods are referred to as dry decontamination, as solutions are not used. One reason to select dry decontamination is temperature—when appropriate for the contaminants, dry decontamination may be preferred to limit the risk of hypothermia.

Care is needed during removal by scraping, brushing or wiping to not degrade the PPE and to minimize the spread of contamination into the air. Any adsorbent or absorbing material(s) used in dry decontamination must be compatible with the contaminant to be removed. When using pressurized air, the pressure should be regulated to prevent injury to the person being decontaminated and to protect the PPE; a pressure reducer is installed in the line, as needed.

### Chemical Removal

Removing contaminants with a chemical requires special planning and training. The solution must be chemically compatible with the PPE and equipment being cleaned. Some specific methods of chemically removing contaminants include halogen stripping, neutralization, oxidation/reduction, and thermal degradation. If contaminated



materials are transferred outside the CRZ for chemical decon, the SOP will include handling, packaging, transfer and unpacking procedures.

### **Rinsing off Contaminants**

A soap and water solution is most frequently used to help remove contaminants. The soap may be referred to as a surfactant.

Rinsing is an important method. Multiple rinses with clean solutions will remove more contaminants than a single rinse with the same volume of solution. The most common type of removal is a water rinse with or without soap, either pressurized or by gravity flow. Chemical leaching, extraction, evaporation, vaporization, and steam jets may be used for specialized applications.

### **Disinfecting and Sterilizing**

Disinfectant methods are used to deactivate infectious agents. Examples of methods are dry heat, gas/vapor, irradiation, bleach solution and steam sterilization; specialized procedures and training are required. Disposable PPE is often selected for use with infectious agents in order to minimize need for decon. If contaminated materials are transferred outside the CRZ for these decon methods, the SOP will include handling, packaging, transfer and unpacking procedures.

### **Notes**

Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Care must be taken to prevent inhalation of the evaporating chemicals.

Dust and vapors that cling to PPE and equipment may become trapped in small openings, such as the weave of the fabric, and can be removed with water or a liquid rinse.

Removal of tightly-adhering contaminants such as glues, cements or resins may be improved by solidifying, adsorption or absorption (powdered lime, kitty litter, clay, charcoal, poly fibers, or other materials); melting or freezing (dry ice or ice) may be used on PPE after removal, if compatible with the manufacturer instructions.

## Evaluating the Effectiveness of Decontamination

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Decontamination methods vary in effectiveness to remove different substances. The effectiveness of any decontamination method should be assessed during development of the ERP and when new information is available. If contaminated materials are not being removed or are penetrating protective clothing, the decontamination program must be revised. The following methods may be useful in assessing the effectiveness of decontamination.

### Visual Observation

There is no reliable test to immediately determine how effective decontamination is. In some cases, effectiveness can be estimated by visual observation.

In natural light, any discoloration, stain, corrosion, visible dirt, or alteration to fabric surfaces may indicate that contaminants have not been removed. However, not all contaminants leave visible traces or effects; many contaminants can permeate clothing and are not easily observed.

### Ultraviolet Light

Certain contaminants, such as polycyclic aromatic hydrocarbons, which are common in many refined oils and solvent wastes, fluoresce and can be visually detected when exposed to ultraviolet light. Ultraviolet light can be used to observe contamination of skin, clothing, and equipment; however, certain areas of the skin may fluoresce naturally, thereby introducing uncertainty into the test. In addition, use of ultraviolet light can increase the risk of skin cancer and eye damage; therefore, a qualified health professional should assess the benefits and risks associated with ultraviolet light prior to its use.

### Wipe Sampling

Wipe testing provides after-the-response information on the effectiveness of decontamination. In this procedure, a dry or wet cloth, glass fiber filter paper, or swab is wiped over the surface of the potentially contaminated object and then analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be sampled separately. Skin contamination may also be evaluated using wipe samples.

### Cleaning Solution Analysis

Another way to test the effectiveness of decontamination procedures is to analyze for contaminants in the used cleaning solutions. Elevated levels of contaminants in the final rinse solution may suggest that additional cleaning and rinsing are needed.

### Testing for Permeation

Testing for the presence of permeated chemical contaminants requires that pieces of the protective garments be sent to a laboratory for analysis.

## **Decontamination of Equipment and Breathing Apparatus**

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Decontamination of equipment is an important method of controlling the spread of hazardous substances and preventing deterioration of the equipment.

- **Monitors** - If monitoring equipment becomes contaminated, it will require special cleaning. The manufacturer or local/regional government agencies can provide information on proper decontamination methods.
- **Tools** - Metal tools should be cleaned, as appropriate by chemical or physical means. EPA regional laboratories may be consulted for specific methods to decontaminate tools. Wooden tools and tools with wooden handles are difficult to decontaminate because they absorb chemicals. Wooden tools should be discarded if contamination is suspected.

**Respirators and SCBAs** - Certain parts of contaminated respirators and SCBAs, such as the harness assembly and leather or fabric components are difficult to decontaminate. If grossly contaminated, they may be discarded rather than implement costly decon. Rubber components can be soaked in soap and water and scrubbed with a brush depending on the contaminant. All parts of the respirator should be decontaminated and maintained according to manufacturer recommendations. Persons responsible for decontaminating respirators should be thoroughly trained in respirator cleaning and inspection.

### **Containing Contaminated Solutions**

Contaminated wash and rinse solutions are contained by using step-in containers to hold spent solutions, or other methods of containment.

### **Disposal of Contaminated Materials**

All contaminated material, equipment and spent solutions must be segregated and placed in properly selected and labeled drums/containers for disposal according to local, state, and federal regulations.

## **Other Considerations**

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### **Protecting those on the Decontamination Line**

Personnel stationed in the warm zone to decontaminate those who have performed duties in the hot zone must be protected from exposure. Those at the beginning of the line (closest to the Hot Zone) may require more protection from contaminants than those assigned to the last station in the decontamination line. These workers on the decontamination line generally wear protection one level below that of personnel in the Hot Zone. For example, if Level B is worn in the Hot Zone, Level C may be appropriate

for those in the CRZ. However, in some cases, decontamination personnel use the same level of PPE as is worn in the Hot Zone. The selection of the PPE for the decon line workers is detailed in the ERP. Decon line personnel go through appropriate decon after everyone from the hot zone has been deconned.

### **Safety Precautions for Decontamination**

- Decontamination solutions must be compatible with the hazardous substances being removed to prevent a reaction which could produce an explosion, heat, or toxic products
- Include adequate personnel to help each person through the line
- If plastic sheeting is used or other slippery surfaces may be encountered, “gripper” decals or other material should be used to reduce the likelihood of slips
- Provide handholds while boots are being washed or boot covers removed
- Provide stools (not wooden unless they will be disposed of after the response) for personnel to sit on at stations where boots or suits are removed
- Shower and change rooms provided outside of a contaminated area must meet the requirements of OSHA 29 CFR 1910.141
- Unauthorized employees must not remove contaminated protective clothing or equipment from the decon line areas to avoid the spread of contamination

### **Protecting Decontamination Line Workers**

Emergency responders may be stationed in the CRZ to assist in decontaminating those who have performed duties in the Exclusion Zone. Decontamination workers at the beginning of the line (closest to the Hot Zone) will require more protection from contaminants than decontamination workers who are assigned to the last station in the decontamination line. The workers on the decontamination line generally wear protection, one level below that of personnel in the Hot Zone. For example, if Level B is worn in the Hot Zone, Level C may be appropriate for decontamination workers. In some cases, decontamination personnel should wear the same levels of PPE as workers in the Hot Zone. All decontamination personnel must be decontaminated before re-entering the Cold Zone. The emergency response plan should specify the level of PPE to be worn at all positions by decon line workers.

### **Decontamination of Equipment and Breathing Apparatus**

Decontamination of equipment is an important method of controlling the spread of hazardous substances and preventing deterioration of the equipment.

**Monitors** - If monitoring equipment becomes contaminated, it will require special cleaning. The manufacturer or local/regional government agencies can provide information on proper decontamination methods.

**Tools** - Metal tools should be cleaned, as appropriate, by chemical or physical means. EPA regional laboratories may be consulted for specific methods to decontaminate tools. Wooden tools and tools with wooden handles are difficult to decontaminate because they absorb chemicals. Wooden tools should be discarded if contamination is suspected.

**Respirators and SCBAs** - certain parts of contaminated respirators and SCBAs, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush depending on the contaminant. Regulators must be maintained according to the manufacturer's recommendations. Persons responsible for decontaminating respirators should be thoroughly trained in respirator maintenance. The safety and health plan must detail the methods to be used to decontaminate respirators and SCBAs.

### **Preventing Spread of Contamination**

Contaminated wash and rinse solutions must be contained by using step-in containers to hold spent solutions or other methods of containment. Tools that were used in the Exclusion Zone must not be removed without proper decontamination.

### **Disposal of Contaminated Materials**

All contaminated material and equipment used for decontamination must be disposed of. Clothing, tools, buckets, brushes, and any other contaminated equipment must be secured in drums or other containers and properly labeled. The spent solutions must be transferred to drums which are appropriately labeled and disposed of according to local, state, and federal regulations.

## **Suit-up and Decontamination Lab**

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During this lab you will have an opportunity to review inspection and maintenance of PPE, suit-up into Level A or B PPE, go through a decon line, and perform the activities of a decon line worker.

For this lab you will be teamed up with a buddy. Be sure to go through all activities with this buddy. At each station you will complete a checklist after you have finished the tasks assigned by the station leader. When you have completed the checklist, have the station leader sign it.



- 5. Did you check the by-pass valve?.....  Yes  No
- 6. Did your buddy ask if you could breathe okay before your suit was closed?..... Yes  No



Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Suit-up & Decon Lab Performance Checklist (cont.) Donning and Doffing Level A**

**Hooked to Air in Level A**

- 7. Did your buddy check your suit's sealing points (zipper, cuff, etc.) after your suit was closed? .....  Yes  No
- 8. Did you and your buddy review the communications system after your suit was closed?  Yes  No
- 9. Did you withdraw your hand from the sleeve of the suit and turn on the SCBA emergency by-pass valve? .....  Yes  No
- 10. Did you have to withdraw your hand and defog your face shield? .....  Yes  No
- 11. Did you do an assigned task? .....  Yes  No

If yes, describe the defects:

\_\_\_\_\_

**Doffing the Equipment**

- 12. Did you touch the outside of your suit as it was being removed?.....  Yes  No
- 13. Did you properly remove your inner gloves? .....  Yes  No
- 14. Did you dry your suit as instructed? .....  Yes  No
- 15. After doffing the SCBA, did you:
  - a. Extend the harness straps? .....  Yes  No
  - b. Extend the facepiece straps? .....  Yes  No
  - c. Clean the facepiece? .....  Yes  No

- 16. Did the cylinder need to be changed? .....  Yes  No

If yes, did you change it or have it changed? .....  Yes  No

- 17. How long did you stay in Level A?..... Minutes \_\_\_\_\_

Date \_\_\_\_\_ Station Leader's Signature \_\_\_\_\_

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Suit-up & Decon Lab Performance Checklist Donning and Doffing Level B**

1. List the size that you chose for all of the following equipment. If you did not wear the listed equipment, put an "X" on the line.

- a. SCBA Facepiece Size Brand \_\_\_\_\_
- b. Boots Size
- c. Inner Gloves Size
- d. Outer Gloves Size
- e. Chemical-Protective Clothing Size  
1-piece \_\_\_\_\_, 2-piece \_\_\_\_\_
- f. Hard Hat Adjustable

List any equipment for which you could not find a proper size and state whether you needed a larger or smaller size.

Type of Equipment \_\_\_\_\_ Size

\_\_\_\_\_

Type of Equipment \_\_\_\_\_ Size

\_\_\_\_\_

Type of Equipment \_\_\_\_\_ Size

\_\_\_\_\_

2. Did you inspect the equipment before donning it? .....  Yes  No

3. Did your buddy:

a. Make pull tabs when taping your boots/pants? .....  Yes  No

b. Make pull tabs when taping your gloves/sleeves? .....  Yes  No

- c. Review the communications system with you?.....  Yes  No
- 4. Did you do an assigned task? .....  Yes  No

If yes, describe the task:

- 5. After doffing the SCBA, did you:
  - a. Extend the harness straps? .....  Yes  No
  - b. Extend the facepiece straps?.....  Yes  No
  - c. Clean the facepiece? .....  Yes  No
  - d. Check the cylinder? .....  Yes  No

If yes, did the cylinder need to be changed? .....  Yes  No

If yes, did you change it or have it changed?.....  Yes  No

- 6. Did the cylinder need to be changed? .....  Yes  No

If yes, did you change it or have it changed? .....  Yes  No

- 7. How long did you stay in Level B?..... Minutes \_\_\_\_\_

Date \_\_\_\_\_ Station Leader's Signature \_\_\_\_\_

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Suit-up & Decon Lab Performance Checklist Donning and Doffing Level C**

1. List the size that you chose for all of the following equipment. If you did not wear the listed equipment, put an "X" on the line.

- a. Chemical-protective clothing                      Size\_\_\_\_                      Brand \_\_\_\_\_  
1-piece \_\_\_\_\_, 2-piece \_\_\_\_\_
- b. Air-purifying respirator                              Size\_\_\_\_                      Brand \_\_\_\_\_
- c. Boots    Size\_\_\_\_
- d. Inner gloves    Size\_\_\_\_
- e. Outer gloves    Size\_\_\_\_
- f. Hard hat    Size\_\_\_\_

List any equipment for which you could not find a proper size, and state whether you needed a larger or smaller size.

