IUOE National Training Fund

National HAZMAT Program

Student Manual

HAZWOPER

Annual Refresher

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- It is not the intent of the content developers to provide compliance-based training in this presentation, the intent is to address hazard awareness in the hazardous waste operations and emergency response (HAZWOPER) industry, and to recognize the overlapping hazards present in many construction workplaces.

- It should NOT be assumed that the suggestions, comments, or recommendations contained herein constitute a thorough review of the applicable standards, nor should discussion of "issues" or "concerns" be construed as a prioritization of hazards or possible controls. Where opinions ("best practices") have been expressed, it is important to remember that safety issues general and HAZWOPER jobsites specifically will require a great deal of site- or hazard-specificity – a "one size fits all" approach is not recommended, nor will it likely be very effective.

To: Users of IUOE National Training Fund Programs

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- Technical safety and health, emergency/disaster response, and energy security and restoration assistance
- Training data information from the National training database for Local Union members and others who have completed training through the National HAZMAT Program
- Expertise to provide best practices and information sharing, develop scenarios, and conduct exercises to prepare all stakeholders to protect and restore critical infrastructure should an event, manmade or natural, occur
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Inquiries regarding the services the IUOE National Training Fund -- National HAZMAT Program have to offer can be directed to Barbara McCabe at 1293 Airport Road, Beaver, WV 25813, called in at (304) 253-8674, faxed to (304) 253-7758, or emailed to hazmat@iuoehazmat.org.

The IUOE National Training Fund encourages all workers to take advantage of the National HAZMAT Program's services to assist you to be employable, competitive, and safe in the workplace.

Sincerely,

Jeffrey R. Vincent
Executive Director,
IUOE National Training Fund

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Preface

This Student Handbook is an overview of topics and procedures required by the Occupational Safety and Health Act of 1970 for Hazardous Waste Operations and Emergency Response (HAZWOPER) 8-Hour Refresher Training. It meets or exceeds NIEHS Minimum Criteria and U.S. Department of Energy Objectives for this training. This curriculum does not legally interpret the federal codes, and is not intended to take the place of specialized training programs, such as those for confined space, radiation worker, and others, where that specialized training is required.

This HAZWOPER 8-Hour Refresher Curriculum includes, for each separate module/topic:

1. "Issues/topics for discussion" to be chosen by the presenter to generally cover a subject and assess the course participants' knowledge. Presenters should add to this list as future applicable issues emerge.
2. Information presented in question/answer format. Each Q/A is its own subtopic. Presenters may use these questions to quickly poll the course participants to see if they already understand the answers; choose specific, relevant questions to answer in detail.
3. Updates to standards and regulations, where applicable.
4. Glossary "Terms to understand" will be located in the back of the manual..
5. Optional "hands on" exercises can be used at the discretion of the instructor.
6. Tables and charts to illustrate/supplement course content.

Chapter 1
Introduction to Government Regulations

Issues and topics for discussion:

- Under OSHA standards, are subcontractors responsible for complying with regulations? Are general contractors ultimately responsible for the subcontractor employees?
- What is the best way for employees to learn more about work-related safety and health issues?
- What should employees who have concerns about their safety and health do to address work-site problems?
- Why do government agencies require annual HAZWOPER refresher training?

Introduction

Government regulations to protect workers, the public, and the environment are the foundation for all safety and health requirements at the work site. A basic understanding of these regulations enables workers to determine their rights and whether they are being properly protected.

Which government agencies affect workplace safety and health recommendations and requirements?

U.S. Department of Labor (1930) develops and administers policies relating to wage earners, working conditions, and employment opportunities.

Occupational Safety and Health Act of 1970 established the **Occupational Safety and Health Administration (OSHA)**, a federal agency, within the U.S. Department of Labor. OSHA protects American workers by developing mandatory job-safety and health standards, and enforcing them through worksite inspections, (targeting those workplaces with the highest injury/illness rate), employer assistance, and by imposing citations or penalties for violations. OSHA publishes permissible exposure levels.

The OSH Act also established the **National Institute for Occupational Safety and Health (NIOSH)**. NIOSH, the research agency for occupational safety and health, is part of the U.S. Department of Health and Human Services. NIOSH publishes the Registry of Toxic Effects of Chemical Substances (RTECS) and the NIOSH Guide to Chemical Hazards.

Mine Safety and Health Administration (MSHA), enacted in 1969 and strengthened by Congress in 1977, is a branch of the Department of Labor established to protect workers in mining operations.

Environmental Protection Agency (EPA) was created in 1970. The Resource Conservation and Recovery Act (RCRA), in 1976, made the EPA responsible for identifying and managing hazardous waste from generation, to transport, to treatment and disposal, cradle to grave. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), passed in 1980, established federal funding (Superfund) to clean up hazardous waste. The Superfund Amendments and Reauthorization Act (SARA), in 1986, extends the authority of the federal government to respond to released or threatened releases of hazardous substances.

U.S. Department of Transportation (DOT) was established in 1967.

U.S. Department of Energy (DOE), established in 1977, runs the largest environmental restoration and waste management program in the world.

The Code of Federal Regulations		
Agency	**Scope**	**Title**
OSHA	Safety and Health Regulations	29
NIOSH	Research relating to worker safety and health	42
MSHA	Mining safety and health	30
EPA	Protection of air, water, and soil	40
DOL	Labor policies and laws	29
DOT	Transportation policies	49
DOE	Energy research amd development	10

Table 1.1

Where can employees find more information on specific federal regulations?

Government regulations are published in the Code of Federal Regulations (CFR). CFR Parts “1910- General Industry” and “1926- Construction” are most applicable to operating engineers and hazardous materials workers.

In this example, “29 “ shows that this is an OSHA or Department of Labor standard, “CFR” indicates that it is from the Code of Federal Regulations, and “1910” indicates that it pertains to General Industry.

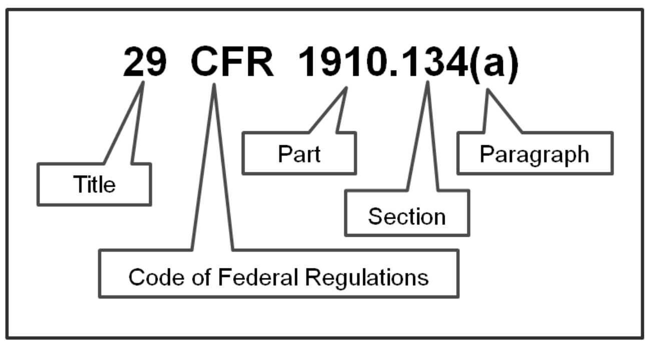

Figure 1.1

29 CFR 1910.120 is the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard for general industry.

29 CFR 1926.65 is the HAZWOPER standard for the construction industry. Although the numbers are different, the language in each is almost identical. The difference is the referencing of other standards.

The citation above is for the introductory paragraph of the Respiratory Protection Standard. Sometimes, instead of duplicating the wording, the standard will be written in full in one part, and referenced in the other. For example, the respiratory protection standard is written completely in 29 CFR 1910.134, and simply cited in 29 CFR 1926.103 as applying to construction.

What are important employer responsibilities as defined by the OSH Act?

The General Duty Clause, or Section 5(a)(1) of the OSH Act, requires that each employer "furnish... a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees."

Under OSHA standards, the employer is ultimately responsible for providing a safe and healthful workplace. Employers must be familiar with and comply with standards that apply to their establishments. OSHA standards require that employers:

- Maintain conditions, and establish safe, appropriate practices and standard operating procedures, that are reasonably necessary to protect workers on the job.
- Identify, communicate, and monitor hazardous conditions.
- Provide and maintain appropriate personal protective equipment where engineering controls are not enough to eliminate hazards.
- Train employees regarding rules, regulations, and procedures.
- Keep and make available records on training and employee safety and health issues and events.
- Abate cited violations within the prescribed period.
- Not discriminate against employees who properly exercise their rights under this Act.
- Cooperate with the OSHA compliance officer by furnishing names of authorized employee representatives who may be asked to accompany the compliance officer during an inspection.
- Post OSHA citations and notices at or near work site involved.
- Post the current OSHA poster (OSHA 2203), informing employees of their rights and responsibilities.

Multi-Employer Worksites

On multi-employer worksites, both construction and non-construction, citations normally shall be issued to employer whose employees are exposed to hazards (the exposing employer).

Additionally, the following employers normally shall be cited, whether or not their own employees are exposed:

- The employer who actually creates the hazard (the creating employer);
- The employer who is responsible, by contract or through actual practice, for safety and health conditions on the worksite: i.e., the employer who has the authority for ensuring that the hazardous condition is corrected (the controlling employer);
- The employer who has the responsibility for actually correcting the hazard (the correcting employer).

What are important employer rights as defined by the Occupational Safety and Health Act?