- Type of Equipment \_\_\_\_\_                      Size \_\_\_\_\_
- Type of Equipment \_\_\_\_\_                      Size \_\_\_\_\_
- Type of Equipment \_\_\_\_\_                      Size \_\_\_\_\_

- 2. Did you inspect the equipment before donning it?.....  Yes       No
- 3. Did you and your buddy:
  - a. Make pull tabs when taping your boots/pants? .....  Yes       No
  - b. Make pull tabs when taping your gloves/sleeves? .....  Yes       No
  - c. Review the communications system with you? .....  Yes       No
- 4. Did you do an assigned task? .....  Yes       No

If yes, describe the task: \_\_\_\_\_

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Suit-up & Decon Lab Performance Checklist (cont.): Donning and Doffing Level C**

- 5. Did you take off the suit in a manner that would protect you and the other workers around you from contamination?.....  Yes  No
- 6. Did you properly remove your inner gloves? .....  Yes  No
- 7. When removing your respirator, were you wearing inner gloves? .....  Yes  No
- 8. After removing your respirator:
  - a. Did you extend your facepiece straps? .....  Yes  No
  - b. Did you wash the respirator? .....  Yes  No
- 9. How long did you stay in Level C? ..... \_\_\_\_\_ Minutes

Date \_\_\_\_\_ Station Leader's Signature \_\_\_\_\_

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Suit-up & Decon Lab Performance Checklist Inspection and Maintenance of PPE**

1. Did the instructor tell you how to wash your respirator?       Yes    No
2. Did you clean your respirator?       Yes    No
3. Were inspection procedures described for:
  - a. Boots?    Yes    No
  - b. Outer gloves?    Yes    No
  - c. Hard hats?       Yes    No
  - d. Reusable suits?  Yes    No
4. Did someone in your lab inspect a glove?       Yes    No
5. Did he/she find defects in the glove?  Yes    No

If yes, describe the defects:  
\_\_\_\_\_

6. Did someone in your lab inspect a reusable suit?  Yes       No
7. Did he/she find defects in the reusable suit?  Yes    No

If yes, describe the defects:  
\_\_\_\_\_

8. Did you observe the leak-test procedure for a Level A suit?  Yes       No
9. Did you see the repair kit for the Level A suit?  Yes       No

Date \_\_\_\_\_ Station Leader's Signature \_\_\_\_\_

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Suit-up & Decon Lab Performance Checklist Decontamination Line**

Think about when you were on the decon line, then answer the following questions by checking the appropriate box.

Was all of the needed decon equipment assembled?     Yes    NoWas the decon team ready when the work team arrived?    Yes    NoDid all of the equipment work properly?    Yes    NoWere the decon workers wearing appropriate level(s) of protection?     Yes    NoDid the decon team stay in communication with the work team?    Yes    NoDid the work team follow the decon team's instructions?    Yes    NoWere all work team members fully decontaminated?     Yes    NoWere wastewater and materials controlled?     Yes    NoWere the reusable supplies and equipment decontaminated?     Yes    No10. Did the decon team decontaminate themselves before leaving the area?    Yes    No

Date \_\_\_\_\_ Station Leader's Signature \_\_\_\_\_

## Summary - Decontamination

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Decontamination is important for preventing the spread of hazardous materials beyond the scene of the incident. Proper procedures must be developed before an incident occurs. Precautions should be taken to prevent contamination of personnel and expensive equipment, such as monitors. During the size-up of an incident, work zones should be established according to the ERP to control the spread of contaminants.

There are three zones:

- The **Hot Zone** is the area immediately contaminated by the spill or release. Only personnel in the highest level of PPE should be in this zone
- The **Warm Zone or Contamination Reduction Zone (CRZ)** is the area where decontamination occurs
- The **Cold Zone or Support Zone** is the area where there is no contamination and support activities occur

Methods to decontaminate personnel, PPE, and other equipment will vary depending on the type of incident. Basic methods include:

- Rinsing or dissolving
- Scraping, brushing, and wiping
- Evaporation then rinsing
- Using surfactants like soap
- Chemical disinfection
- Combinations of the above methods

The decontamination line is:

- An organized series of procedures
- Performed in a specific sequence
- Used to reduce levels of contamination on personnel, PPE, and equipment
- In operation until no contaminant is present

Each procedure is performed at a separate station. Stations are arranged in order of decreasing contamination, preferably in a straight line.

All personnel working the decon line must be decontaminated before leaving the CRZ. All decon equipment must be decontaminated or disposed of properly.

When decontamination is incomplete or not possible, the materials must be disposed of appropriately. All decon procedures are described in the ERP.



**Review Questions**

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1. Why is it important to decontaminate personnel, PPE, and other equipment before re-entering the clean zone?

2. How can contamination be prevented?

3. Describe the basic activities in each zone.

4. What are some basic decontamination methods?

## **WORK PRACTICES**

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Some work practices for the operations-level first responder are outlined in this chapter. To respond effectively to a spill or release, an emergency responder needs to learn specific skills and use safe work practices. Standard Operating Procedures (SOPs) are written instructions for safe work practices that are site specific.

### **Chapter Objectives**

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

- Identify general work practices required for confined space entry, lockout and fire protection
- Identify information required for sizing up (hazards and risk assessment) the scene of a hazardous materials emergency
- Identify work practices that may be performed at the Operations Level
- Demonstrate one or more of the following techniques: absorbing, diking, diverting, blocking

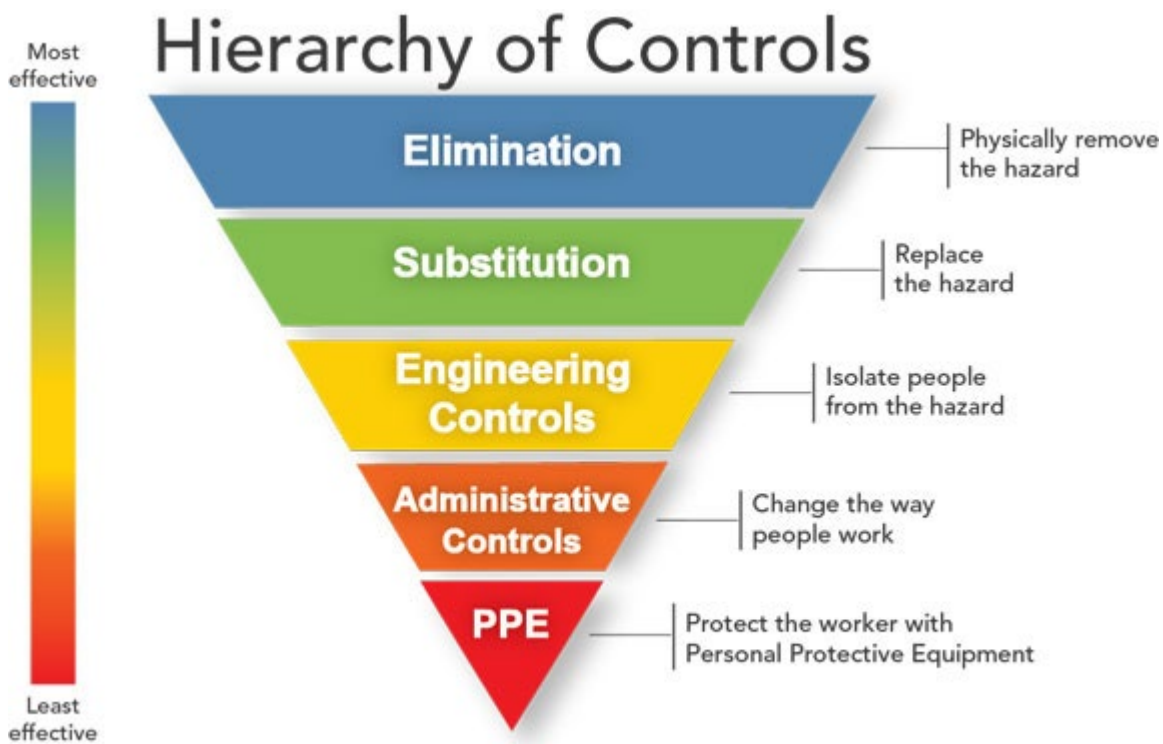
Before describing Work Practices, the hierarchy of controls used for workplace hazards is presented.

## **Types of Hazard Control**

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### **Hierarchy of Controls**

The hierarchy of controls refers to the preferred methods of hazard control. Traditionally, in order from most-preferred to least-preferred, they are:



source: <https://www.cdc.gov/niosh/topics/hierarchy/default.html>

During an emergency response it is not possible to eliminate all hazards. However, a range of controls can be employed. The hierarchy can also be used to reduce hazards during routine operations, reducing the hazard if a material is released.

**Elimination**

Disconnecting power during an emergency (eliminating electrical hazards) is one example.

**Substitution**

Using a 'green' pesticide made from household chemicals to eradicate poison ivy near the storage area (where there is potential for a release) would reduce chemical exposure to the applicators while reducing risk of contact by a responder.

**Modify**

When practices are changed to no longer require entry into a confined space a modification has reduced the potential exposure.

**Contain**

Double sided tanks provide added ability to contain a material, and reduce the potential for a release that is an emergency

**Ventilate**

Removing solvent vapors prior to a confined space entry using mechanical exhaust is an example of ventilation.

**Work Practice Change**

Adding a sign-off during chemical delivery to assure that the material is going to the proper receptacle a change in the work practice.

**Personal Protective Equipment**

When the above controls are not possible, personal protective equipment is used.

**Hazard controls are further defined as Engineering or Administrative.**

When engineering controls are used to control hazards, a piece of technology is used to reduce exposure. Examples include having an air-conditioned control rooms for chemical operators to reduce employee heat exposure and shielding to reduce radiation exposures. When use of confined space entry permitting process is the only way of accomplishing a task, a ventilation fan is used to provide fresh breathing air inside the confined space, helping to reduce the risk. Ventilation is a commonly-used engineering control.

Administrative controls are policies and practices written before the work begins to minimize exposure to chemical and physical hazards. Examples include industrial hygiene monitoring

programs, medical surveillance programs, confined space entry and hot-work permits and policies, and lock-out procedures. Other examples are work plans limiting the duration of exposure (e.g., to noise and radiation), developing a written plan describing the maintenance of protective clothing, and implementing specific work practices which reduce or prevent exposure. All of these controls are examples of a universal Standard Operating Guideline (SOG). At your worksite, hazards are addressed with site-specific Standard Operating Procedures (SOPs).

## **Standard Operating Procedures**

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Standard Operating Procedures (SOPs) are carefully planned and detailed written work instructions intended to provide workers with necessary guidelines to carry out work tasks safely. Some SOPs are used in routine plant operations; others provide guidelines for actions that should and should not be taken during an emergency.

In this program we may use the term Standard Operating Guide (SOG) - generic guidance on how to do a task.

### **Routine SOPs**

Workers are guided by company-specific SOPs while performing their regular work tasks. Examples of some areas covered by SOPs are:

- Confined space entry
- Lock-out
- Fire prevention

Some of these SOPs will also be helpful to the emergency responder.

### **SOGs for training only**

Some common topics included in a safe work practice for each of these tasks are described in the following pages and are considered SOGs. These SOGs are not adequate information to conduct the activities; plant-specific training is required for competency.

### **Confined Space Entry Procedures**

A confined space generally has three distinct properties which set it apart from other areas and dramatically increase the risk of injury or illness.

#### Properties of Confined Spaces

- Is large enough and so configured that an employee can bodily enter and perform assigned work

- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry)
- Is not designed for continuous employee occupancy

Some common confined spaces that are found at manufacturing facilities include, but are not limited to:

- Ditches, culverts, and ravines
- Excavations and trenches
- Tank cars
- Vaults
- Sewer systems with manhole entrances
- Vats
- Tanks

The OSHA Permit-Required Confined Space Entry Standard (29 CFR 1910.146) requires that the employer survey all confined spaces and designate those for which a permit is required. Remember that in an emergency, the hazards of a space may change. For example, a ditch not usually containing any hazard could be a catch basin for spilled material. Although not designated a permit-required confined space, it has become one as a result of the release.

A permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

- Contains or may contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section
- Contains any other recognized serious safety or health hazard

All personnel must be informed of the hazards before entry.

Entry into confined spaces poses many dangers. Chemical vapors can accumulate quickly in confined spaces. A confined space might also contain a material that could trap a worker or a moving part that could trap or injure. Entry into confined spaces may block your view of what else is happening around you.

Lack of natural ventilation makes it easier for toxic or flammable materials to accumulate. Something as simple as rusting metal or the operation of fuel-powered engines can deplete

the existing oxygen supply. Decaying organic materials such as plants or animals can create hydrogen sulfide gas.

Many toxic gases don't have any warning properties, so emergency responders about to enter the confined space have no way of knowing what hazards they might face without first testing the air. The most common confined space injuries are asphyxiation from lack of oxygen, being overcome by very high concentrations of toxic vapors, or rapid skin absorption of organic solvents.

Other common confined space hazards involve explosions or fires. Getting in and out of a confined space can cause injuries and hinder rescue efforts in emergencies. Responders who may be required to rescue victims must be provided training in the types of spaces at the facility and perform a simulated rescue annually.

Several steps must be taken to make work safer in confined spaces. Careful advance planning for confined space entry can help minimize the risk of injury. This advance planning must include the following points:

- Identifying confined spaces. (Determine which require a permit to enter.)
- Developing written standard operating procedures (SOPs)
- Arranging for and strategically locating adequate supplies of air-supplying respirators and protective and life-saving equipment
- Training personnel who must enter permit-required confined spaces to deal with emergency events
- Training personnel how to monitor and properly safeguard the space before and during entry
- Posting a qualified and trained safety attendant who is ready to provide assistance, if required, outside the confined space entrance at all times
- Training personnel to recognize when the hazards of a confined space may have changed

The hazards of confined space entry are further reduced by:

- Monitoring confined spaces before entry and during work for oxygen deficiency and flammable or toxic atmospheres. Monitoring must be conducted throughout the space, not just at the entry point.
- Providing appropriate ventilation before and during the work.
- Complying with the permit and logging system. Under this system, confined space entry is permitted only after information about oxygen and toxic and flammable vapor levels has been collected. The permit must be signed by a properly trained supervisor. No personnel can enter the confined space without a signed entry permit. Permits are valid only for a specific date, time, and place.

A confined space entry standard operating procedure (SOP) minimizes danger by trying to control factors that may cause or contribute to accidents or emergencies through careful monitoring, training, and planning. These required SOP's are an administrative control.

### **Lock-out Procedures**

**Lock-out** procedures are used to prevent injury during the repair of mechanical equipment. The equipment is locked out of operation so that it will not be turned on by someone who is unaware of the activity of another responder.

Know the site lock-out procedure before attempting any operation.

Never assume a machine, circuit, or pipe is locked out just because it should be.

### **When in doubt, lock it out!**

Common examples of equipment requiring lock-out include the following:

- Electrical junction boxes
- Pipes with liquid, steam, etc.
- Mechanical equipment with moving parts (grinders, crushers, pulverizers, hydraulics)
- Spring-loaded or -activated devices

The risk of ignition of flammable materials and electrocution is lessened by locking out an electrical circuit. Locking out a steam or hot water pipe may cut off a transmission path for vapors or fumes and prevent burns or accidental contact with the contents of the piping system.

Lock-out requirements are described in 29 CFR 1910.147, The Control of Hazardous Energy (Lock-Out/Tag-Out).



**Example of a lock-out tag:**

# LOCKED OUT

This tag must always be used and completely filled out before it is used.

**Do Not Start!    Do Not Open!    Do Not Close!    Do Not Energize!    Do Not Operate!**

1. Employee name \_\_\_\_\_

2. Date lock placed

3. Time lock placed

4. Was starter pushed to determine equipment to be worked on did de-energize?  
Yes  No

5. Has the undersigned verified that the correct main breaker has been locked out?  
Yes  No

6. Has the equipment been isolated from other energy systems such as hydraulic or pneumatic which could endanger others?  
Yes  No

Comments \_\_\_\_\_

The following list identifies the minimum recommended procedures for lock-out.

- Get lock-out approval/permit (lock-out tag).
- The first person to work on a piece of equipment should be sure the primary power source is turned off and install a personal lock with a lock-out clamp. This clamp must be installed so that the disconnect cannot be turned on with the clamp and lock in place. The switch is then activated to see if the circuit is truly de-energized. (This will also bleed off any stored energy.)
- Each person who works on the equipment must go through the standard process described above.
- Each person must remove his or her lock after completing the job and all personnel are out of the danger area. After the last lock and clamp are removed, the warning tag can be removed and the equipment re-energized.
- A lock must be removed only by the person who installed it. Any exceptions are detailed in the SOP and must be included in the site-specific training.
- Critique any problems and revise the SOP.
- Annually, review and update the SOP if needed.

Failure to follow lock-out procedures may result in an emergency immediately hazardous to life and property. Hazards to responders' safety and health when the lock-out policy is not followed include electrocution; chemical or other burns; or being caught in or crushed by mechanical, pneumatic, or other moving parts.



**Typical Lock-Out Device with Multiple Locks**

## Fire Prevention

Although it is necessary to monitor for the presence of flammable vapors, constant attention must also be given to preventing fires and explosions. Prevention is the responsibility of both the employer and the employee.

### **Employer Responsibilities for Fire Prevention**

- Maintaining adequate supplies of fire-extinguishing media appropriate for the hazards
- Making certain that fire-extinguishing equipment and supplies are properly positioned
- Ensuring that responsible fire brigade crews are adequately trained to use the specific firefighting equipment and supplies for the hazards which may be present
- Conducting routine evacuation and fire-response drills
- Conducting frequent walk-through inspections for fire safety purposes
- Inspecting fire-suppression equipment routinely
- Posting evacuation routes
- Training personnel in hazard recognition
- Handling and storing compressed gases properly

### **Worker Responsibilities for Fire Prevention**

- Using non-sparking tools
- Observing no-smoking rules
- Using non-sparking radios and other electrical equipment
- Following other reasonable rules to reduce the possibility of fire

## **SOPs needed for Emergencies**

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The primary SOP for emergencies is the Emergency Response Plan (ERP). The full listing of parts of the ERP was shown in the Program Introduction.

Each of these parts of the ERP are described briefly below.

### **Pre-Emergency Planning and Coordination with outside parties**

Advance planning for emergencies is important for effective emergency response. Planning activities may include:

- Identifying potential emergency situations, such as:
  - Chemical releases
  - Machinery failure
  - Fire or explosion
  - Physical plant failure
  - Weather events
  - Power outage
  - Injury or illness requiring outside help
  - Events at nearby facilities (industrial, water treatment, power generation)
  - Release on highway
- Developing procedures and a detailed emergency response plan
  - Identifying names and contact numbers for local resources
  - Identifying procedures to be followed for each anticipated emergency
  - Training
  - Developing a protocol for updating the plan.
- Coordinating with emergency service organizations such as the fire department, police department, hospital, and local emergency planning committee (LEPC).
- Drills, internal and without side service organizations

## **Personnel Roles, Lines of Authority, Training, and Communication**

A structured system of authority and communication referred to as the Incident Command System (ICS) is used to respond efficiently and effectively to an emergency. The lines of authority and reporting are known to all. Each person must have clearly defined functions and be adequately trained to perform the specified duties. Methods of communication appropriate for the response activities must be in place. Details of the ICS, training and communication are covered in the Emergency Response Plan section of this program.

## **Emergency Recognition and Prevention**

Pre-emergency planning through the ERP will prepare team members to quickly size-up the scene if an emergency occurs. Information gained during size-up will be used to plan response actions such as evacuation, control of the situation, and clean-up. During risk assessment (size-up), the emergency response team needs to determine:

- The source and size of the spill or release
- The immediate effects of the spill or release
- Characteristics of the scene
- Preliminary identification of the material, if possible
- Potential hazards

Many factors should be considered in evaluating the source and size of the spill or release. Usually the source can be directly observed, but sometimes it will not be obvious. For example, a pool of liquid on the loading dock may have come from a drum that has already been shipped. It may be difficult to pinpoint the location of a leaking pipe in an area where a number of pipes are grouped together.

The **size** of the spill or release should be estimated. Container size can predict the total quantity which may be spilled. The actual quantity of the spill will be affected by a number of factors, including the size of the hole and its location. For example, a puncture of an upright 55-gallon drum halfway up the side will not likely release more than 30 gallons of a material, because the level of the liquid will be lower than the hole.

The **immediate effects** of the spill or release should be observed as part of sizing up the situation. Gather as much information as possible about how the spill has affected people and property. Sample questions which might be asked are shown below.

- Has the chemical affected workers in the immediate area?
- Is the air discolored?
- Is there an unusual smell?
- Has the chemical burned or discolored the floor or gravel?

- Are there any signs of reactions taking place?

The **characteristics of the scene** may affect the extent of the potential damage and the response. Some important questions that might be asked about the scene are shown below.

- Which way will the spill drain or flow?
- Is there access to sewers, drain ditches, sumps, or culverts?
- Are there electrical or ignition sources nearby (such as boilers, transformers)?
- Are there people in the area? How many?
- If the incident is outside:
  - What is the wind direction and strength?
  - Are there nearby waterways?
- If the incident is inside, how might the plant ventilation system affect the movement of vapors or fumes?

The **preliminary identification** of the material will also affect the choice of response action. Pre-emergency planning can be very helpful here. Some clues to identifying the materials include:

- Placards or labels
- Shipping papers
- Physical characteristics: color; state (solid, liquid, gas)
- Monitoring results

With information about the source and size of the spill, its immediate effects, the scene's characteristics, and the preliminary identification of the material involved, it is possible to assess the potential hazards to life and property. If the material is identified, information about fire, reactivity, and health hazards of the material can be found from the placard or labeling system, an SDS, or shipping papers. All members of the emergency response team should understand the hazards of the situation before the response proceeds.

### **Safe Distances and Places of Refuge**

The Incident Commander will determine safe distances. The pre-entry briefing will include locations of refuge.

### **Site Security and Control**

Site security and control is managed through the Incident Command System (ICS).

## **Evacuation Routes and Procedures**

The ERP must describe conditions requiring an evacuation, who can authorize an evacuation and how it should be done. The ERP should specify evacuation routes, alarm or communication systems that will be used, and the gathering place for those who evacuate.

## **Decontamination**

Prevention of spread of the hazard includes removing the contamination from protective clothing and equipment. A description of SOPs for decontamination activities is included in the Decontamination section of this manual.

## **Emergency Medical Treatment and First Aid**

The ERP must specify who can provide emergency medical treatment and First Aid. Certified training in these topics is needed to qualify those who will provide emergency medical treatment or First Aid. Each emergency responder must know who to notify, should medical treatment be needed. Specific training in emergency medical treatment and First Aid is outside the scope of this program.

## **Emergency Alerting and Response Procedures**

### Alerting

A system must be in place to alert workers of the emergency condition.

### Response Procedures for Operations-level First Responders

Many options exist for emergency response. The type of response will be determined not only by the material and the scene characteristics, but also by the training level of available response personnel, available PPE and ER equipment and supplies, and the specifics of the ERP.

This section describes some of the response actions which may be taken by an operations-level first responder.

According to HAZWOPER, an operations-level first responder is one who will respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of **protecting nearby persons, property or the environment** from the effects of the release (Emphasis added, OSHA Standard 1910.120(q)(6)(ii)).

HAZWOPER also requires that operations-level first responders respond in a “defensive fashion without actually trying to stop a release.” (1910.120 (q) (6) (ii)). The release should therefore be contained from a safe distance and kept from spreading. Prevention of exposure to the material is an important consideration. More aggressive actions should be

attempted only by responders trained at or above the Hazardous Materials Technician level.

**Basic control** is the first step to prevent further release. This step may include shutting off a valve or shutting off a piece of machinery or system from a remote location. Other situations defined in the ERP may call for the responder to shut off valves/machinery at the incident scene. (Generally, the operator will shut down the process before the response team arrives.)

**Containment** includes those procedures taken to keep a material in its container. For the operations-level first responders, containment activities will generally not be undertaken except to assist the HazMat Technician from an area away from the release.

**Confinement** includes those procedures taken to keep a material in a defined area. These activities will vary from plant to plant and will be determined by the ERP. The operations-level first responder may confine a spill or release by: (a) diking, (b) blocking, (c) absorption, and/or (d) collection.

**Diking** - Dikes may be built of sand, earth, straw, sorbent, or similar materials around the perimeter of the leak. The type of diking material used must be compatible with the spill material. Plastic sheeting can be used as an additional barrier to slow leakage, if appropriate.

**Blocking** - Drains, ditches, or storm sewers should be covered and blocked to prevent run-off of spill materials. This blocking can be done with a sorbent pad, a piece of plastic, or a rubber pad. If flammable or toxic materials enter these systems, the potential for damage to property or people is increased.

**Absorption** - Run-off can sometimes be absorbed with dirt, sand, soda ash, sawdust, wood chips, peat moss, vermiculite, or other material. The sorbent materials should be positioned so that spill material runs into it. Care must be taken to be certain that the absorbent is compatible with the spill.

**Collection** - Run-off can also be collected in containers such as drums or buckets.

Specific methods of control, containment, and confinement at a plant should be outlined in the ERP. These methods should be consistent with response team members' levels of training.

### **Critique of Response and Follow-up**

Supplies should be restocked and stored and equipment inspected and recharged as soon as possible to prepare for any future use. Following a response, the person in charge should conduct a meeting to critique the response. Each step of the response from size-up to termination, should be reviewed. This discussion may suggest ways to improve pre-



planning, including the need for additional equipment, resources, training, or revisions in the ERP.

### **Termination Procedures**

Termination procedures are the actions which close out an emergency response. These procedures may involve transfer of responsibility to an outside responder or clean-up contractor, decontamination of equipment and PPE, and disposal of hazardous wastes. Termination procedures may also address those internal and external reports that need to be filed and filing deadlines. Personal notes or copies of reports, if available, may be useful for future reference. The procedures which will involve operations-level responders should be included in the ERP.

## Personal Protective Equipment and Emergency Equipment

The type and amount of emergency response equipment will be determined during preplanning. Specific hazards in the plant, the scope of response by personnel, and the level of training will be determining factors. The following are some examples of typical equipment and supplies that operations-level first-response team members might use:

### Communication Gear

- Hand-held radio

### Recordkeeping and Related supplies

- Paper and note pads
- Pens, pencils, markers
- Clipboards
- Green marking tape (perimeter)
- “Restricted Area” signs

### Tools, Supplies, and Equipment

- Portable wash unit
- Disposable towels
- Detergent
- Plastic drop sheet
- Clean water supply
- Duct tape
- Wrecking bar (non-sparking, 30” x 3/4”.)
- Shovel (D handle, round point, non-sparking)
- Garden hose (50 ft., 5/8” in. ID)
- Scrub brushes
- Plastic buckets
- Plastic garbage cans
- Diking materials
- Heavy plastic sealing mat

### Monitoring and Observation Equipment

- Combustible-gas indicator
- Oxygen meters
- Specific gas detectors

### Respiratory and Personal Protective Equipment

- Positive-pressure, self-contained breathing apparatus with extra air cylinder
- Full-face, air-purifying respirators with appropriate canisters
- Fit testing equipment
- Chemical-resistant goggles/face shield
- Anti-fog solution
- PVC disposable gloves
- Neoprene gloves
- Butyl gloves
- Natural rubber gloves
- PVC disposable boots
- Splash suits

### Resource and Reference Materials

- NFPA Guide on Hazardous Materials
- NIOSH/OSHA Pocket Guide to Chemical Substances

**Note:** This list is for training purposes only and is not intended to be comprehensive.

## **Work Practice Lab**

---

This lab is divided into two different sections: a small group exercise and hands-on activities.

The first section of the lab is a small-group activity in which you and other group members will react to and answer questions about a hypothetical incident.

The second section of this lab, hands-on activities, provides an opportunity to practice the techniques of diking and drain-blocking during simulated spills. In order to become ready to perform these activities in a real emergency, additional practice will be required, and the ERP should be read to understand where each of these methods might be used at the plant. The Incident Commander and/or Team Leader will go over this information during the practice sessions.

The hands-on activities will be done by a group, working as a team, just as if an emergency had occurred. For each hands-on activity there is a list of available equipment and supplies. The group will determine which equipment and supplies to use and then conduct the activity. Each member of the group will complete a performance checklist as a record of the actions taken, materials used, and the results of activity.

You will find more detailed descriptions of each activity and the performance checklists on the following pages.

## **Small Group Activity**

---

**Background:** You are walking to the loading dock when you hear the brakes being set on a semi. You go over to help the driver get the truck ready to unload. As you reach the cab, you notice the driver has already left. You also notice some liquid dripping from the trailer's rear doors.

**Instructions:** Without getting any closer to the scene, how would you answer the following questions? Do not look ahead in the notebook.

1. What information would you want to gather?
  
2. What should you do at this point?

Now you are a member of the response team. The chemical has been identified as **acetone** - a chemical that is routinely received at the plant.

3. What should you know about the chemical?
  
4. What previous training should you have had?

## **Diking and Absorbing Lab**

---

During this lab a spill will be controlled by diking and absorbing the material with available supplies. After finishing this lab you will be better able to:

Demonstrate ability to work at the perimeter of a spill.