Under the OSH Act, employers have the right to:

- Seek free advice and off-site consultation.
- Request and receive proper identification of the OSHA compliance officer prior to inspection.
- Be advised by the compliance officer of the reason for an inspection.
- Accompany the compliance officer on the inspection.
- Have an opening and closing conference with the compliance officer.
- Request an informal settlement agreement process after an inspection.
- File a Notice of Contest to dispute inspection results.
- Apply to OSHA for a temporary or permanent variance.
- Be assured of confidentiality of any trade secrets observed by the OSHA compliance officer during inspection.

What are important employee responsibilities as defined by the Occupational Safety and Health Act?

The employee has the right to expect the employer to fulfill his responsibilities. But the employee has a general responsibility as well.

Section 5(b) of the OSH Act requires that employees diligently follow all safety and health standards, rules and procedures that apply to their own actions and conduct.

To do this, employees must attend training, and communicate with their employers regarding safety and health issues and events.

Under the OSH Act, employees have the additional responsibility to:

- Read the OSHA poster at the job site.
- Follow all employer safety and health regulations, and wear or use prescribed protective equipment while working.
- Report hazardous conditions to the supervisor.
- Report any job-related injury or illness to the employer, and seek prompt treatment.
- Cooperate with the OSHA compliance officer conducting an inspection.
- Exercise rights under the OSH Act in a responsible manner.

What are important employee rights as defined by the Occupational Safety and Health Act?

Under the OSH Act, employees have the right to:

- Review copies of appropriate OSHA standards, rules, regulations, and requirements that employers must have available at the workplace.
- Request information from the employer on safety and health hazards in the workplace, precautions that should be taken, and procedures to be followed if an employee is involved in an accident or is exposed to toxic substances.
- Receive adequate training and information on workplace safety and health issues.
- Have access to relevant employee exposure and medical records.
- Submit a written request to the National Institute for Occupational Safety and Health (NIOSH) for information on whether any substance in the workplace has potentially toxic effects in the concentration being used, and have names withheld from the employer.
- Request that the OSHA area director conduct an inspection if they believe hazardous conditions or violations of standards exist in the workplace.
- Have their name withheld from the employer if a written and signed complaint is filed.

- Have an authorized employee representative accompany the OSHA compliance officer during an inspection tour.
- Respond to questions from OSHA.
- Observe any monitoring or measuring of hazardous materials and see any resulting or related records.
- Have an authorized representative, or themselves, review the Log and Summary of Occupational Injuries and Illnesses (OSHA 300).
- Request a closing discussion following an inspection.
- Be informed by posting of any OSHA citation.
- Object to the abatement period set by OSHA for correcting any violation in the citation.
- Participate in hearings.

Should safety and health violations be reported immediately to OSHA?

Employees should first discuss safety and health concerns with other workers, their supervisor, site safety officer, employer, and/or their Union representatives. In most cases, employers and employees work as a team to achieve the goal of a safe work environment.

Do employees have the right to refuse unsafe work?

Although OSHA law does not specifically give employees the right to refuse to perform an unsafe or unhealthful job assignment, OSHA's regulations, which have been upheld by the U.S. Supreme Court, provide that an employee may refuse to work when faced with an imminent danger of death or serious injury.

Can employees be fired or demoted for reporting safety or health issues?

Section 11(c) of the OSH Act says the employer "shall not" punish or discriminate against employees for exercising such rights as complaining to the employer, union, OSHA, or any other government agency about job safety and health hazards; or for participating in OSHA inspections, conferences, hearings, or other OSHA-related activities.

What work-site programs or systems are currently used to help make safety and health an integral part of each job?

DOE hazardous-waste sites use the Integrated Safety Management (ISM) approach that incorporates safety into management and work practices at all levels. An important guiding principle is to evaluate all types of work and hazards, and then identify and implement safety standards and requirements to protect the public, the workers, and the environment. One of the core functions of the ISM is to provide feedback and continuous improvement through worker and management commitment.

OSHA's Voluntary Protection Programs complement the ISM system by rewarding good safety management programs that go beyond OSHA standards to protect workers more effectively than simple compliance.

What are OSHA's Voluntary Protection Programs (VPPs)?

OSHA's Voluntary Protection Programs are designed to recognize and promote effective safety and health management. In the VPP, management, labor, and OSHA establish a cooperative relationship at a workplace that has implemented strong safety and health programs.

- Management agrees to operate an effective program that meets an established set of criteria.
- Employees (and their unions) agree to participate in the program and work with management to assure a safe and healthful workplace.
- VPP-participant sites must not only remain compliant with OSHA's rules, but also excel by using flexible and creative safety strategies that go beyond the requirements. OSHA initially verifies that the program meets the VPP criteria. OSHA then publicly recognizes the site's exemplary program, and removes the site from routine scheduled inspection lists. (OSHA may still investigate major accidents, valid formal employee complaints, and chemical spills.)
- OSHA also reassesses periodically to confirm that the site continues to meet VPP criteria.

What are the benefits of participating in OSHA's VPP?

Employer, employee, and OSHA benefits include:

- Improved employee motivation to work safely, leading to better quality and productivity.
- Reduced workers' compensation costs.
- Recognition in the community.

- VPP-participant sites generally experience from 60- to 80-percent fewer lost workday injuries than would be expected of an “average” site of the same size in their industries.
- Cooperative interaction with OSHA gives contractors, employers, and employees the opportunity to provide OSHA with input on safety and health matters.

Does more employee involvement mean that workers participating in these programs must now assume legal responsibility for complying with regulations?

Participation in any of the programs does not diminish existing employer and employee responsibilities and rights under the OSH Act and, for Federal agencies, under 29 CFR 1960. The site culture must enable and encourage effective employee involvement in the planning and operation of the safety and health program, and in decisions that affect employees’ safety and health. However, although employees are given more responsibility for their own safety and health, workers taking part in an OSHA-approved VPP safety and health program do not assume the employer’s statutory or common law responsibilities for providing safe and healthful workplaces. Employees or their representatives are not expected to guarantee a safe and healthful work environment.

Why do government agencies require specific HAZWOPER training?

Workers at hazardous waste sites face the additional challenges of working in often unpredictable and potentially dangerous environments. A general understanding of the HAZWOPER standard can greatly reduce the possibility of harm from exposure to hazardous materials.

HAZWOPER Quick Reference	
¶*	Subject
(a)	Scope, Application, and Definitions - operations covered by the standard
(b)	Health and Safety Plan - requirements of a written program
(c)	Site Characterization and Analysis - evaluation of hazardous waste sites
(d)	Site Control - control of employee and public exposure before cleanup begins
(e)	Training - requirements according to job function and responsibility
(f)	Medical Surveillance - employee covered and program requirements
(g)	Engineering Controls, Work Practices, and PPE - protection of employees with emphasis on PPE Program
(h)	Monitoring - procedures to assure proper selection of engineering xontrols, PPE, and work practices based on monitoring results
(i)	Informational Programs - communicate with employees, contractors, and subcontractors regarding possible exposures
(j)	Handling Drums and Containers - handling, transporting, labeling, and disposing
(k)	Decontamination - removal of contaminants from personnel and equipment
(l)	Emeergency Response by Employees at Uncontrolled Hazardous Sites - planning prior to start of a hazardous waste operation
(m)	Illumination - lighting requirements
(n)	Sanitation at Temporary Work Places - water and toilet facilities
(o)	New Technology Programs - introduction and evaluation of new technologies and equipment
(p)	Operations Conducted Under RCRA - operations at TSD facilities
(q)	Emergency Response to Hazardous Substances Release - response, containment, and cleanup
¶* = paragraph	

Table 1.2

Updates

Government standards and regulations are occasionally reviewed and revised. The "Update" section within each of the following topic areas will highlight changes where applicable. In many cases, OSHA and other regulatory agencies rewrite regulations in more plain language in order to simplify them.

For example, OSHA's revised injury and illness recordkeeping rule went into effect on January 1, 2002. There are major differences between OSHA's old 29 CFR 1904 recordkeeping rule and the new rule that employers began using in 2002. The new OSHA Form 300 (Log of Work-Related Injuries and Illnesses) has been simplified and can be printed on smaller legal-sized paper. (This topic is covered in greater detail in the specific "Medical Surveillance" chapter.)

Revisions to the Voluntary Protection Programs to Provide Safe and Healthful Working Conditions.

Voluntary Protection Programs (VPPs) adopted by OSHA in Federal Register Notice 47 FR 29025, July 2, 1982. VPP participation requirements center on comprehensive management systems with active employee involvement to prevent or control the safety and health hazards at the worksite. Employers who qualify generally view OSHA standards as a minimum level of safety and health performance and set their own more stringent standards where necessary for effective employee protection.

On June 22, 2011 OSHA issued a Notice of Proposed Rulemaking to modify the industry coverage of the recordkeeping rule and the Fatality/Catastrophe reporting requirements.

OSHA's experience with VPP and other programs led it to publish its voluntary "Safety and Health Program Management Guidelines" (the Guidelines) in the Federal Register on January 26, 1989, 54 FR 3904. The Guidelines present effective criteria for organizing a managed safety and health program. To maintain consistency in OSHA's approach to safety and health program management, the Agency has decided to reorganize the VPP criteria to conform more closely to the Guidelines.