- Demonstrate methods of protecting yourself from contamination during a simulation
- Demonstrate how to approach, dike, and absorb a spill
- Evaluate performance during diking/absorbing

The following equipment is available:

- Spill liquid (non-toxic)
- Absorbent materials (absorbent socks, clay chips, dirt/sand, cat litter, etc.)
- Non-sparking tools (shovel, scoop, push broom, etc.)
- Impervious work boots
- Protective clothing, as appropriate
- Waste drums

### **Procedure**

Working in a group, check to make sure that all the necessary equipment is available. Don required protective clothing and determine a strategy for accomplishing the activity. Remember that you want to approach the spill and perform the task in a manner which minimizes the amount of potential contact with the “hazardous material.” When the strategy is determined, go over it with the instructor for this portion of the lab.

Approach the spill in a manner that minimizes your possible exposures. Stand off to one side or at the perimeter of the spill, and set up a dike to control the flow of the spill. Place absorbent material along the dike on the side of the spill to increase confinement efficiency. Remember, operations-level workers are not trained to come into contact with the spill. Clean up of the spill is to be left for technician-level workers. It is, however, your responsibility to take care of your clothing and tools. Consider the disposal of disposable protective clothing, tools, and equipment. Complete the performance checklist on the following page.

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Diking/Absorbing Performance Checklist**

Please answer the following questions by checking the appropriate box.

1. Did the team size up and plan the diking task .....  Yes  No  
Was the chemical identified? .....  Yes  No
2. Were the tools and equipment required for the diking task assembled? .....  Yes  No
3. Was diking/absorbing material used? .....  Yes  No
4. Did the team start to apply the diking material far away enough from the spill? .....  Yes  No
5. Did the teamwork from the edge of the spill inward? .....  Yes  No
6. Was diking/absorbing material handled so as to minimize contact with the spilled chemical? .....  Yes  No
7. Did you make an effort to minimize your contact with the spilled chemical? .....  Yes  No
8. Did you remove your disposable contaminated clothes correctly? .....  Yes  No
9. Did you place your contaminated tools/materials in a barrel? .....  Yes  No
10. Could all tools be decontaminated? .....  Yes  No
11. Did you place your contaminated disposable clothes in a waste barrel? .....  Yes  No
12. If this was a real incident, should you have gone through the decon line? .....  Yes  No

## **Block the Drain Lab**

---

During this lab, a drain will be protected from a spill with available supplies. After finishing this lab, you will be better able to:

- Demonstrate the ability to block a drain to prevent the “spill” from entering
- Demonstrate methods of protecting yourself from contamination during a simulation
- Evaluate performance during a simulation of drain blocking

The following equipment is available:

- Spill liquid (non-toxic)
- Blocking materials (carpet, plastic sheeting, garbage can cover, etc.)
- Non-spark tools (shovel, scoop, push broom, etc.)
- Impervious work boots
- Protective clothing, as appropriate
- Waste drums
- Dirt or other weights

### **Procedure**

Working in a group, check to make sure all the necessary equipment is available. Don the required protective clothing, and determine a strategy for accomplishing the activity. Remember that you want to approach the spill and perform the task in a manner which minimizes the amount of potential contact with the “hazardous material.” When the strategy is determined, go over it with the instructor for this portion of the lab.

Approach the spill. Stand off to one side or at the perimeter of the spill, and place the blocking material over the drain until it is completely covered. Diking may be needed to control the spill, as part of the overall strategy. Initiate the clean-up activity. You must consider the disposal of the disposable protective clothing, tools, and equipment. Remember that clean-up is only performed after the chemical is identified and its properties are known.

Complete the performance checklist on the following page. If time permits, discuss how you would label the waste barrel.

Name \_\_\_\_\_

Buddy's Name \_\_\_\_\_

**Blocking the Drain Performance Checklist**

Please answer the following questions by checking the appropriate box.

- 1. Did the team size up and plan the drain blocking task together?.....  Yes     No
  
- 2. Were the tools and equipment needed for the drain blocking assembled?.....  Yes     No
  
- 3. Did the team select the right tools and equipment for the drain-blocking task? .....  Yes     No
  
- 4. Did you make an effort to minimize your contact with the spilled chemical? .....  Yes     No
  
- 5. Was contaminated drain-blocking material handled so as to minimize contact with team members? .....  Yes     No
  
- 6. Was the dike built ahead of the flow of the spill?.....  Yes     No
  
- 7. Was the sewer grate covered or the dike built around it? .....  Yes     No



## **Summary – Work Practices**

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The hierarchy of controls refers to the preferred methods of hazard control. Traditionally, in order from most-preferred to least-preferred, they are:

- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- PPE

Standard Operating Procedures (SOPs) are routinely used at a work site. Common SOPs include:

- Confined space entry
- Lock-out/tag-out
- Fire prevention

SOPs for emergency response, including clear lines of authority, roles, and communication are described in the Emergency Response Plan (ERP). The SOP includes each of the following topics:

- Pre-Emergency Planning and Coordination with outside parties
- Personnel Roles, Lines of Authority, Training, and Communication
- Emergency Recognition and Prevention
- Safe Distances and Places of Refuge
- Site Security and Control
- Evacuation Routes and Procedures
- Decontamination
- Emergency Medical Treatment and First Aid
- Emergency Alerting and Response Procedures
- Critique of Response and Follow-up

Pre-emergency planning is critical for ensuring the health and safety of the responders and in minimizing damage to property and the environment by assuring that equipment and supplies are available to address anticipated emergencies and to assure that everyone is trained in procedures.

During risk assessment (size-up), the team determines the source and size of the spill or release, the scene characteristics, the preliminary identification of material, the immediate effect, and the potential hazards. Decontamination procedures prevent the spread of contamination; when decontamination of PPE or tools/equipment is not possible, disposal procedures are implemented.

Emergency response procedures at the operations level are defensive - confinement of spilled material. Additional training is required to stop a release at the point of emission.

A post-response critique and follow-up (termination) is performed to improve preplanning and procedures and reduce the potential for a similar occurrence in the future.



6. What is the primary SOP for an emergency response?

7. What “immediate effects” occur at a release or spill?

8. Preliminary identification includes the use of which resources?

9. What are the duties of the operations-level first responder, according to 29 CFR 1910.120 or the ERP at the plant?

10. List an example of basic control.

Containment.

Confinement.

11. Why is a critique of an incident required?

12. What actions can be taken to ensure that the equipment and supplies are ready in case of an emergency?

# **EMERGENCY RESPONSE PLAN**

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The Emergency Response Plan (ERP) contains vital information about procedures to be followed during an emergency situation. This section outlines information which should be found in an ERP. Practice activities for finding information in an ERP are included in this section.

## **Chapter Objectives**

---

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

- Identify the topics that must be covered in the Emergency Response Plan (ERP)
- Identify the roles of key positions in the Incident Command System (ICS)
- Identify response activities that occur in each zone

## **Emergency Response Plan (ERP)**

---

A plan, developed prior to an emergency, is activated when an emergency occurs. This Emergency Response Plan is a detailed, specific set of procedures or SOPs to be followed by trained responders, under the direction of an Incident Commander.

OSHA 1910.120(q)(2) is a list of elements that must be included in the ERP:

The specific topics covered in the ERP are:

- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination procedures
- Emergency medical treatment and First Aid procedures
- Emergency alerting and response procedures
- Critique of response and follow-up
- Personal protective equipment and emergency equipment

Implementation of the ERP is managed through the Incident Management System, as detailed here. A carefully developed ERP with defined personnel roles and lines of authority, training for each function and effective communication will help assure an efficient response that decreases injury to workers and property.

Before looking at an ERP for training purposes only, details on the required section on personnel roles, lines of authority, training and communication are provided.

### Exception to the Requirement for an ERP

Employers who meet all the following conditions are not required by OSHA to have an ERP.

- They evacuate their employees from the workplace when an emergency occurs.
- They do not permit any of their employees to assist in handling the emergency.
- They have already in existence an emergency action plan in accordance with OSHA Standard 1910.38 (Employee Emergency Plans and Fire Prevention Plans).

### Personnel Roles, Lines of Authority, Training and Communication

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#### Incident Command System (ICS)

The Incident Command System is the overall structure for roles (referred to in NIMS as functions) and lines of authority. See [https://www.fema.gov/sites/default/files/2020-07/fema\\_nims\\_doctrine-2017.pdf](https://www.fema.gov/sites/default/files/2020-07/fema_nims_doctrine-2017.pdf)

The ICS includes personnel fulfilling a number of different functions. The number of people involved and their functions depend on the types and nature of emergencies that could occur at a response.

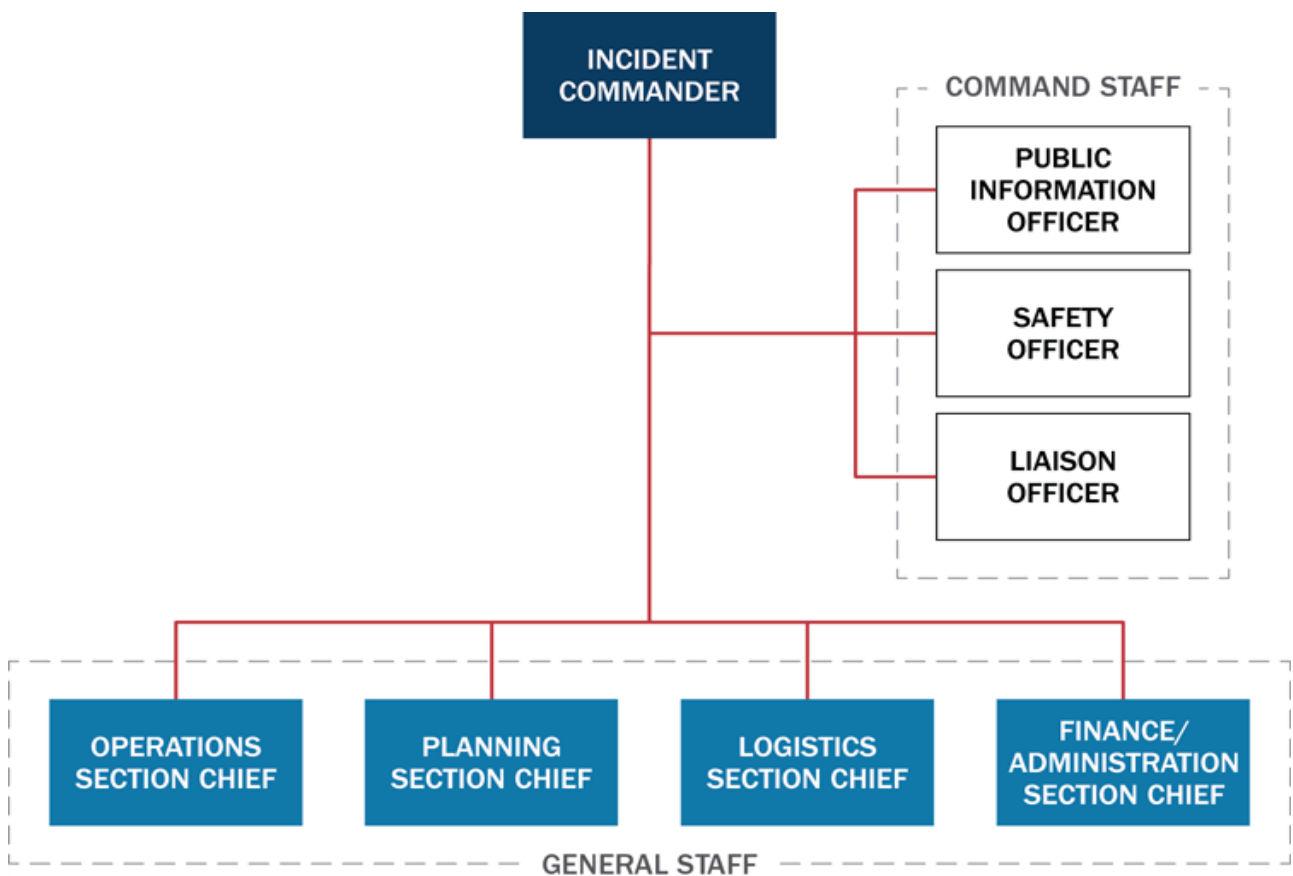
Important functions organized under the ICS include:

- Phone calls, to and from the response location
- Overseeing an assembly area
- Chemical Hazard and Risk Assessment
- PPE selection
- Monitoring needs
- Decon
- 2 in, 2 out
- Communication within the emergency response area
- Entry briefing
  - Written instructions
  - Pictures
- Medical needs and follow up
- Facility control
- Termination



Preplanning, training and practice are required to ensure that each person is prepared for assigned responsibilities in the response. Specialized training may be required depending on expected assigned duties.

An example of an incident command organizational chart is shown below. An example of the structure of a response team follows, using the standard terms in the National Incident Management System (NIMS). This system was promoted after the 9/11 attack where the need for uniform terminology was identified as essential to assure effective communication between parties.



Source: [https://www.fema.gov/sites/default/files/2020-07/fema\\_nims\\_doctrine-2017.pdf](https://www.fema.gov/sites/default/files/2020-07/fema_nims_doctrine-2017.pdf)

Key functions of the Incident Commander (person in charge of a response), and response team members in the Command Staff and General Staff are shown below: (reference under figure above).

### Personnel roles and lines of authority

**Incident Commander** – (The person in charge who oversees all aspects of the response)

Functions:

- Establishes a single Incident Command Post (ICP) for the incident
- Establishes consolidated incident objectives, priorities, and strategic guidance, and updating them every operational period
- Selects a single section chief for each position on the General Staff needed based on current incident priorities
- Establishes a single system for ordering resources
- Approves a consolidated Incident Action Plan (IAP) for each operational period
- Establishes procedures for joint decision making and documentation
- Captures lessons learned and best practices

### **Public Information Officer (PIO)**

Functions:

- Interface with public, media and/or other agencies with information needs
- Gathers, verifies, coordinates and disseminates information to both internal and external parties
- Monitors the media and other sources and provides information to relevant components of the responders
- Releases accurate information concerning the incident after it is cleared by the Incident Commander

### **Safety Officer**

Functions:

- Reports directly to the Incident Commander
- Monitors incident operations
- Advises the IC on health and safety matters of incident personnel
- Establishes the systems and procedures to assess, communicate and mitigate hazardous environments
  - Developing and maintaining the Safety Plan
  - Coordinating safety efforts
  - Implementing measures to promote safety
- Stops or prevents unsafe acts

### **Liaison Officer**

Functions:

- IC's point of contact for representatives from agencies such as fire and law enforcement or other jurisdictions
- Receives input from outside groups to Maintains communication between outside agencies and in-house response
- Point of contact to facilitate coordination of assisting or cooperating agencies or jurisdictions

### **General Staff (see figure above)**

#### **Operations Section, led by Section Chief**

Functions:

- Section Chief appointed by the IC; assigned personnel may change as the incident evolves
- Directing management of tactical activities to achieve objectives established by the IC
- Developing and implementing strategies and tactics to achieve incident objectives
- Section Chief organizes the group to meet the needs, maintain manageable span of control and optimize use of resources
- Supporting Action Plan development for each part of the response

#### **Planning Section, led by Section Chief**

Functions:

- Collect, evaluate and disseminate incident information to the IC or other personnel
- Prepare status reports, display information, maintain the status of resources
- Facilitate the incident action planning process and prepare the incident Plan sing input from other sections and command staff and IC guidance
- Facilitate incident planning meetings
- Record status of resources and anticipated needs
- Collecting, organizing, displaying and disseminating status information and analyzing the situation as it changes
- Planning for the orderly, safe and efficient demobilization of resources
- Collecting, recording and safeguarding incident documents

**Logistic Section, led by Section Chief**

Functions:

- Ordering, receiving, storing/housing and processing incident-related resources
- Providing ground transportation during an incident, maintaining and supplying vehicles, keeping vehicles usage records and developing incident traffic plans
- Setting up, maintaining, securing and demobilizing incident facilities
- Determining food and water needs, including ordering food, providing cooking facilities, maintaining food service areas and managing food security and safety (in cooperation with the Safety Officer)
- Maintaining an incident Communications Plan and acquiring, setting up, issuing, maintaining and accounting for communications and IT equipment
- Providing medical services to incident personnel

**Finance/Administration Section, led by Section Chief**

Functions:

- Tracking costs, analyzing cost data, making estimates and recommending cost savings measures
- Analyzing, reporting and recording financial concerns resulting from property damage, responder injuries or fatalities at the incident
- Managing financial matters concerning leases and vendor contracts
- Managing administrative databases and spreadsheets for analysis and decision making
- Recording time for incident personnel and leased equipment

Additional functions may be integrated into the ICS. For example, in a response that could involve criminal activity, an Intelligence/Investigations Section might be activated by the IC. The basic ICS structure is flexible and can be scaled for more complex incidents, including events that involve multiple geographical or governmental jurisdictions or take place in more than one location.

Response functions are conducted by trained personnel. Training and practice are required to assure that competency in assignments. Training differs for those who will contain materials, confine it to the source, have overall responsibility or provide specialized skills such as those required during response to a chlorine release.

## **Training**

---

These are five distinct levels of training; they should not be confused or substituted (1910.120(q)(6)):

- Awareness
- Operations-Level, First Responder
- Hazardous Materials Technician
- Hazardous Materials Specialist
- On-Scene Incident Commander

Specific duties of responders and the training required are:

### **Awareness Level** (report a release):

- Understand hazardous materials and associated risks
- Understand potential outcomes of emergencies
- Have the ability to recognize hazardous materials
- Identify hazardous materials if possible
- Understand the role of the emergency responder
- Have the ability to contact appropriate personnel

### **Operations Level** (act defensively, away from release):

- Fulfill requirements of Awareness Level
- Know basic hazard and risk assessment techniques
- Select and use proper personal protective equipment that is provided
- Know basic hazardous materials terms
- Know basic control, containment, and/or confinement operations
- Know basic decontamination
- Understand relevant standard operating procedures
- Know termination procedures

### **Technician Level** (offensive actions to stop a release):

- Have fulfilled requirements of Awareness and Operations levels
- Able to implement an emergency response plan
- Can identify, classify, and verify materials using air monitoring instruments and field survey techniques
- Know toxicological terms and behaviors
- Can perform advanced control, containment, and/or confinement operations
- Able to select and decontaminate personal protective equipment

- Understand risk assessment and incident command
- Understand and can implement termination procedures

### **Specialist Level:**

- Have fulfilled requirements of Awareness, Operations, and Technician levels
- Able to implement the local emergency response plan
- Know the state emergency response plan
- Able to develop a site safety and control plan
- Have specialized skills in risk assessment, selection of PPE, control, and containment

### **Incident Commander (lead response):**

- Have fulfilled requirements of Operations level
- Able to implement incident command system and emergency response plan
- Understand hazards for employees working in personal protective equipment
- Know the state emergency response plan and the federal regional response team plan
- Understand the importance of decontamination procedures

### **Communication**

In order to alert all employees of an emergency situation, the employer must establish an alarm system (29 CFR 1910.165). The alarm system must:

- Notify all employees of an emergency
- Result in work being stopped if necessary
- Lower the background noise to speed communication
- Signal the start of emergency procedures

The alarm system must produce a signal (noise, light, or other) that can be perceived by all employees in the affected area of the response. All alarms must be distinct and recognized as signaling a specific action.

Emergency telephone numbers must be posted in conspicuous locations when telephones are used to report. If another communication system is used, the emergency message shall have priority over all other messages. All manually operated warning systems used to supplement the alarm must be unobstructed, conspicuous, and readily accessible for use. The employer shall ensure that all components of the alarm system are approved for the work site and operating properly. After use (for testing or alarm), the system must be

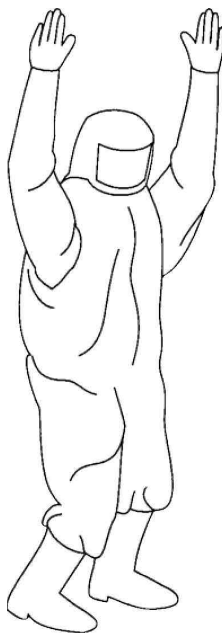
returned to normal operation as soon as possible by the employer. Back-up parts or systems must be available, as appropriate.

The system must be tested at least every two months. If several methods are available to activate the system, a different method must be used for each successive test. The system must be operational at all times, unless undergoing repairs or maintenance. Maintenance work must be done by trained personnel. Systems installed after January 1, 1981 designed to be supervised must be operated as designed and tested annually.

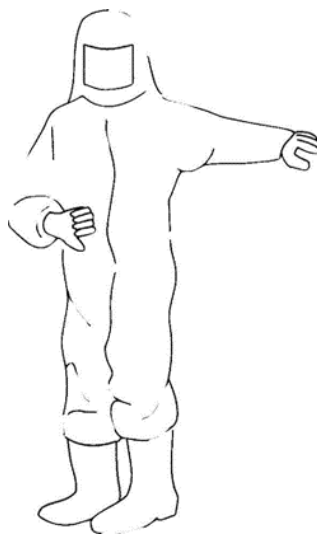
### Communication during an emergency

The “buddy system” is a protective procedure where workers perform in pairs or within close proximity of one another in order to safeguard other’s safety and health. A buddy provides assistance, observes the partner for signs of chemical or heat exposure, periodically checks the integrity of the partner’s protective clothing, and notifies the command post supervisor or others if emergency help is needed. Buddies should work in line-of-sight contact or communication with each other and the command post supervisor. Workers must make sure that hand signals are understood. Some common hand signals are shown below.

### COMMON HAND SYMBOLS



In trouble – need help getting out of suit



Task cannot be completed with remaining air



Out of air

Communication systems are established to alert workers to changing situations, transmit information, and initiate changes in response activities. Communication systems may be

internal or external. Internal systems consist of visual cues such as hand signals, lights, flags, and audio cues such as bells, whistles, or compressed-air horns. External systems include telephones or radios; the use of these may be limited due to static electricity or constraints of protective clothing. Employees also must be trained to recognize and use these emergency systems.

### **Zones and Primary Activities in Each Work Zone**

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The purpose of work zones is to reduce the accidental spread of hazardous substances while responders work in the incident area, as described in the Decontamination Chapter. Zones are described again here to match activities and location of members of the ICS.

Zones help:

- Ensure that personnel are properly protected from the hazards present
- Keep work activities and contamination confined to the appropriate areas
- Quickly locate and evacuate personnel in an emergency

A number of factors should be considered when determining locations of zones:

- Accessibility for people and supplies
- Extent of the release
- Resources: phone, water, utilities, and lighting
- Visibility
- Floor plan, plant layout (use of columns for barrier tape, safety showers for decon, etc.)
- Wind direction, ventilation flow
- Escape routes

The set-up of the three zones (Hot, Warm, and Cold) should be based on plant layout, visual observation, and monitoring results. Consideration should be given to entry and exit routes and to the amount of hazardous materials that could possibly be released. Movement of personnel and equipment in these areas should be minimized and restricted to specific points to prevent the spread of contamination.

The general layout of zones for an emergency response was shown in the section on Decontamination chapter. The activities conducted in each area are described here.

In each zone, certain activities are performed by specific personnel. The personnel who can be in each zone should be outlined in the ERP.



## The Hot Zone

The Hot Zone is where the spill or release has occurred. The size of the zone is determined by the extent of the spill or release, characteristics of the scene, and access points. The “Hot line” is the outer boundary and should be clearly marked with hazard tape, lines, signs, or ropes. Further subdivision of the area may be necessary, depending on the hazard and incompatibility of materials spilled.

### Procedures

- Size-up activities
- Control, confinement, and containment of materials
- Clean-up work

### Personnel

- Entry team (minimum of 2)
- Specialists (as needed)

### PPE

- The level of PPE necessary will be determined by the material released, monitoring, and the ERP
- Usually Level A or Level B

**Note:** Operations-level emergency responders may work in the Hot Zone in a defensive fashion. Only persons trained at the technician’s level will approach the point of release. The entry team may include people with several levels of training.

## The Warm Zone

This zone is the transition zone. Decontamination takes place in the Warm Zone in a designated area called the Contamination Reduction Corridor (CRC). The degree of contamination increases closer to the Hot Zone.

### Procedures

- Decontamination line
- Equipment resupply
- Sample packaging for on-scene and off-scene laboratories
- Entry team rest area
- Drainage of water and other decon liquids
- Surveillance of response activities

### Personnel

- Safety officer
- Decontamination team members
- Specialists, as needed

### PPE

- Usually one level lower than Hot Zone (same level as Hot Zone may be needed for specific material)

**Note:** Operations-level emergency responders will generally be included in the personnel in the Warm Zone. Activities may include decontamination and equipment resupply.

### **The Cold Zone**

This zone is the zone free of contamination. The cold zone is the location of administrative and other support functions which keep the Warm and Hot Zone activities running smoothly.

### Procedures

- Command post
- Staging
- Communication with outside personnel
- Surveillance of response activities

### Personnel

- Incident Commander
- Project team leaders
- Public information officer
- Back-up team (minimum of 2)
- Specialists, as needed

### PPE

- Level D

**Note:** Operations-level Emergency Response may provide a number of functions in the Cold Zone, including assisting with staging.

**Exercise - Emergency Response**

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An example of an ERP is presented following the questions for this exercise. Review this plan or use your plant's ERP. In small groups, answer all of the following questions that are assigned to your group. Your instructor will lead a discussion of each group's answers when you have finished.

**Pre-emergency Planning and Coordination with outside parties**

1. What is the importance of pre-emergency planning?
  
  
  
  
  
  
  
  
  
  
2. What pre-emergency planning is included in the plan?
  
  
  
  
  
  
  
  
  
  
3. What other pre-planning items might be included to improve the plan?

**Personnel Roles and Lines of Authority**

4. What is the chain-of-command in this command in this ERP?
  
  
  
  
  
  
  
  
  
  
5. Who are the members of the ER team?

6. What are the duties of the Incident Commander?

7. What are the duties of the Operations-Level First Responder?

### **Training**

8. What training is required for personnel?

9. Are the training requirements consistent with 29 CFR 1910.120?

10. Why is training important?

### **Communication**

11. What are the purposes of communication during an emergency?

12. What can happen to interfere with communications?

### Emergency Recognition and Prevention

13. What are the procedures for fire alarms?

14. What is required for fire prevention?

15. What types of chemical accidents are possible? What are the procedures to notify personnel?

16. What are the evacuation procedures? Who can authorize an evacuation?

### Safe distances and places of refuge

17. Where is the place of refuge?

### Site security and control

18. Who is in charge of site security?

### Evacuation routes and procedures

19. Why are various alarms needed?

### Decontamination

20. What are the decon procedures?

21. Are the decontamination procedures adequate? If not, what additional information is needed?

### Emergency Medical Treatment and First Aid procedures

22. Who will provide First Aid?

23. Are the emergency medical treatment procedures adequate? If not, what additional information is needed?

### Emergency alerting and response procedures

24. What are the procedures for clean-up of small spills?

25. What are the procedures for clean-up of large spills?

26. Are the procedures for spill clean-up adequate? If not, what additional is needed?

### **Critique of response and follow-up**

27. Is there a formal procedure to assemble data and report on all activities?

28. Who is in charge of follow-up? Why might this part of the plan be a concern?

### **PPE and Emergency Equipment**

29. What emergency equipment is available?

30. What procedures are in place to maintain and inspect this equipment?

## **Example of an Emergency Response Plan - for Training Only**

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### **1.0 Description of the Facility**

The ABC Company manufactures small electronic components from aluminum metal plates delivered to the facility by tractor-trailer. The parts are formed by a punch press, loaded into baskets and degreased in a vapor-phase unit containing trichloroethylene (TCE). The degreaser unit is 6' x 3' x 5'.

The 700 employees are organized by department depending on the component produced. Each of the 20 departments has a degreaser. TCE is delivered by railcar and transferred to outside storage tanks.

Identified emergency situations at the facility include:

- TCE Spill
- Fire
- Confined Space Entry

### **2.0 Purpose**

In accordance with 29 CFR 1910.120 (p) (8), the following plan is designed to minimize or prevent damage to human health and the environment in the event of an unplanned sudden or non-sudden release of hazardous material within the plant perimeter. It is understood that provisions of this plan must be carried out immediately when such an event occasion would necessitate an immediate response.

### **3.0 Pre-Emergency Planning and Coordination**

The following procedures describe the actions facility personnel must take in order to ensure compliance with 29 CFR 1910.120(p) in response to an emergency. Arrangements have been made to coordinate the emergency plan and emergency services with the local police department, fire department, hospitals, and Local Emergency Preparedness Committee (LEPC), which developed the Local Emergency Response Plan (LERP).