The revisions were effective January 1, 2001 (except III.F.4.a.(2) and III.G.4.— effective July 24, 2000). The VPP criteria have been rewritten to make them more easily understood, in keeping with the President's "Plain Language in Government Writing" Memorandum of June 1, 1998. This has involved changes in both language and organization. However, except for a variety of minor clarifications, the substance of the criteria has changed little.

The three most notable changes are an expansion of eligibility to certain classes of worksites previously not covered by the program; increased expectations concerning the management of the safety and health of contractors' employees working at VPP sites; and a new illness reporting requirement. This last means OSHA will consider a worksite's illness experience together with its injury performance when assessing the site's level of achievement.

Chapter 2
Health and Safety Plan

Issues and topics for discussion:

- Why is the employer's written Health and Safety Plan (HASP) required for a hazardous waste site?
- What are the functions of Health and Safety Plans?
- Why is site characterization important?
- Discuss the three phases of site characterization and the role of site zones.
- What are the required components of the HASP
- Where and to who must the HASP be available

Introduction

Planning is critical to protect the health and safety of workers performing clean up at hazardous waste sites. A Health and Safety Plan (HASP) is required to identify, evaluate, and control the health and safety hazards at the site, and to facilitate emergency response. It is an organization-wide policy.

The HASP must be maintained by the employer and made available to all employees, union representatives, contractors, subcontractors, and regulatory-agency compliance officers.

HASP Table of Contents (Sample)			
	Title	Sections	
1.0	Introduction	1.1 1.2	Scope and applicability of the sire HASP Visitors
2.0	Key Personnel/ Identification Of Health And Safety Personnel	2.0 2.1 2.2 2.3	Key Personnel/Identification of Health and Safety Personnel Key Personnel Site-specific health and safety personnel Organizational responsibility
3.0	Task/Operation Safety And Health Risk Analysis	3.1 3.2	Historical overview of the site Task-by-task risk analysis
4.0	Personnel Training Requirements	4.1 4.2 4.3	Pre-assignment and annual refresher training Site supervisors training Training and briefing topics
5.0	Personal Protective Equipment	5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9 5.10	PPE Selection PPE use and limitations Work mission duration PPE maintenance and storage PPE decontamination and disposal PPE training and proper fitting PPE donning and doffing procedures PPE inspection procedures Evaluation of PPE Program effectiveness Limitations

HASP Table of Contents (Sample Continued)			
	Title	Sections	
6.0	Medical Monitoring Program Requirements	6.1 6.2 6.3 6.4	Baseline or pre-assignment monitoring Periodic monitoring Site-specific medical monitoring Exposure/injury/medical support
7.0	Frequency And Types Of Air Monitoring/Sampling	7.1 7.2	Direct-reading monitoring instruments Site Air Monitoring program
8.0	Site Control Measures	8.1 8.2 8.3 8.4 8.5 8.6	“Buddy” system Site Communications Program Work zone definition Nearest medical assistance Safe work practices Emergency alarm procedures
9.0	Decontamination Plan	9.1 9.2 9.3 9.4	SOPs Levels of decontamination protection required for personnel Equipment decontamination Disposal of decontamination wastes
10.0	Emergency Plan	10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9	Pre-emergency planning Personnel roles and lines of authority Emergency recognition/prevention Evacuation routes/procedures Emergency contact/notification system Emergency medical treatment procedures Fire or explosion Spill Containment Program Emergency equipment/facilities
11.0	Permit-Required Confined Space Entry	11.1 11.2 11.3 11.4	Definitions General provisions Procedures Confined space observer (standby person)
12.0	Hazard Communication	12.1 12.2 12.3	Written Program Inventory Training

Table 2.1

Ten Elements of a Health and Safety Plan

OSHA requires the health and safety plan to cover a minimum of the following 10 elements:

1. Health and safety risk or hazard analysis
2. Employee training
3. Personal protective equipment (PPE)
4. Specific medical monitoring
5. Air monitoring
6. Site control
7. Decontamination
8. Emergency response
9. Confined spaces
10. Spill containment

The HASP must available to employees. Be sure to review it and ask questions.

Health and Safety Risk or Hazard Analysis

In simplest terms, what will you be dealing with? The HASP is only as effective as the accuracy of the information about the site itself and the hazardous materials contained there.

Determining the health and safety risk and analyzing the hazards is called site characterization. It's a three-phase process.

The first step is **off-site characterization.** As much research and evaluation as possible is done beforehand away from the site so that workers can be protected the first time they actually enter it. The employer gathers data about atmospheric hazards that can be inhaled, any immediately dangerous to life or health atmospheres, and any other conditions that are pertinent. This information can be attained through a research of records, interviews with those who know the site, and a survey of the site's perimeter. Here are examples of the data that can be acquired before site entry:

- Site and topographic maps, geological surveys, and photographs
- Previous surveying, sampling, and monitoring data
- Meteorological and groundwater data

Indicators of Dangerous Conditions

- Confined spaces that must be entered, such as containers, tanks, buildings, or trenches
- Bulging drums, foaming, or gas generation
- Extremely hazardous materials (for example, cyanide, phosgene)
- Visible vapor clouds
- Biological indicators (dead animals, vegetation)
- Strange odors

- Site, generator, transporter, and utility records
- Federal, state, and local regulatory and enforcement agency records
- Waste storage inventories, manifests, and shipping papers
- Interviews with workers and nearby residents
- Media reports

At a site where the hazards are largely unknown or there is no need to go on site immediately, observation and sampling should be done from the perimeter.

The next step is on-site surveys and assessments. Based on the information from the off-site characterization, you have some idea of what you'll face. Still, there might be many unknown hazards present. That's why Level B PPE is the minimum level of protection recommended for entering the site the first time. You should also monitor the air and make a visual survey of potential hazards. Additional sampling of soil and water is also recommended.

The initial entry team should consist of four people: two who are fully protected with PPE and respirators and two outside support people also in PPE prepared to assist in an emergency.

The information gained during the on-site assessment should prove invaluable in revising the first draft of the HASP. The survey should identify the hazards present. It should also give an accurate idea of the location, size, topography, and accessibility of the site. That's important for establishing zones.

Once work begins at the site, there will usually be three zones. The exclusion zone is the contaminated area itself. The contamination reduction zone is where decontamination takes place. The support zone is the "clean" area where administrative activities take place. The initial survey and assessment provide the information necessary to determine where to establish those zones, including evacuation routes.

The final phase of the site characterization process is ongoing monitoring. This provides the safety and health officer with data that might indicate the need to change the HASP. For instance, levels of airborne contaminants might have risen or decreased, new tasks might have begun, or site conditions have changed, especially weather. The monitoring makes certain the health and safety plan remains a living document.

The final HASP describes the activities to be completed during cleanup and how long they should take.

Employee Training

OSHA regulations work to ensure that you are properly trained and prepared before you tackle hazardous waste work. OSHA requires that you receive a minimum of 40 hours of training. The instruction should help you recognize and understand the health and hazards found on hazardous waste sites. It should also teach you how to protect yourself and your coworkers from these hazards.

OSHA also requires that you receive a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor when you begin a job. This additional training helps you work safely with the specific hazards at the site you're assigned to. The safety and health officer provides you with a copy of the health and safety plan and reviews it with you to highlight the most significant hazards. Then the supervisor can alert you to such things as especially dangerous toxic chemicals, possible explosive or radioactive danger, unusual containers, unstable ground or unusual terrain, or an unfamiliar type of cleanup work. Note that only a portion of the actual supervised field experience takes place during the first three days on the job. You receive the rest of the field experience as the job calls for it.

The following table summarizes general training requirements when working at uncontrolled hazardous waste sites.

Type of Employee	Training Required
General site employees	• 40 hours classroom training • 24 hours supervised field experience
Occasional and general site employees unlikely to be exposed above permissible exposure limits	• 24 hours classroom training • 8 hours supervised field experience
Supervisors	• 40 hours classroom training • 8 hours supervisory training
Site employees assigned site emergency response duties	• 40 classroom training • Training to a level of competency
All site workers	• 8 hours annual refresher training

Table 2.2

Personal Protective Equipment

The health and safety plan details the specific personal protective equipment (PPE) that is supplied for that site. You are required to pass a fit test for the type of respirator to be used there. You also learn about any special clothing needed for hazards unique to that site. The safety and health officer trains you on the site's self-contained breathing apparatus (SCBA) if you're unfamiliar with it. You also will be notified of any updates or changes in the PPE.

Specific Medical Monitoring

The HASP identifies the standard medical monitoring program for the site. Of course, the medical monitoring requirements vary from site to site, depending on the conditions of the site and the chemicals you are exposed to. For example, if previous investigations of the site showed the presence of chemicals that attack specific organs, you might be regularly tested for exposure to them, such as routine urinalysis to test for lead exposure.

The monitoring also can vary from worker to worker depending on the task each worker is doing. For instance, if you work much of the time with a particularly noisy piece of equipment, your hearing might be monitored.