Community telephone contacts include:

Police .....	911
Fire Department .....	663-9101
Hospital .....	663-5107
LEPC Coordinator.....	550-3156

A meeting was held with the following representatives of these organizations on January 3, 2002:

- Police: Officer Sam Sonite
- Fire: Chief Red Trucker
- Hospital: Ms. Ann Other
- LEPC: Coordinator Lou Planner

Meetings will be held annually with personnel from these groups. Minutes will be kept by the Plant Supervisor, whose responsibility it is to call the meeting.

A copy of the emergency plan and all revisions will be maintained at the Facility in the main office area and will be submitted to the local district police department, fire department, and hospital.

The emergency plan will be reviewed and immediately amended whenever:

- Applicable regulations are revised
- The plan fails in the event of an emergency
- The Facility changes in design, construction, operation, maintenance, or other circumstances that may increase the potential for fires, explosions, or releases of hazardous materials, or changes in the response necessary in an emergency
- The list of emergency coordinators changes
- The list of emergency equipment changes

## **4.0 Personnel Roles, Lines of Authority, Training, and Communication**

### 4.1 Personnel

The facility has personnel on-site 24 hours/day, 7 days/week the entire year. The head person in the guard shack will be aware of the primary and alternate emergency coordinators in the emergency plan, as well as all emergency procedures. The primary and alternate emergency coordinators are thoroughly familiar with all aspects of the Facility emergency plan, all operations and activities at the Facility, the location and characteristics of hazardous material, the location of all records with the facility, and the Facility layout. The Emergency Response Team for the Facility consists of:

- ER Coordinator (1), Alternates (2)
- ER Technician level (12)
- ER Operations level (24)

The Emergency Coordinator and Alternates shall have been trained at the On-Scene Incident Commander level. Responsibilities of the Emergency Coordinator include:

- Identifying the material involved in the emergency
- Activating the internal facility alarms or communication systems to notify all personnel
- Notifying, if needed, police/fire departments, and state and national organizations
- Assuming overall authority for managing the Emergency (unless higher command arrives), performing termination procedures, and conducting critique and follow-up

The ER Technician level personnel shall perform all duties assigned by the Coordinator, consistent with his or her training at the Technician level. These may include:

- Implement the ER plan
- Use monitoring equipment
- Function within the Incident Command System
- Select and use specialized PPE
- Perform advanced control, containment, and/or confinement operations
- Implement the decon procedures
- Participate in hazard and risk assessment and termination procedures

The ER Operations level personnel (Operations-Level First Responder) shall perform all duties assigned by the Coordinator consistent with training at the Operations level. These may include:

- Use provided PPE
- Basic control, containment, and/or confinement measures

- Implement basic decon procedures
- Participate in the ER procedures, termination process, and basic hazard and risk assessment techniques

The owner or operator must note in the operating record the time, date, and details of any incident that require implementing the emergency plan. The report must include:

- Name, address, and telephone number of the owner or operator
- Name, address, and telephone number of the facility
- Date, time, and type of incident
- Name and quantity of material(s) involved
- Extent of injuries
- Assessment of actual or potential hazards to human health or the environment
- Estimated quantity and disposition of recovered material(s)

### 4.2 Lines of Authority

If the incident response is limited to plant personnel, the Emergency Coordinator has overall responsibility for all actions. Personnel should check with the Emergency Coordinator before undertaking any actions not directly ordered by him or her.

If additional personnel are involved, the Emergency Coordinator will defer to the Incident Commander, who gives all instructions.

### 4.3 Training

Individual members of the ER team will receive training as specified in 1920.120 (q). In addition, all plant employees will receive four hours of training annually to update Hazard Communication Training (1910.1200).

Personnel who may be expected to wear SCBAs receive monthly training drills in donning, doffing, and maneuverability as described in the written respirator program required under 1910.134

### 4.4 Communication

The Emergency Coordinator is in charge of all communication while the incident is under the sole control of plant personnel. When outside help is sought the Emergency Coordinator assumes a role of direct responsibility to the Incident Commander of the outside group.

#### Internal Communication

The specifics of the internal communication systems (radios, who has them, frequency band, consequences of jamming the system) are included in the appended SOP.

Following are the primary and alternate emergency coordinators for this Facility, their names, title, business phone numbers, and home phone numbers:

- Fred Friendly X-313, Supervisor of Emergency Response (555) 777-3333
- Susan Smith x556, Laboratory Director (662) 551-3177
- Johnny Spot x753, Quality Control Supervisor, (555) 832-1176

### External Communication

The Emergency Coordinator is in charge of all communication until additional personnel are called. Communication with outside personnel is the sole responsibility of the Coordinator (or his or her designee). The following may be called:

- Police.....911
- Fire Department..... 663-9101
- Hospital.....663-5107

When making a call, include the following information:

- Identify yourself
- State the exact location
- Describe the emergency
- Give the names of persons involved
- Identify the areas potentially affected

## 5.0 Emergency Recognition and Prevention

### 5.1 Fire

Whenever the fire alarm sounds (continuous ringing), all no supervisory personnel must evacuate the facility immediately. After exiting the building, proceed quickly to the consolidation area (flagpole). Do not re-enter the building until the “all clear” condition has been established and the Emergency Coordinator has verified conditions are suitable for re-entry. Supervisory personnel will shut down the line and immediately evacuate.

In the event that alarms sound on the weekends, at nights, or on holidays, it is important that the gate operator be notified, so that the front gate is open when the fire equipment arrives. The phone number for contacting the gate operator is x111.

#### False Alarms

False alarms do occur, fortunately far more frequently than legitimate occurrences. Very often, they are the result of power failures. However, should the alarm be triggered accidentally, the person responsible should present himself/herself to the Fire Department upon their arrival and explain. No charges will be filed unless the act was malicious or intentional. In fact, the Fire Department will be relieved to learn that no emergency exists.

#### Fire Prevention

In order to minimize the potential for fire, the following SOPs have been developed:

- Maintenance degreasers
- Fire-suppression system maintenance and testing

These SOPs are appended. In addition, a no-smoking policy has been adopted in the manufacturing areas. All employees are trained at employment and yearly in the no-smoking policy and the fire alarm system. Degreaser maintenance and testing are required monthly and the results reported to the Plant Safety Officer.

### 5.2 Chemical Accidents

Chemical accidents at this plant may result from a release of TCE or due to entry into the degreaser.

Recognition of a release of TCE will generally be the result of a visual observation of a leak or unusual behavior of a pressure gauge. All degreaser employees have been told to report any suspected leak to the supervisor immediately. Reminders of this policy are posted at each degreaser.

Degreaser maintenance is conducted only after the heating element has been disengaged and lock-out assured by the foreperson. All maintenance activities are

conducted according to the SOP, which includes sections on the buddy system and confined space entry procedures. (SEE SOP, appended).

All maintenance personnel receive annual training in the safety practices pertinent to the degreasers.

### 6.0 Safe Distances & Places of Refuge

#### 6.1 Evacuation

If the evacuation horn is sounded, all non-supervisory personnel must report immediately to the flagpole area. Supervisors should secure their area per previous training and then report to the flagpole.

#### 6.2 Non-Evacuation

All personnel will follow the direction of the Emergency Coordinator. Unless you have a direct role or are requested to assist, leave the area.

### 7.0 Site Security & Control

The Emergency Coordinator manages site security and control. The SOP will be followed (appended).

### 8.0 Evacuation Routes & Procedures

Whenever a need arises to evacuate any area of the Facility, all employees in that area shall proceed to the nearest exit after hearing the fire alarm. It shall be each employee's responsibility to be completely aware of the exit plan for those areas in the Facility in which they work. The Emergency Coordinator or a designee shall then count all employees present once they are assembled at the flagpole. Only when the "all-clear" signal is given and verified by the Emergency Coordinator will employees be allowed to re-enter the Facility.

The following alarms are used:

- Fire notice - continuous blast
- "All clear" - short 1-second blasts

An exit plan is posted at each supervisor's station, at each stairwell, and near each time clock. In case of fire do not use the freight elevators; use only stairwells or emergency escape ladders located at each window above the second floor.

The consolidation area is the flagpole in front of the Administration Building, southwest of the facility. Upon regrouping, check to see that everyone known to have been in the facility is outside. This "head count" will be reported to the fire department, so it is

imperative that all personnel go directly to the consolidation area. Stay in the consolidation area until instructed otherwise. Be prepared to move cars if necessary. Also, attempt to determine the reason for the alarm, nature of the fire, and identities of missing persons so that this information can be provided to the fire department upon its arrival.

### 9.0 Decontamination

All emergency apparatus (brooms, shovels, temporary dikes, etc.) will be rinsed on-site and washed in a tub (20- to 30-gallon) several times with detergent water and/or any of several varieties of commercial decon solutions with brushes and sponges, then placed on a bench or rack for drying. Fire extinguishers will be sent off-site for refilling, and SCBA/air purifying respirators will be cleaned in accordance to manufacturer's specifications. All personnel gloves (inner and outer), hats, boots, coveralls, and coats will be placed in sealed plastic bags to be sent out for proper disposal.

### 10.0 Emergency Medical Treatment & First Aid

#### 10.1 First Aid

One person on each shift is trained in First Aid. A nurse is on duty during the first shift. The nurse and/or supervisor are authorized to decide whether First Aid is insufficient.

#### 10.2 Medical Care

The Facility is located 0.25 miles from Friend-of-the-Plant Hospital. Hospital/ER personnel can respond within three minutes. Annual meetings to review hazards at the plant include hospital representatives.

### 11.0 Emergency Alerting and Response

#### 11.0 Emergency alerting and response procedures

Emergency situations may arise at any time and in any location within the Facility. In an emergency or disaster, all employees present must handle the situation as calmly and promptly as possible. Emergencies will generally be in the nature of spills, fires, or explosions, which could result in the spread of hazardous material. Since it is not possible to devise a set of rules or procedures to govern all possible emergencies, the following considerations are presented only as a guide to aid the user in establishing more specific emergency procedures applicable to his or her working conditions.

The Supervisor and the Emergency Coordinators should be notified immediately. If neither can be reached of the emergency is of such a nature to require outside help immediately call one of the following numbers. (See figure for phone locations.)

## 11.1 Emergency Alerting

<u>Emergency</u>	<u>Contact for</u>	<u>Telephone</u>
Injury or severe, sudden illness	Life Squad/Hospital	911
Fire or explosion	Fire Department	911
Accidental release of hazardous waste	Main Office/Guard	x-222
Loss of essential building services or utilities	Police	555-2222

Then:

- **Identify yourself** to the person who answers
- **State the exact location** of the emergency, either in the Facility itself or on the grounds
- **Describe** the nature of the emergency briefly and calmly
- **Give the name(s)** of the person(s) involved

During an emergency, alertness and prompt action by the employees present at the facility will help prevent further injury or property damage.

### 11.1.1 Fire Emergency

The fire alarm system is an automatic/manual network consisting of automatic sprinkler/hose flow sensors, manual pull boxes, alarm bells, a notifier connected to the Fire Department, and a system control box.

Activation

The alarm system may be triggered in any of the following ways:

- Any flow in the sprinkler/hose system automatically trips the alarm. Hence, fire hoses should not be used for anything other than firefighting.
- The alarm may be activated manually by use of any pull box.
- Through the notifier box, located on the loading dock, the Fire Department is alerted any time the alarm system is activated. They are required to respond and will do so shortly after the alarm sounds.



## Deactivation

The alarm may be silenced after the arrival of the Fire Department by use of the "SILENCE" button on the alarm control panel located on the right hand wall just inside the door of the fire pump room. Do not silence the alarm prematurely. The notifer box must be manually reset by the Fire Department before the alarm system can be used again.

## Action

Any time the alarm sounds, all personnel are required to evacuate the facility.

## 11.2 Response Procedures

### 11.2.1 Small Spills

For small spills, a mobile spill cart has been assembled which will contain two 55-gallon drums with accompanying shovel, tools, and adsorbents. Persons using the spill cart will be properly attired with neoprene boots, chemical-resistant pants, jacket, goggles, and air-purifying respirators. Four SCBAs are conveniently located on each floor for use by persons performing plugging, patching, or other aggressive control actions.

Personnel using this equipment will have been trained in the Safety Equipment SOP (appended).

After proper protective attire has been donned, adsorbent will be placed on the spill. The contaminated adsorbent will then be shoveled into a receiving drum. The drum, containing the absorbed substance, will be secured into the drum storage area. The drum storage area, which is diked, can contain the rupture of the largest container (55-gallon drum) plus 20% of the total capacity.

Following the absorbing procedure, the area where the spill has occurred will be washed with detergent and rinsed three times with potable water. The run-off will be collected, analyzed and, if nonhazardous, discharged into the floor drains in the facility.

In the event that toxic vapors, mists, or fumes are released into the air as a secondary hazard, the vapors will be settled by spraying a fine water mist into the air with a hose. The collected fluid will be analyzed and, if nonhazardous, discharged through the floor drains.

All equipment used to clean up a spill will be washed thoroughly with water. The water from this rinsing will also be collected and analyzed. If it is nonhazardous, it can be discharged into the sewer or shipped to an appropriate disposal facility. Clothing will be bagged and considered hazardous waste.

### 11.2.2 Large Spills

For large spills such as the rupturing of one of the holding tanks, an outside emergency response team will be contacted. Both the emergency response team from the Fire Department and the National Response Center may be called. This immediate notice

must be given by phone to the National Response Center (NRC) (toll free: 800-424-8802 or toll call: 202-426-2675). This notice must include:

- Name and phone number of reporter
- Name and address of carrier
- Date, time, and location of incident
- Extent of injuries
- Hazard class, name, and quantity of hazardous material involved
- Type of incident and nature of materials involved

Two companies with the capabilities of initiating remedial action within 15 hours are:

- In-A-Flash 1-800-555-5656
- R. Mead Action 1-800-555-8899

The above company telephones are operated 24 hours a day. The Emergency Coordinator will call the company and describe the incident. The company will immediately send an advance team to assess the problem and decide what equipment is needed. The following persons have the authority to commit funds to initiate remedial action:

- Susan B. Incident (Primary)
- Johnny O. Spot (Alternate)
- Karl Fast (Alternate)
- Sam King (Alternate)

Also, the Chemical Manufacturer's Association (CMA) maintains a public service center in Washington, D.C. under the title of the Chemical Transportation Emergency Center (Chemtrec). The toll-free number is 800-424-9300, and it is available on a 24-hour-per-day basis.