Air Monitoring

One of the most dangerous hazards you're exposed to when hazardous materials are present is airborne contaminants. That's why respiratory protection is so important. It's also why the health and safety plan must have a thorough air monitoring system in place. The plan lists the chemicals to be monitored, how frequently the air is to be checked, any activities that require additional monitoring, action levels (levels that trigger evacuation or ending an activity when exceeded), and the types of monitoring instruments to be used, including how they are to be calibrated and maintained.

Site Control

Site control is important to reduce worker contamination, site control is also important to prevent the contamination from spreading outside the site through workers or equipment leaving. The HASP should cover the following site control requirements:

- Security and physical barriers exclude unnecessary personnel from the general area.
- The minimum number of workers and equipment needed for a job is used.
- Work zones are established.
- Control points regulate access to work zones.
- Operations are conducted in a way that reduces personnel and equipment exposure and eliminates the potential for airborne movement.
- Decontamination procedures are in place.

The following elements of the HASP address site control:

- A site map shows the topography of the site, prevailing wind direction, drainage, and the location of buildings, containers, impoundments, pits, ponds, streams. The map lays the groundwork for planning, assigning personnel, identifying access and evacuation routes and problem areas, and determining the areas requiring PPE. The map should be prepared before site entry.
- In order to control hazardous materials from contaminating areas outside the site, the HASP designates work zones. The zones feature access control points to limit movement between zones. Typically there are three zones: the exclusion zone, the contamination reduction zone, and the support zone.

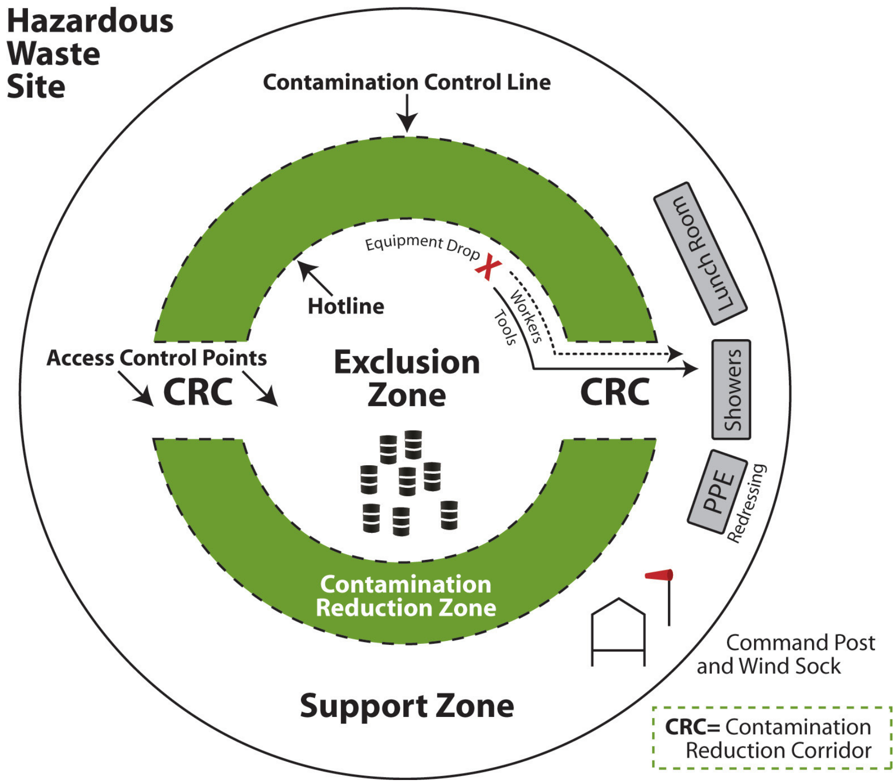

Figure 2.1

- The **exclusion zone** is the area where the hazardous materials are present and where contamination occurs. It's sometimes called the "hot zone." It's the innermost of the three zones and requires appropriate PPE for those entering it.
- The **contamination reduction zone** is where decontamination takes place. It's the transition area between the contaminated exclusion zone and the clean support zone. Generally there are two contamination reduction zones, one for people and one for equipment and tools.
- The **support zone** is the area on the outermost part of the site and is considered noncontaminated, or clean. The command post is always located in the support zone.

- The **buddy system** is standard operating procedure when working in a hazardous area. By always performing work with another or within a group or team, you have someone to assist you if something goes wrong, to check each other for chemical or heat exposure, to check each other's protective clothing periodically, and to call for emergency help. The access control point to enter the exclusion zone is a prime place for enforcing the buddy system.

- Site security is important for a number of reasons: It prevents unauthorized, unprotected people from exposure to the site's hazards. It protects against vandals and illegal dumping. It prevents theft and promotes safe working conditions. Here are some security tips the HASP can require:
  - Maintain security in the support zone and at access control points.
  - Establish an identification system.
  - Assign responsibility for enforcing entry and exit requirements.
  - Erect a fence or other barrier around the site.
  - If there's not a fence, post signs and have guards patrol the perimeter.

- A hazardous waste site requires two types of site communications. The external communications system connects the site with important outside agencies such as the fire department, police, hospital, or rescue team. The internal system is used to notify workers of emergencies, communicate work changes, maintain site control, or pass along safety information such as the amount of air or time left before the next rest period. Visual signals can be worked out ahead of time to help with the difficulty of communicating in loud environments or when PPE is being worn.

- Standard operating procedures (SOPs) are uniform instructions for doing a specific job. Learning the safety SOPs is a major part of the preparation you do when working with hazardous waste. They exist to protect your safety and to maintain the control and safety of the site. Follow them at all times.

Decontamination

You review decontamination in depth elsewhere in this training, but know that the HASP must describe the specific decontamination methods for the site. The HASP explains the decontamination procedure that must be in place before any workers or equipment enter an area where potential exposure might occur.

The decontamination section of the HASP also explains the disposal of contaminated clothing and decontamination water along with requirements for showering and cleaning contaminated clothing.

Emergency Response

Within the overall health and safety plan resides another important written document, the emergency response plan. This training goes into the emergency response plan in far greater detail elsewhere. In summary, the emergency response plan takes care of the advance planning; the personnel roles; the incident command system; the site map for emergency use; the communication and locator systems; the equipment needs; training and drills; escape routes, refuges, and selfrescue; emergency response procedures; request for off-site assistance; follow-up; and emergency aid and medical treatment. It’s important to know your role in an emergency and how to react. This plan within the overall HASP offers you that information.

Confined Spaces

Again, this training goes into depth elsewhere on working in confined spaces. Remember that confined spaces offer some of the deadliest hazards you face on a hazardous waste site or any jobsite for that matter. Your job might take you into these spaces, though, for testing, inspecting, working, and repairing. The HASP must have a program for training you in working within confined spaces. The safety and health officer is responsible for making certain you receive and understand this training.

Spill Containment

Making a bad situation worse. That's what can happen when a hazardous material spills at a hazardous waste site. The spill can put more people at risk of exposure, so it's vital to contain the spill and clean it up. The HASP outlines the steps for reducing the likelihood of a spill, containing spilled material and handling it quickly, alerting personnel if an emergency develops, and notifying the appropriate agencies.

Prevention is always the best cure, so an effective spill containment plan lists procedures for handling containers. The plan also provides for appropriate equipment, such as drum handling equipment and pumps, along with the use of carrier boxes and bins.

Containing a spill can involve several approaches outlined in the plan: berms and dikes, overpacks, diversion and collection trenches or ditches, collecting pans under equipment, absorbent materials, and vapor suppression and solidification agents/foams.

The emergency response plan identifies who decides the appropriate response in a spill and what response is necessary, such as evacuation. A hazardous material spill also might require certain federal, state, or local agencies to be notified.

Establishing Site Control Zones

How many people make up the initial entry team?

The entry team should consist of at least four persons: two properly protected workers who will enter the site, and two outside support persons suited in PPE and prepared to assist in case of an emergency. The "buddy system" is used as a safety measure so that each member of the group is observed by at least one other member.

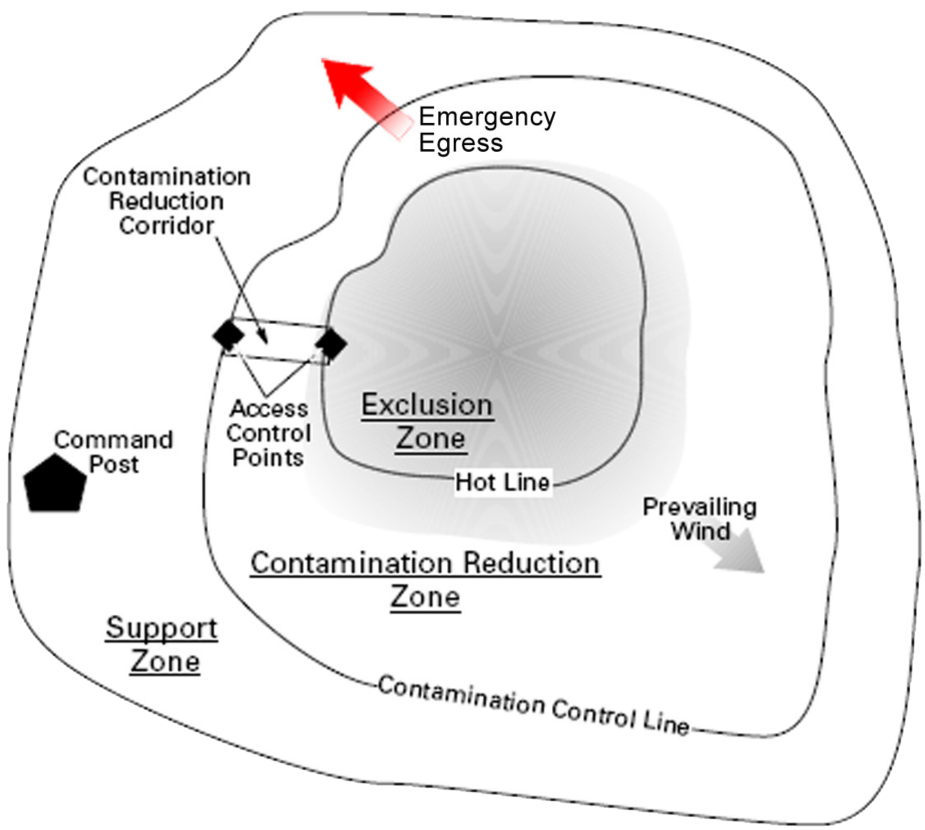

Figure 2.2

What is the purpose of site control zones and how are they established?

The purpose of site control is to reduce the possibility of contaminating workers and to protect the public from site's hazards.

At most sites, any sampling done during the initial site entry will provide accurate information about the level of PPE and the proper designation of work zones.

What are the three site control zones?

The site is divided into three general zones:

Exclusion Zone
This is the contaminated area. The primary work performed in this zone is clean-up work, such as contaminant excavation, drum removal, drum staging, and materials bulking, and installation of wells for groundwater monitoring.

The hot-line boundary of the exclusion zone should be clearly marked by hazard tape and signs, or enclosed by physical barriers. Access control points should be set up at the boundary of the exclusion zone to control the flow of workers and equipment, and to allow verification that the proper procedures for entering and exiting are followed.

Contamination Reduction Zone (CRZ)
This is the transition area between the exclusion zone and the support zone. Because of the contamination present in the CRZ, the workers assigned there should wear appropriate protection. Entry to and exit from the CRZ is done only through access control points located in the Contamination Reduction Corridor.

The **Contamination Reduction Corridor (CRC)**, located within the CRZ, is the area where decontamination is performed. At least two decontamination lines should be set up, one for tools and equipment, and the other for workers.

Support Zone
This is the "clean" area where the command post, medical station, equipment and supply centers, and administrative offices are located.

Should the HASP be amended if conditions change?

Once the initial site entry is done, the site manager is responsible for updating the original HASP to reflect changes. Site characterization is a continuous process.

- Workers should be alert for new information about site conditions. At each phase, information should be gathered and evaluated to determine the possible hazards and whether the HASP needs modification.
- If a subcontractor is working at a site, the subcontractor should carefully evaluate and identify all work and prepare an addition to the HASP for any hazards. An approved plan must be developed for each site-specific area before work can start. This assessment can then be used to amend the original Health and Safety Plan.
- The HAZWOPER Standard requires that the site HASP be updated when a new technology is introduced to a site.

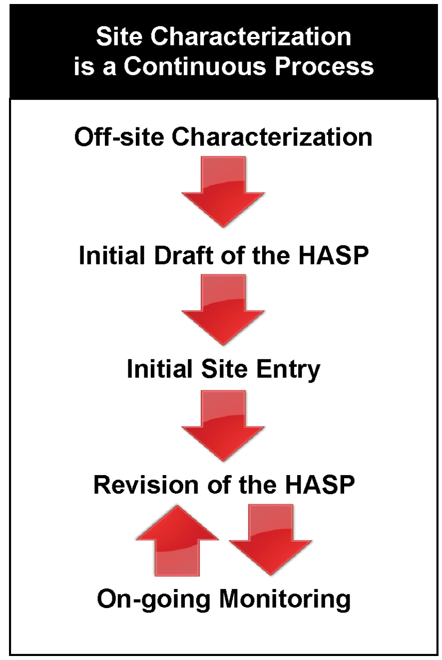

Figure 2.3

How often must monitoring be done after the HASP has been established?

On-going monitoring during remediation provides a continuous source of information about site conditions. Periodic monitoring should be done when:

- Work begins at new location or site;
- Exposures have risen above the PELs;
- Site conditions change, especially weather;
- Other dangerous conditions exist; or
- New tasks are initiated.

Monitoring should be performed on workers who may have the highest exposures to hazards.

What is the best way to assess, report, and communicate safety and health hazards associated with innovative remediation technologies?

The Technology Safety Data Sheet (TSDS) is a proactive, standardized tool to analyze and address worker safety and health concerns associated with new technologies. The TSDS:

- Improves new technology design by focusing on and enhancing safety in the development phase, before it is deployed in the field.
- Provides workers with information to work more safely and efficiently by:
    - Identifying hazards.
    - Communicating risk ratings for potential safety and health hazards.
    - Prescribing required safety and health precautions.

The TSDS can be incorporated into a site's required Hazard Communication or HASP informational program, particularly the site-specific elements of required HAZWOPER training.

> The HASP must be maintained by the employer and made available to all employees; be sure to review it and ask questions.

Training Requirements – HazardousWaste Cleanup Operations	
Workers [1910.120(e)(3)]	
• General site employees (e.g., equipment operators, general laborers, etc.) [1910.120(e)(3)(i)]	• 40 hours initial training • 24 hours supervised field experience • 8 hours annual refresher
• Employees occasionally on site for a limited task (e.g., groundwater monitoring, land surveying, etc.) with minimal exposure [1910.120(e)(3)(ii)]	• 24 hours initial training • 8 hours supervised field experience • 8 hours annual refresher
• Employees regularly on site who are not exposed to health hazards [1910.120(e)(3)(iii)]	• 24 hours initial training • 8 hours supervised field experience • 8 hours annual refresher
• Employees under (e)(3)(ii) or (iii) who become general site workers under (e)(3)(i) [(e)(3)(iv)]	• 16 hours of additional training • 16 hours of additional supervised field experience
Supervisors/Managers [1910.120(e)(4)]	
• Supervisors of general site employees (e.g., equipment operators, general laborers, etc.)	• 40 hours initial training • 24 hours supervised field experience • 8 hours of specialized training in employer’s safety and health-related programs • 8 hours annual refresher
• Supervisors of employees occasionally on site for a limited task (e.g., groundwater monitoring, land surveying, etc.) with minimal exposure	• 24 hours initial training • 8 hours supervised field experience • 8 hours specialized training in employer’s safety and health-related programs • 8 hours annual refresher
• Supervisors of employees regularly on site who are not exposed to health hazards	• 24 hours initial training • 8 hours supervised field experience • 8 hours specialized training in employer’s safety and health-related programs • 8 hours annual refresher

Table 2.3

Chapter 3
Toxicology

Issues and topics for discussion:

- Why is it important to understand how chemicals affect the body?
- How can workers avoid exposure to hazardous substances by being aware of the most common routes of entry?
- Is it safe to assume that small doses of a toxic chemical are harmless as long as workers do not experience adverse health effects?
- Why are time-weighted average exposure limits especially important for employees who work more than 8-hours per day?

Introduction

Toxicology is the science of poisons. The damage done to the body by a chemical is called toxicity. It is often difficult to distinguish between an illness and a reaction to a toxic substance. Workers who encounter hazardous chemical exposure need to understand how chemicals affect the body.

What are the factors that influence how toxic chemicals can damage workers' health?

Hazardous chemicals can damage workers' health in a variety of ways, depending on:

- The way in which the body is exposed to it,
- The amount and nature of the chemical,
- The sensitivity of the individual, and
- The dose/duration of the exposure.

How do hazardous chemicals enter or affect the body?

Common routes of entry are:

- Inhalation; breathing any contaminant into the lungs can quickly transmit it to the blood and to all parts of the body.
- Absorption; may enter the bloodstream.
- Skin contact; may do local damage to the skin.
- Ingestion; workers can carry chemicals to their mouths on contaminated hands by eating, drinking, smoking, or applying cosmetics in contaminated areas.
- Injection; pressurized gas or liquid can puncture the skin.

What happens to a chemical that enters the body?

The body can do three things with the chemical separately or simultaneously:

1. Metabolize it,
2. Store it, or
3. Excrete it.

The structure of the chemical determines how it interacts with the body. For example, if the body can quickly excrete the chemical, it will have less chance to do damage.

Do hazardous chemicals in the body affect everyone in the same way?

Individuals can be more or less susceptible. The very young and the very old are less able to metabolize and excrete chemicals. Individuals with underlying illnesses that affect metabolism, like kidney or liver disease, have less tolerance for toxic substances. Some chemicals affect males and females differently, possibly based on hormonal differences and body composition. There is also the hazard that pregnant or nursing women can pass on a toxic chemical to the baby. What other differences may affect the way chemicals react with your body?