Should a major spill or tank rupture occur, the containment of the drainage is of primary concern. Mechanical plugs are available for the drain system that is near the tankage. In the event that a spill becomes a major catastrophe with ensuing fire/explosion and release of toxic fumes and vapor, it may become necessary for the Emergency Coordinator to have the building evacuated (in accordance with standard evacuation procedures) and the facility shut down. The main power supply will be turned off at the direction of the Emergency Coordinator.

### 11.2.3 Fire

See Section 5.1. It has been determined to rely on the Fire Department for response.

### 11.2.4 Confined Space Entry

The Plant Manager is responsible for compliance with the Confined Space Entry SOP (appended). Should injury occur in the course of an entry, emergency provisions of the SOP will be immediately implemented.

### 12.0 Critique of Response and Follow-Up

A thorough investigation is required to ensure the adequacy of procedures and identify needed changes in the response plan. Immediately upon completion of the termination procedures, a debriefing will be conducted with all department personnel and any outside agencies. A meeting will be called by the Emergency Coordinator, who will make a full report to the plant manager. Sections of the report will include:

- Description of the emergency
- Personnel responding and roles
- Environmental measurements
- Site security operations
- Actions or events contributing to the emergency
- Diagram
- Material released – Identity and quantity
- Zones
- Reported health effects
- Needed follow-up action

### 13.0 Personal Protective Equipment and Emergency Equipment

#### 13.1 Personal Protective Equipment

Personnel protective equipment is maintained by the staff of the Safety Director. A full inventory is available on the internal computer system. Response procedures have been established at the Facility for response to emergency situations.

#### 13.2 Emergency Equipment

Both the fixed and portable safety apparatus to be used for most emergency conditions are found in the appendix. Descriptions and specifications are provided. A general listing of the emergency equipment available at the Facility includes:

- Safety showers
- Self-contained breathing apparatus SCBA (4 per floor)
- Respirators
- Safety glasses
- Fire hoses
- Eye wash
- Spill-control cart (Protective gear, adsorbents, etc.)
- Gloves
- First Aid supplies (kits and cabinet)
- Fire extinguisher

## **Summary – Emergency Response Plan**

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An Emergency Response Plan (ERP) must be developed and implemented prior to an emergency.

### **Emergency Response Plan Topics**

The specific topics which must be covered in the ERP are:

- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination procedures
- Emergency medical treatment and First Aid procedures
- Emergency alerting and response procedures
- Critique of response and follow-up
- Personal protective equipment and emergency equipment

The Incident Command System (ICS) provides a necessary structure for personnel responding to emergencies. Specific job titles, roles, and duties are defined in the ERP.

Communication is critical in alerting employees that an emergency is occurring and keeping them informed during the emergency response.

The ERP references or includes SOPs which must be understood and practiced prior to an emergency situation.

The purpose of work zones is to reduce the spread of hazardous substances from the area of the release/incident to clean areas where workers are not in protective gear. The zones are: Hot (contamination), Warm (reducing contamination through decontamination), Cold (clean, no protection needed).

### Review Questions

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1. What are some required parts of the ERP?
2. Why is preplanning necessary?
3. What SOPs might be included in the ERP?
4. Describe the function of the ICS, and list personnel and duties that may be part of it.

## SIMULATIONS

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The exercises in this section will allow you to apply knowledge gained from this training program to a “real-life” situation. The exercises involve formulating a response to a hazardous materials incident in a manufacturing setting. The first step is to develop a response and lay it out on the figures included in the section. Then the parts of the response will be practiced during a hands-on simulation. The section ends with a critique of the response.

### Chapter Objectives

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

- Use resource materials to determine physical, chemical, and health hazards
- Select appropriate PPE from that available on a spill cart
- Secure an incident area
- Plan a response
- Terminate the response and plan post-response steps

## Overview of Simulations

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During this session, you will have an opportunity to practice and evaluate some of the techniques you have learned in this program and to observe first-hand how a response should go.

The exercises in this section have been selected to represent those you might face in your own plant. As you carry out your assigned tasks, be aware of the activities of others. A safe and successful response depends on all team members doing their job properly. There are four parts to this section.

NOTE: if there are needed functions in the Personnel for which trained participants are not available, these functions will be filled by facilitators. Always respond within your level of training.

- A tabletop exercise in which your small group will develop an emergency response to a case problem. Here you will use resources to lay out your response on paper. This exercise will take about one hour.
- Then you will present and critique your responses. The correct response will be discussed.
- You will then perform various hands-on activities related to this same exercise. Here, you will put into action the key elements of the response that has already been laid out. These activities will include overall coordination of the response, site security, research support, diking and diverting, and decon. Those individuals who are not assigned specific tasks will act as evaluators.
- This part of the program will require about two hours.
- Finally, you will all be involved in a critique of the exercise, including a discussion of the response plan prepared, a report from the evaluators, and a general discussion of the entire exercise.

You are strongly encouraged to “act” your role but also to play within the ground rules provided by the instructors.

## Spill Response Tabletop Exercise

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Read and answer the following questions in a small group. Select a record keeper who will take notes during the session and report the responses back to the class. You will have 45 minutes to complete the exercise. The class will then critique each group's response. After the critiques, your instructor will explain the hands-on portion of this session.

### The Scene

All members of the small group work at ABC Manufacturing Company. (See map in Figure 1.) All of you have been trained as operations-level first responders. On the first shift, the plant manager is the Incident Commander. No one except the Incident Commander is trained at the technician or specialist level. You have been instructed to act as a spill team whenever one is needed at ABC. The following resources are available to you:

- Diagram of the area
- Detailed diagram of the spill
- SDS
- Spill cart
- DOT Guidebook
- NIOSH Pocket Guide

### The Incident

It is around noon on a hot summer day. There is a slight wind blowing north to south. The plant manager calls for the spill team to assemble at the shipping and receiving office. When you assemble, the manager tells you that an employee in the warehouse has reported a liquid dripping from a semi-trailer which is at the top of receiving Bay 1. The manager also reports the following information. An XYZ Chemical semi-trailer was backing into Bay 1 of the unloading dock. The driver stopped at the top of the ramp to open the doors before backing up to the dock. He opened one door and walked to the side of the truck to hook the back door. When he returned to open the other door, he saw liquid dripping from the trailer. (See figure 2.) He shut off the truck and went to the shipping office to tell the unloading supervisor about the liquid. The supervisor looked out the open Bay 3 door to verify this situation. The warehouse worker entered the office to report her findings. The supervisor then called the plant manager. The supervisor said that Bay 1 and 2 doors were closed. He also said that the driver reported that there were seventy 55-gallon drums of acetone and no other cargo aboard the trailer.



Figure 1  
Diagram of the Area

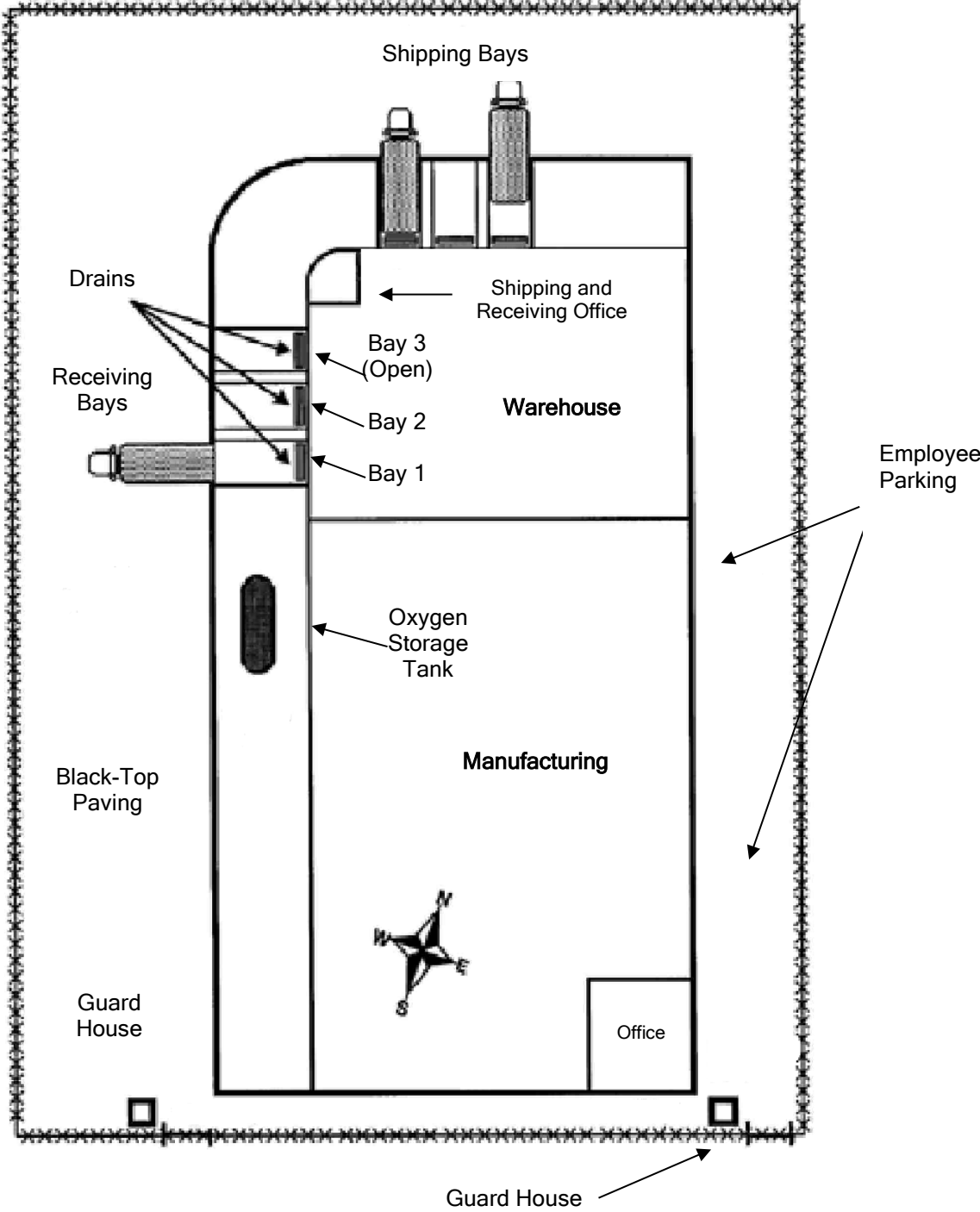
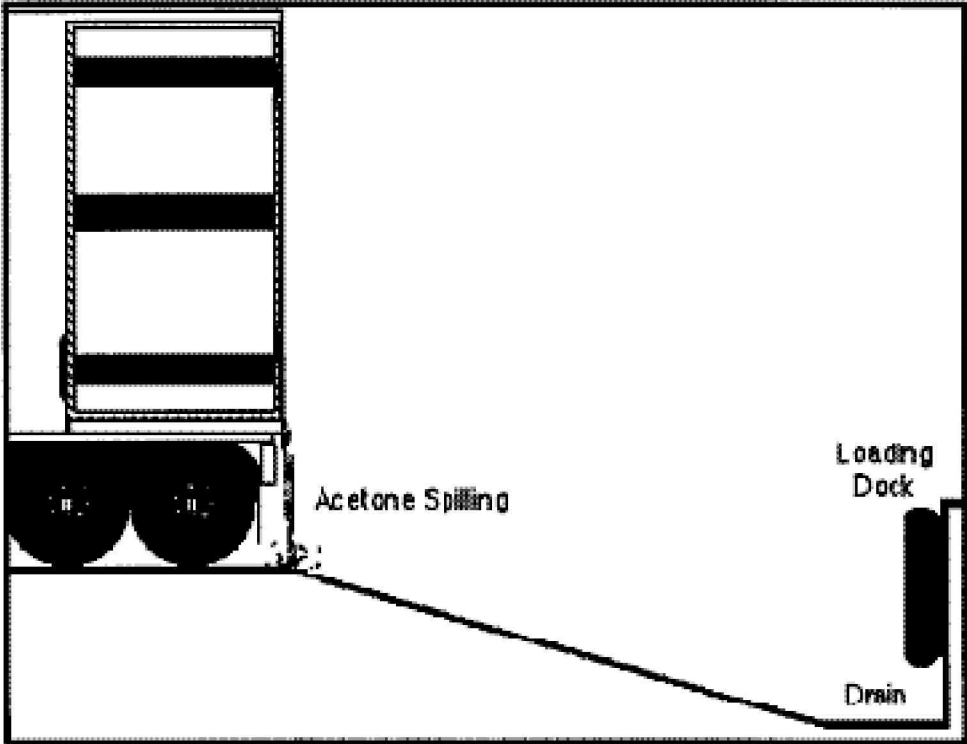


Figure 2  
The Spill



# Safety Data Sheet

Version 4.5  
 Revision Date 03/29/2013  
 Print Date 09/11/2013

## 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Acetone  
 Product Number : 12345  
 Brand : Chemco  
 Supplier : Chemco  
 909 Chemway Ct.  
 Montgomery, AL  
 USA  
 Telephone : +1 800-999-9999  
 Fax : +1 800-888-8888  
 Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555  
 Preparation Information : Chemco  
 Product Safety – North America  
 1-800-777-7777

## 2. HAZARDS IDENTIFICATION

### Emergency Overview

### OSHA Hazards

Flammable liquid, Target Organ Effect, Irritant

### Target Organs

Liver, Kidney

### GHS Classification

Flammable liquids (Category 2)

Skin irritation (Category 3)

Eye irritation (Category 2A)

Specific target organ toxicity - single exposure (Category 3)

### GHS Label elements, including precautionary statements

Pictogram



Signal word Danger

Hazard statement(s)

H225 Highly flammable liquid and vapour.  
 H316 Causes mild skin irritation.  
 H319 Causes serious eye irritation.  
 H336 May cause drowsiness or dizziness.

Precautionary statement(s)

P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.  
 P261 Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.  
 P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

### Other hazards

Repeated exposure may cause skin dryness or cracking.

### HMIS Classification

Health hazard: 2  
 Chronic Health Hazard: \*  
 Flammability: 3

**Physical hazards:** 0

**NFPA Rating**

**Health hazard:** 2

**Fire:** 3

**Reactivity Hazard:** 0

**Potential Health Effects**

**Inhalation** May be harmful if inhaled. Causes respiratory tract irritation. Vapours may cause drowsiness and dizziness.