In what ways do toxic chemicals affect "target organs"?

Toxic chemicals damage the body by speeding up or slowing down body functions. The poison may have widespread effects throughout the body, or cause changes in the function of just one organ. The organs most affected by toxic substances are called "target organs". For example:

- Toxic materials that penetrate to the inner layer of **skin** may have direct access to the bloodstream. Benzene not only causes a rash and very dry skin, but also can be absorbed and cause leukemia, a cancer of the blood.
- Signs and symptoms of damage to the **central nervous system** (the brain and spinal cord) include staggering, slurring of speech, dizziness, trembling, and twitching.
- Some toxic materials (such as ketone) may have an acute effect on normal **liver** functions. Chronic exposure could produce cirrhosis (alcohol) and liver cancer (carbon tetrachloride).
- Some chemicals, for example ethylene glycol (antifreeze), can cause such severe damage to the **kidneys** that kidney failure results.
- **Blood** circulates oxygen, carbon dioxide, infection-fighting organisms, proteins, sugars, and sometimes toxic materials throughout the body. Within the circulatory system the following may be affected by toxic materials:
  - Bone marrow - produces red blood cells.
  - Platelets - assist in blood clotting.
  - White blood cells - fight infections and foreign materials.
  - Red blood cells - carry oxygen and carbon dioxide in the blood.

- Some contaminants cause **reproductive system** problems in one or both sexes. Common problems are sterility, infertility, and disrupted hormone activity.

- There are four groups of toxic materials that can produce acute or chronic effects to the **respiratory system:**
  - Simple asphyxiants - gases which replace oxygen in the atmosphere.
  - Chemical asphyxiants - gases like carbon monoxide or carbon dioxide which interfere with the body's ability to use oxygen.
  - Irritants - substances which cause coughing or wheezing, for example, ammonia.
  - Fibrotic agents - substances which cause lungs to become scarred and less efficient, for example, silica and asbestos.

- Corrosives damage the **eyes** by direct contact. Some toxic materials can enter the eye and go directly into the bloodstream. Lacrimators, such as ether and irritant smoke, are substances that cause tearing of the eyes. Eyes can serve as a direct route of absorption as well.

What is an "acute exposure"?

HAZCOM 2012: Acute toxicity refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.

Do acute exposures always cause "acute effects"?

An "acute exposure" is a single exposure to a chemical. "Acute toxicity or effect" is the development of symptoms soon after a single exposure to a chemical. Although an acute exposure is most likely to cause an acute effect, sometimes one severe exposure can cause permanent damage. Examples of acute effects are:

- Inhaled contaminants - coughing, wheezing, nose and throat burning, headache.
- Skin contact - redness, rash, blistering.
- Ingested contaminants - nausea, vomiting, diarrhea.

How do "chronic" exposures and effects differ from acute ones?

In contrast to acute, chronic means "occurring over a period of time". While an exposure to a substance may have no apparent effect on a worker's health, it is important to understand that chronic exposures to small doses can eventually cause injury. "Chronic effects" are serious health problems that occur after many years as a result of a toxic substance accumulating in the body. Chemical carcinogens, such as asbestos or silica, cause cancer, one of the most feared chronic effects.

Examples of Naturally-Occurring Toxicants		
Food	**Contains**	**Cause/Effects**
Mushrooms	Hydrazine	Carcinogen
Celery	Furocoumarin	Carcinogen
Alfalfa Sprouts	Canavanine	Affect the immune system
Black pepper, nutmeg, cinnamon	Safrole	Carcinogen
Chocolate	Theobromine	Carcinogens
Coffee	Chlorogenic Acid	Mutagen
Vitamin A	In very high doses is an animal teratogen	
Rutabagas	Contain a potent inducer of thyroid cancer	
Naturally occurring toxic compounds are in the foods we eat and have eaten for centuries. Remember, the chemicals are synthesized by the most accomplished chemist of all – a living plant. We survive these naturally occurring toxic compounds in our diet because our intake of them is very small and our built-in defense mechanisms take care of them.		

Table 3.1

Why is it critical that workers understand "dose response"?

The dose makes the poison. The amount of the chemical received by the body is the most important factor in determining whether the body is injured. Generally, the greater the dose, the greater the severity of the response to a particular toxic substance. If something isn't good for you, the less of it you get, the better off you are. The "dose-response curve" depicts the way in which an increase in the amount of the dose increases the severity of the response.

"The devil is in the dose."

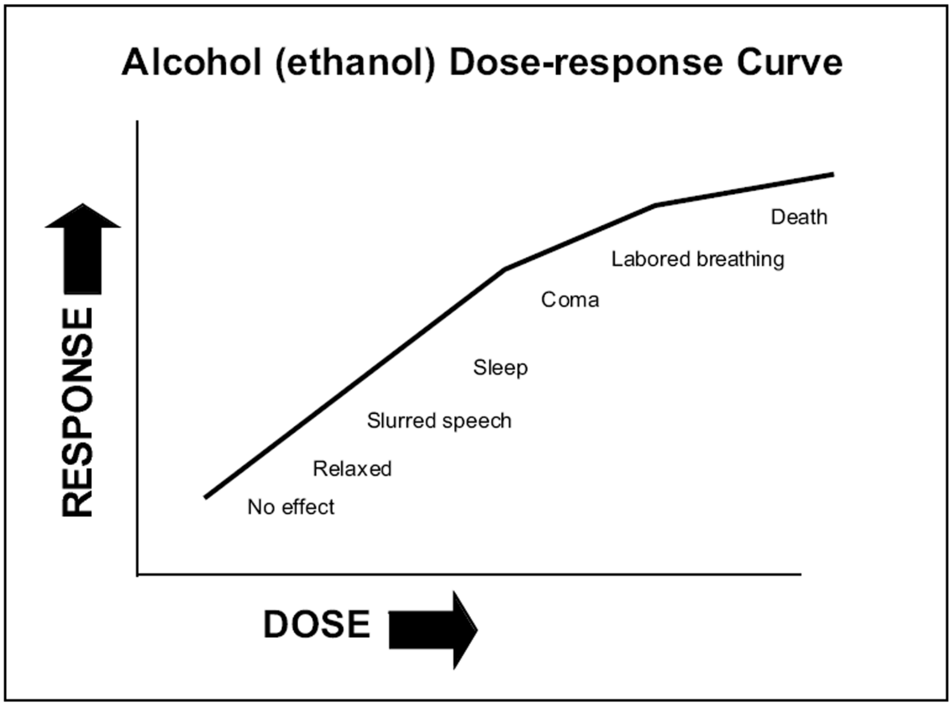

Figure 3.1

How can workers evaluate or compare the toxicity of chemicals they encounter on the job?

Dose-response terms, often found in Safety Data Sheets (SDSs) and other sources of health information, are useful for comparing the toxicity of chemicals:

- **LD50** (lethal dose for 50% of the subjects) is a term for a dose that kills half of the individuals who receive it. LD50 takes individual susceptibility into consideration - it is a midpoint between the most frail and the most hardy members of the group exposed.
- **LC50** (lethal concentration) is the concentration of a material in the air which is fatal to 50% of test animals subjected to a single, usually one-hour, exposure.

Factors Influening Toxicity			
Relating to the Chemical	**Relating to the Exposure**	**Relating to the Person Exposed**	**Relating to the Environment**
• Composition • Physical characteristics (liquid, solid, etc.) • Physical properties (volatility, solubility, etc.) • Presence of impurities • Breakdown products	• Dose • Concentration • Route of exposure • Duration	• Health status • Age • Previous illiness	• Media (air, water, soil) • Additional chemicals present • Temperature • Humidity

Table 3.2

What occupational exposure limits have been established, and which are enforceable by law?

OSHA Permissible Exposure Limits (PELs) are airborne concentrations of chemicals to which workers may be legally exposed to day after day for a lifetime.

- Measured in parts per million (ppm) by volume of vapor, gas, or other contaminants; or milligrams per cubic meter (mg/m^3), a weighted measurement of air concentrations of gases, vapors, mists, fumes, dusts, and fibers in a given area.
- The lower the PEL, the more dangerous the chemical.
- PELs are published by OSHA. Only OSHA PELs are legally binding, but they do not necessarily provide the highest level of protection.

ACGIH Threshhold Limit Value (TLVs) are airborne concentrations of substances. TLVs represent conditions under which it is believed nearly all workers may be repeatedly exposed, day after day, without adverse effect.

- Measured in ppm or mg/m^3.
- The lower TLV, the more dangerous the chemical.
- TLVs are ACGIH recommendations.

NIOSH Recommended Exposure Limits (RELs) are recommended airborne concentrations of chemicals. RELs are NIOSH recommendations; they are not enforceable. They are published in NIOSH criteria documents along with appropriate means to reduce adverse health effects

Time-Weighted Average (TWA) refers to oncentrations of airborne toxic materials weighted for a certain time duration, usually eight hours.

- Expressed in ppm or in mg/m^3.
- TWA is applicable to the PEL or TLV. It is important to remember that most PELs are calculated for eight-hour workdays. When workers put in a ten-hour day, they can easily be overexposed. Time-weighted average exposure evolved as a method to calculate daily or full-shift average exposures.

To Calculate TWA
$\frac{\text{Measured concentration x hours worked within concentration}}{\text{8 hours}} = \text{TWA}$
Example 1: The worker works with a chemical for 8 hours. The measurement of exposure showed the worker's exposure was 800 ppm and the PEL was 800 ppm. What is the TWA? Is the worker overexposed? The calculation is:
$\text{TWA} = \frac{\text{(800 ppm x 8 hours)}}{\text{8 hours}} = \text{800 ppm}$
Example 2: What if the worker works with the chemical for 10 hours? What is the TWA? Is the worker overexposed? The calculation is:
$\text{TWA} = \frac{\text{(800 ppm x 10 hours)}}{\text{8 hours}} = \text{1,000 ppm}$

Table 3.3

Short-Term Exposure Limit (STEL) (also TLV-STEL) is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) only 4 times throughout the day with at least one hour between exposures.

Ceiling Limit (C) (also TLV-C) is an airborne concentration of a toxic substance in a work environment that may never be exceeded at any time. Ceiling is even more restrictive than STEL. If a concentration in a work environment has met or exceeded the Ceiling, that environment should not be entered unless proper PPE is used.

Immediately Dangerous to Life or Health (IDLH) is any atmosphere that poses an immediate (acute) hazard to life or poses immediate, irreversible debilitating effects on health.

Where can employees find information on exposure limits for the toxic chemicals that they may work with at their job site?

Exposure limits for specific hazardous chemicals are found in section 8, Exposure Controls – Personal Protection section of each SDS that must be provided by the employer .

What exposures have you encountered at work or at home and where can information for them?

Parts per Million: Realistic Equivalencies

1 inch/16 miles

$12 \frac{\text{inches}}{\text{foot}} \times 5{,}280 \frac{\text{feet}}{\text{mile}} \times 16 \text{ miles} = 1{,}013{,}760 \text{ inches}$

1 yard/10,000 Football fields

$100 \frac{\text{yards}}{\text{field}} \times 10{,}000 \text{ fields} = 1{,}000{,}000 \text{ yards}$

1 minute/2 years

$60 \frac{\text{min}}{\text{hour}} \times 24 \frac{\text{hour}}{\text{day}} \times 365 \frac{\text{days}}{\text{year}} \times 2 \text{ years} = 1{,}051{,}200 \text{ minutes}$

1 hour/115 years

$24 \frac{\text{hour}}{\text{day}} \times 365 \frac{\text{day}}{\text{year}} \times 115 \text{ years} = 1{,}007{,}400 \text{ hours}$

1 fluid ounce/8,000 gallon semi-truck tanker

$16 \frac{\text{oz}}{\text{pint}} \times 2 \frac{\text{pint}}{\text{quart}} \times 4 \frac{\text{qt}}{\text{gallon}} \times 8{,}000 \text{ gallons} = 1{,}024{,}000 \text{ fl. ounces}$

1 cubic inch/room size 8’ x 10’ w/8’ ceiling

$8' \times 10' \times 8' \times 1728 \frac{\text{cubic inch}}{\text{cubic foot}} = 1{,}105{,}920 \text{ cu. inches}$

(12” x 12” x 12”) = 1,728 cu. inches)

1 second/11 days

$60 \frac{\text{sec}}{\text{min}} \times 60 \frac{\text{min}}{\text{hour}} \times 24 \frac{\text{hour}}{\text{day}} \times 11 \text{ days} = 950{,}400 \text{ seconds}$

$\times 12 \text{ days} = 1{,}036{,}800 \text{ seconds}$

Parts per Billion: Realistic Equivalencies

1 inch/16,000 miles

$12 \frac{\text{inch}}{\text{foot}} \times 5{,}280 \frac{\text{feet}}{\text{mile}} \times 16{,}000 \text{ miles} = 1{,}013{,}760{,}000 \text{ inches}$

1 square foot/36 square miles

$27{,}878{,}400 \frac{\text{sq. ft}}{\text{sq. mile}} \times 36 \text{ miles} = 1{,}003{,}622{,}400 \text{ square miles}$

1 second/32 years

$60 \frac{\text{sec}}{\text{min}} \times 60 \frac{\text{min}}{\text{hour}} \times 24 \frac{\text{hour}}{\text{day}} \times 365 \frac{\text{day}}{\text{year}} \times 32 \text{ years} =$

$1{,}009{,}152{,}000 \text{ seconds}$

Notes

Chapter 4
Hazard Communication

Issues and topics for discussion:

- Why is hazard communication important?
- What are employer's responsibilities for hazard communication?
- What are HAZCOM 2012 and the Globally Harmonized System of Hazard Classification?
- How does HAZCOM 2012 classify and communicate hazards to workers?

Introduction

Employees have both a need and a right to know the identities and hazards of the chemicals they are exposed to when working. They also need to know how to protect themselves from the adverse effects from exposure. The HazCom standard provides language that protects the worker from health hazards that may be encountered when the worker is exposed to even small amounts of a chemical.

What is hazard communication?

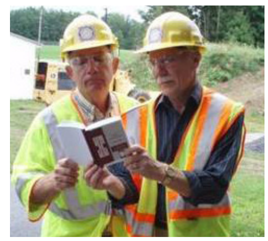

Figure 4.1 Workers strudy the Hazard Communication Standard on the job.

Hazard Communication (Hazcom) is the communication of chemical hazards to workers. Why is this important?

OSHA has a Hazcom standard. Why have one?

- 32 million workers work with, and are potentially exposed to, one or more chemical hazards - OSHA.
- 69,053,967 chemicals are commercially available - CHEMCATS
- Over 600 new chemicals are introduced every year - CAS
- Only 295,207 substances are inventoried or regulated-CHEMLIST
- Roughly 22% of workplace diseases and injuries are caused by chemicals- International Labor Organization

According to the International Labor Organization's (ILO) 2011 report on occupational disease, there are 41 known occupational diseases caused by chemical agents.

The Hazard Communication Standard is also known as:

- "Hazcom", also known as: "RIGHT TO KNOW"
- OSHA 29 CFR 1910.1200 or "HCS" or HCS 2012

OSHA describes the HCS as largely a performance-oriented standard that gives employers the flexibility to adapt the rule to the needs of the workplace, instead of having to follow specific, rigid requirements. Consequently, the HCS generally identifies categories of information to be included in the MSDS, including physical and chemical characteristics, physical hazards, and applicable precautions and/or control measures for handling materials safely.

The Hazard Communication Standard (HCS) is based on a simple concept: workers have both a need and a right to know the identities of the chemicals they are exposed to when working and the hazards associated with these chemicals. They also need to know what protective measures are available to prevent adverse effects from occurring. The HCS is designed to provide employees with the information they need.

Knowledge acquired under the HCS will help employers provide safer workplaces for their workers. When employers have information about the chemicals being used, they can take steps to reduce exposures, substitute less hazardous materials, and establish proper work practices. These efforts will help prevent the occurrence of work-related illnesses and injuries caused by chemicals.

The HCS addresses the issues of evaluating and communicating hazards to workers. Evaluation of chemical hazards involves a number of technical concepts, and is a process that requires the professional judgment of experienced experts. That's why the HCS is designed so that employers who simply use chemicals, rather than produce or import them, are not required to evaluate the hazards of those chemicals. Hazard determination is the responsibility of the producers and importers of the materials. Producers and importers of chemicals are then required to provide the hazard information to employers that purchase their products.

Employers that don't produce or import chemicals need only focus on those parts of the rule that deal with establishing a workplace program and communicating information to their workers. This course is a general guide for such employers to help them determine what's required under the rule. It does not supplant or substitute for the regulatory provisions, but rather provides a simplified outline of the steps an average employer would follow to meet those requirements.

29 CFR 1910.1200 contains 11 paragraphs and 6 appendices

a. Purpose
b. Scope
c. Definitions
d. Hazard classification
e. Written hazard communication program
f. Labels and other forms of warning
g. Safety Data Sheets
h. Employee information and training
i. Trade secrets
j. Effective dates
k. Other standards affected

App. Appendix: A through E

The HCS helps to ensure that workers and employers understand the hazards of chemicals they use or work around. HCS Appendices list mandatory requirements for hazard characterization, labels, SDS, trade secrets and non-mandatory guidance for carcinogens.

Requirements in the Hazcom standard protect workers

- Written Hazcom Program
- Chemical inventory and control
- Hazard classification of chemicals
- SDSs available for hazardous substances in the workplace
- Labeling of hazardous chemicals
- Training workers
- Makes required information available

What is a Hazcom Program?

Employers must develop, implement, and maintain a written, comprehensive Hazcom program at the workplace. A program is the employer's procedure for meeting the requirements of a particular regulation. Workers have the right to review the Hazcom program on work time.