**Skin** May be harmful if absorbed through skin. Causes skin irritation.

**Eyes** Causes eye irritation.

**Ingestion** May be harmful if swallowed.

**3. COMPOSITION/INFORMATION ON INGREDIENTS**

Formula : C<sub>3</sub>H<sub>6</sub>O

Molecular Weight : 58.08 g/mol

Component Concentration

**Acetone**

CAS-No. 67-64-1

EC-No. 200-662-2

Index-No. 606-001-00-8

**4. FIRST AID MEASURES**

**General advice**

Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**

Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

**If swallowed**

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

**5. FIREFIGHTING MEASURES**

**Conditions of flammability**

Flammable in the presence of a source of ignition when the temperature is above the flash point. Keep away from

heat/sparks/open flame/hot surface. No smoking.

**Suitable extinguishing media**

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for firefighters**

Wear self contained breathing apparatus for fire fighting if necessary.

**Hazardous combustion products**

Hazardous decomposition products formed under fire conditions. - Carbon oxides

**Further information**

Use water spray to cool unopened containers.

**6. ACCIDENTAL RELEASE MEASURES**

**Personal precautions**

Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all

sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

**Environmental precautions**

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

**Methods and materials for containment and cleaning up**

Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

**7. HANDLING AND STORAGE**

**Precautions for safe handling**

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Use explosion-proof equipment. Keep away from sources of ignition - No smoking. Take measures to prevent the buildup of electrostatic charge.

**Conditions for safe storage**

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

**8. EXPOSURE CONTROLS/PERSONAL PROTECTION**

**Components with workplace control parameters**

Components	CAS-No.	Value	Control parameters	Basis
<b>Acetone</b>	67-64-1	TWA	500 ppm	USA. ACGIH Threshold Limit Values (TLV)

**Remarks**

Eye & Upper Respiratory Tract irritation. Central Nervous System impairment. Hematologic effects. Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen.

STEL 1,000 ppm Control parameter 750 ppm USA. ACGIH Threshold Limit Values (TLV)

Eye & Upper Respiratory Tract irritation. Central Nervous System impairment. Hematologic effects. Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen.

STEL 1,000 ppm 2,400 mg/m3 USA. OSHA - TABLE Z-1 Limits for Air Contaminants – 1910.1000

The acetone STEL does not apply to the cellulose acetate fiber industry. It is in effect for all other sectors.

TWA 1,000 ppm 2,400 mg/m3 USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants

The value in mg/m3 is approximate.

TWA 250 ppm 590 mg/m3 USA. NIOSH Recommended Exposure Limits 500 ppm

**Personal protective equipment**

**Respiratory protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Hand protection**

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact

Material: butyl-rubber

Minimum layer thickness: 0.3 mm

Break through time: 480 min

Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact

Material: butyl-rubber

Minimum layer thickness: 0.3 mm

Break through time: 480 min

Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Eye protection**

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin and body protection**

Impervious clothing, Flame retardant antistatic protective clothing. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Hygiene measures**

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

**9. PHYSICAL AND CHEMICAL PROPERTIES**

**Appearance**

Form liquid, clear

Colour colourless

**Safety data**

pH no data available

Melting point/freezing point Melting point/range: -94 °C (-137 °F) - lit.

Boiling point 56 °C (133 °F) at 1,013 hPa (760 mmHg) - lit.

Flash point -17.0 °C (1.4 °F) - closed cup

Ignition temperature 465 °C (869 °F)

Auto-ignition temperature 465.0 °C (869.0 °F)

Lower explosion limit 2 %(V)

Upper explosion limit 13 %(V)

Vapour pressure 533.3 hPa (400.0 mmHg) at 39.5 °C (103.1 °F)

245.3 hPa (184.0 mmHg) at 20.0 °C (68.0 °F)

Density 0.791 g/cm<sup>3</sup> at 25 °C (77 °F)

Water solubility completely miscible

Partition coefficient: log Pow: -0.24

n-octanol/water

Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

**10. STABILITY AND REACTIVITY**

**Chemical stability**

Stable under recommended storage conditions.

**Possibility of hazardous reactions**

Vapours may form explosive mixture with air.

**Conditions to avoid**

Heat, flames and sparks. Extremes of temperature and direct sunlight.

**Materials to avoid**

Bases, Oxidizing agents, Reducing agents, Acetone reacts violently with phosphorous oxychloride.

**Hazardous decomposition products**

Hazardous decomposition products formed under fire conditions. - Carbon oxides

Other decomposition products - no data available

**11. TOXICOLOGICAL INFORMATION**

**Acute toxicity**

**Oral LD50**

LD50 Oral - rat - 5,800 mg/kg

Remarks: Behavioral:Altered sleep time (including change in righting reflex). Behavioral:Tremor.

**Inhalation LC50**

LC50 Inhalation - rat - 8 h - 50,100 mg/m3

no data available

**Dermal LD50**

LD50 Dermal - guinea pig - 7,426 mg/kg

**Other information on acute toxicity**

no data available

**Skin corrosion/irritation**

Skin - rabbit - Mild skin irritation - 24 h

**Serious eye damage/eye irritation**

Eyes - rabbit - Eye irritation - 24 h

**Respiratory or skin sensitisation**

Chronic exposure may cause dermatitis.

**Germ cell mutagenicity**

no data available

**Carcinogenicity**

This product is or contains a component that is not classifiable as to its carcinogenicity based on its IARC, ACGIH, NTP, or EPA classification.

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

**Reproductive toxicity**

No data available

**Teratogenicity**

No data available

**Specific target organ toxicity - single exposure (Globally Harmonized System)**

May cause drowsiness or dizziness.

**Specific target organ toxicity - repeated exposure (Globally Harmonized System)**

No data available

**Aspiration hazard**

No data available

**Potential health effects**

**Inhalation** May be harmful if inhaled. Causes respiratory tract irritation. Vapours may cause drowsiness and dizziness.

**Ingestion** May be harmful if swallowed.

**Skin** May be harmful if absorbed through skin. Causes skin irritation.

**Eyes** Causes eye irritation.

**Signs and Symptoms of Exposure**

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

**Synergistic effects**

No data available

**Additional Information**

RTECS: AL3150000

**12. ECOLOGICAL INFORMATION**

**Toxicity**

Toxicity to fish LC50 - *Oncorhynchus mykiss* (rainbow trout) - 5,540.00 mg/l - 96 h

Toxicity to daphnia EC50 - *Daphnia magna* (Water flea) - 13,500.00 mg/l - 48 h

and other aquatic invertebrates

**Persistence and degradability**

No data available

**Bioaccumulative potential**

No data available

**Mobility in soil**

No data available

**PBT and vPvB assessment**

No data available

**Other adverse effects**

No data available

**13. DISPOSAL CONSIDERATIONS**

**Product**

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material

is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed

professional waste disposal service to dispose of this material.

**Contaminated packaging**

Dispose of as unused product.

**14. TRANSPORT INFORMATION**

**DOT (US)**

UN number: 1090 Class: 3 Packing group: II

Proper shipping name: Acetone

Reportable Quantity (RQ): 5000 lbs

Marine pollutant: No

Poison Inhalation Hazard: No

**IMDG**

UN number: 1090 Class: 3 Packing group: II EMS-No: F-E, S-D

Proper shipping name: ACETONE

Marine pollutant: No

**IATA**

UN number: 1090 Class: 3 Packing group: II

Proper shipping name: Acetone

**15. REGULATORY INFORMATION**



**OSHA Hazards**

Flammable liquid, Target Organ Effect, Irritant

**SARA 302 Components**

SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

**SARA 313 Components**

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold

(De Minimis) reporting levels established by SARA Title III, Section 313.

**SARA 311/312 Hazards**

Fire Hazard, Acute Health Hazard, Chronic Health Hazard

**Massachusetts Right To Know Components**

	CAS-No.	Revision Date
Acetone	67-64-1	2007-03-01

**Pennsylvania Right To Know Components**

	CAS-No.	Revision Date
Acetone	67-64-1	2007-03-01

**New Jersey Right To Know Components**

	CAS-No.	Revision Date
Acetone	67-64-1	2007-03-01

**California Prop. 65 Components**

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

**16. OTHER INFORMATION**

**Further information**

Revised 9/11/2013 Chemco

## **Spill Cart**

### Communication Gear

- Hand-held radios

### Monitoring and observation equipment

- Combustible-gas indicator
- Specific gas detectors
- Binoculars (7 x 36mm wide-angle) (2)
- Pressure gauge
- pH paper
- Hand calculator (2)
- Lock-type measure tape
- Oxygen meter

### Recordkeeping and related supplies

- Digital recorder
- Large logbook
- Magnetic hangers
- Paper and note pads
- Clipboards
- Yellow spray paint
- Color-coding DOT security tags
- Photographic equipment
- Paper clips and alligator clips
- Rubber bands
- Pens, pencils, markers
- Black spray paint
- Green marking tape (perimeter)
- "Restricted Area" sign

### Respiratory and personal protective equipment

- Positive pressure, self-contained breathing apparatus with extra air cylinder
- Fit testing equipment
- PVC disposable gloves
- Natural rubber gloves
- Full-face, air-purifying respirators with appropriate canisters
- Anti-fog solution
- Neoprene gloves
- PVC disposable boots

Tools, supplies, and equipment

- First Aid kit
- Fire extinguisher
- Rubber mallet
- Valve packing
- Disposable towels
- Plastic drop sheet
- Electric power outlet strip (8 outlets).
- Clean water supply
- Hacksaw
- Rod and bolt cutter (24 in.)
- Lineman’s pliers (8 in.)
- Locking plier wrench (10 in.)
- Wrench set (combination)
- Heavy-duty stapler and staples
- Wrecking bar (non-sparking, 30 x 3/4 in)
- Sledgehammer (4-lb.) (20)
- Hand hammer (non-sparking, 2 double face, beryllium-copper)
- Shovel (D handle, round point, non-sparking) (2)
- Rope (300 ft. polypropylene, 1 6lb.)
- Heavy-duty extension cord (100 ft.)
- Scrub brushes (4)
- Rechargeable lanterns (2)
- Portable wash unit
- Wood mallet
- Redwood plugs (various sizes)
- Nylon wire
- Detergent (large)
- Rubber tarp tie-down straps
- Air-tight container for sample storage
- Claw hammer
- Duckbill snips (12 in.)
- Diagonal cutting pliers (8 in.)
- Slip joint pliers (8 in.)
- Pipe wrench (non-sparking)
- Screwdrivers (5 slotted, 4 Phillip’s)
- Duct tape
- Spud bar (2)
- Plastic buckets (4)
- Shovel (D handle, square point, non-sparking) (2)
- Shovel (long handle, round point, non-sparking) (2)
- Heavy-duty tow chain (15 ft.)
- Garden hose (50 ft., 5/8" in. ID)
- Safety flares (vehicle use) (2)

**Part A – Size up and Chain of Command**

1. Who is the emergency coordinator (Incident Commander)?
  
2. Where will you do the size-up? Place characters on the map.
  
3. What should you be looking for during the initial size-up?
  
4. Is there a hazardous material present? How do you know?

5. Where will you secure the scene? Sketch this area on the map.

6. What type of protective clothing and respiratory protection do you need at this point? Select these items from the spill cart.

7. Where will you make the entry to the scene? Place characters on the map according to the entry procedures.

**Part B – Monitoring I**

The decision is made to send in two team members dressed in Level B to examine the spill area more closely and monitor. The entry team approaches the scene with a direct reading instrument.

8. What should the two-person team measure first—oxygen or flammables?

**Part C - Monitoring II**

The first reading above zero is obtained at the northwest corner of the entry to the bay. The readings are:

**Oxygen: 20.4%**

**%LEL: 8.9%**

9. What should the two-person team do at this point?

**Part D - Monitoring III**

The team continues to approach the spill and obtains the following readings in the air just above the pool of spilled material.

**Oxygen: 19.9%**

**%LEL: 15.0%**

The team also measures the air at the lower part of the open door.

**Oxygen: 19.6%**

**%LEL: meter “pegs out,” goes to zero**

10. What should the spill team do now?

11. Are the two team members adequately protected?

12. Where should the Hot Zone and the Warm Zone be placed? Mark the zones on the map.

13. Is evacuation necessary?

If “Yes,” describe who should be evacuated and how far away.



14. How will you implement evacuation? Explain your answer.

15. Should the overhead door in Bay 3 be closed? Explain your answer.

16. What should be done about the spill with the information you now have available?

**Part E - Deciding on the Appropriate Response**

The product is near the sewer grate but has not spilled into the sewer system. The decision is made to stop the flow of material before it enters the sewer drain.

17. How will the product flow be confined? Use supplies from the spill cart.

18. How will the flow into the sewer system be prevented? Use supplies from the spill cart.

19. What other procedures may be used?

20. Should outside assistance be requested? Explain your answer.

**Part F - Using Off-Site Emergency Responders**

A decision is made by the ABC Manufacturing Company plant manager to contact the fire department. The HazMat team and the engine company arrive.

21. Where should the ranking fire officer be met? Mark the area on the map.

22. What should the fire officer be told?

23. What should the spill team do after the information is relayed?

24. Who is now the Incident Commander?

**Part G – Nearing Termination**

The fire department uses foam to suppress vapors and begins airing out the trailer. A clean-up contractor, called by personnel at XYZ Chemical, arrives at the gate.

25. Who will relay information to the contractor?

26. What is the role of the spill team now?

27. What is the role of the fire department at this time?

28. What is the role of the contractor at this time?

**Part H - Termination**

The contractor completes the mitigation and clean-up while the fire department waits until no fire hazard exists. The spill team is told to leave the scene.

29. What will each spill team member do to document his or her actions?

30. What tasks should be done to complete the termination of the response?

**Exercise - Spill Response Hands-On Simulation**

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The facilitator will distribute assignments and briefing sheets detailing job assignments for the hands-on simulation. The scene for the simulation is the same as the tabletop.

## **CLOSING AND PROGRAM EVALUATION**

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Thank you for participating in this program.

This is an opportunity to ask any questions you may have, or to discuss how the knowledge and skills learned can be used at work. Were all of your initial questions answered?

Please take the next 10 minutes to complete the program evaluation forms. These are important for improving the program. The Midwest Consortium does take your comments seriously and has made changes in content and the skill exercises based on feedback. Your comments are anonymous.

We hope to see you at another Midwest Consortium program in the future