The OHSA Hazard Communication Standard of 2012 incorporates GHS. The Hazard Communication Standard in 1983 gave the workers the 'right to know,' but the new Globally Harmonized System gives workers the 'right to understand.'

New changes to the Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard are bringing the United States into alignment with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), further improving safety and health protections for America's workers. Building on the success of OSHA's current Hazard Communication Standard, the GHS is expected to prevent injuries and illnesses, save lives and improve trade conditions for chemical manufacturers. The Hazard Communication Standard in 1983 gave the workers the 'right to know,' but the new Globally Harmonized System gives workers the 'right to understand.'

The new hazard communication standard still requires chemical manufacturers and importers to evaluate the chemicals they produce or import and provide hazard information to employers and workers by putting labels on containers and preparing safety data sheets. However, the old standard allowed chemical manufacturers and importers to convey hazard information on labels and material safety data sheets in whatever format they chose. The modified standard provides a single set of harmonized criteria for classifying chemicals according to their health and physical hazards and specifies hazard communication elements for labeling and safety data sheets.

Benefits: The new standard covers over 43 million workers who produce or handle hazardous chemicals in more than five million workplaces across the country. The modification is expected to prevent over 500 workplace injuries and illnesses and 43 fatalities annually. Once fully implemented it will also:

- Enhance worker comprehension of hazards, especially for low and limited-literacy workers, reduce confusion in the workplace, facilitate safety training, and result in safer handling and use of chemicals;
- Provide workers quicker and more efficient access to information on the safety data sheets;
- Result in cost savings to American businesses of more than $475 million in productivity improvements, fewer safety data sheet and label updates and simpler new hazard communication training; and
- Reduce trade barriers by harmonizing with systems around the world.

Rulemaking background: OSHA published a Notice of Proposed Rulemaking to update the Hazard Communication Standard in September 2009 and held public hearings in March 2010.

Major changes to the Hazard Communication Standard:

- **Hazard classification:** Chemical manufacturers and importers are required to determine the hazards of the chemicals they produce or import. Hazard classification under the new, updated standard provides specific criteria to address health and physical hazards as well as classification of chemical mixtures.
- **Labels:** Chemical manufacturers and importers must provide a label that includes a signal word, pictogram, hazard statement, and precautionary statement for each hazard class and category.
- **Safety Data Sheets:** The new format requires 16 specific sections, ensuring consistency in presentation of important protection information.
- **Information and training:** To facilitate understanding of the new system, the new standard requires that workers be trained by December 1, 2013 on the new label elements and safety data sheet format, in addition to the current training requirements.

Changes from the Proposed to the Final Rule: OSHA reviewed the record and revised the Final Rule in response to the comments submitted. Major changes include:

- Maintaining the disclosure of exposure limits (Threshold Limit Values [TLVs]) established by the American Conference of Governmental Industrial Hygienists (ACGIH) and carcinogen status from nationally and internationally recognized lists of carcinogens on the safety data sheets;
- Clarification that the borders of pictograms must be red on the label;
- Flexibility regarding the required precautionary and hazard statements to allow label preparers to consolidate and/or eliminate inappropriate or redundant statements; and
- Longer deadlines for full implementation of the standard (see the chart below).

What you need to do and when:

- **Chemical users:** Continue to update safety data sheets when new ones become available, provide training on the new label elements and update hazard communication programs if new hazards are identified.
- **Chemical Producers:** Review hazard information for all chemicals produced or imported, classify chemicals according to the new classification criteria, and update labels and safety data sheets.

Effective Comple-tion Date	Requirement(s)	Who
December 1, 2013	Train employees on the new label elements and SDS format.	Employers
June 1, 2015* December 1, 2015	Comply with all modified provisions of this final rule, except: Distributors may ship products labeled by manufacturers under the old system until December 1, 2015.	Chemical manufacturers, importers, distributors and employers
June 1, 2016	Update alternative workplace labeling and hazard communication program as necessary, and provide additional employee training for newly identified physical or health hazards.	Employers
Transition Period	Update alternative workplace labeling and hazard communication program as necessary, and provide additional employee training for newly identified physical or health hazards.	All chemical manufacturers, importers, distributors and employers
* This date coincides with the European Union implementation date for classification of mixtures.		

Table 4.1

Other U.S. Agencies: The Department of Transportation (DOT), Environmental Protection Agency, and the Consumer Product Safety Commission actively participated in developing the GHS. DOT has already modified its requirements for classification and labeling to make them consistent with United Nations transport requirements and the new globally harmonized system.

Global implementation: The new system is being implemented throughout the world by countries including Canada, the European Union, China, Australia, and Japan.

Additional information: More information on the hazard communication standard, including the link to the Federal Register notice, can be found on OSHA's hazard communication safety and health topics page at www.osha.gov/dsg/hazcom/index.html.

Why was GHS created?

Figure 4.2 GHS creates a global standard. Compare these two images representing before and after compliance to the GHS.

GHS uses hazard classification criteria and a harmonized hazard communication system to protect workers

Classification Criteria

- Health and Environmental Hazards
  - Acute Toxicity
  - Skin Corrosion/Irritation
  - Serious Eye Damage/Eye Irritation
  - Respiratory or Skin Sensitization
  - Germ Cell Mutagenicity
  - Carcinogenicity
  - Reproductive Toxicity
  - Target Organ Systemic Toxicity – Single and Repeated Dose
  - Hazardous to the Aquatic Environment
- Physical Hazards
  - Explosives
  - Flammability – gases, aerosols, liquids, solids
  - Oxidizers – liquid, solid, gases
  - Self-Reactive
  - Pyrophoric – liquids, solids
  - Self-Heating
  - Organic Peroxides
  - Corrosive to Metals
  - Gases Under Pressure
  - Water-Activated Flammable Gases
- Mixtures
- Hazard Communication
  - Labels
  - Safety Data Sheets

Figure 4.3 Sample warning labels can be found on construction materials.

Hazard classification under the HCS protects workers by applying mandatory hazard classification criteria

Now let us go to the core of GHS – the classification criteria for chemicals.

Chemical manufacturers and importers must classify each chemical they produce or import. The major steps in hazard classification are presented below:

- Determine the appropriate hazard classes and associated hazard categories
- Base this on an evaluation of the full range of available data/evidence on the chemical (no testing is required)
- Use Appendix A for health hazard criteria and Appendix B for physical hazard criteria
- The introduction to Appendix A provides the general approach to classification, including bridging principles (which is the approach used to determine classification of mixtures)

The GHS has set criteria for classification of chemicals according to 3 major hazards - physical, health and environmental hazards.

The hazard classification approach in the GHS is quite different from the performance-oriented approach in the HCS 1994. The GHS has specific criteria for each health and physical hazard, along with detailed instructions for hazard evaluation and determinations as to whether mixtures of the substance are covered. OSHA has included the general provisions for hazard classification in paragraph (d) of the revised rule, and added extensive appendixes that address the criteria for each health or physical effect. Mandatory Appendices A and B provide classification guidance for Health Hazards and Physical Hazards, respectively. The hazard classification criteria contained in the HCS 2012 is test method-neutral. That is, the person classifying a chemical or substance should use available data and no additional testing is required to classify a chemical. Please refer to the Summary and Explanation of the Final Rule to gain a better understanding of the changes.

(d)(1) Chemical manufacturers and importers shall evaluate chemicals produced in their workplaces or imported by them to classify the chemicals in accordance with this section. For each chemical, the chemical manufacturer or importer shall determine the hazard classes, and where appropriate, the category of each class that apply to the chemical being classified. Employers are not required to classify chemicals unless they choose not to rely on the classification performed by the chemical manufacturer or importer for the chemical to satisfy this requirement.

(d)(2) Chemical manufacturers, importers or employers classifying chemicals shall identify and consider the full range of available scientific literature and other evidence concerning the potential hazards. There is no requirement to test the chemical to determine how to classify its hazards. Appendix A to §1910.1200 shall be consulted for classification of health hazards, and Appendix B to §1910.1200 shall be consulted for the classification of physical hazards.

(d)(3) Mixtures.

(d)(3)(i) Chemical manufacturers, importers, or employers evaluating chemicals shall follow the procedures described in Appendices A and B to §1910.1200 to classify the hazards of the chemicals, including determinations regarding when mixtures of the classified chemicals are covered by this section.

(d)(3)(ii) When classifying mixtures they produce or import, chemical manufacturers and importers of mixtures may rely on the information provided on the current safety data sheets of the individual ingredients except where the chemical manufacturer or importer knows, or in the exercise of reasonable diligence should know, that the safety data sheet misstates or omits information required by this section.

Hazard Communication Standard Labels

OSHA has updated the requirements for labeling of hazardous chemicals under its Hazard Communication Standard (HCS). As of June 1, 2015, all labels will be required to have pictograms, a signal word, hazard and precautionary statements, the product identifier, and supplier identification. A sample revised HCS label, identifying the required label elements, is shown on the right. Supplemental information can also be provided on the label as needed.

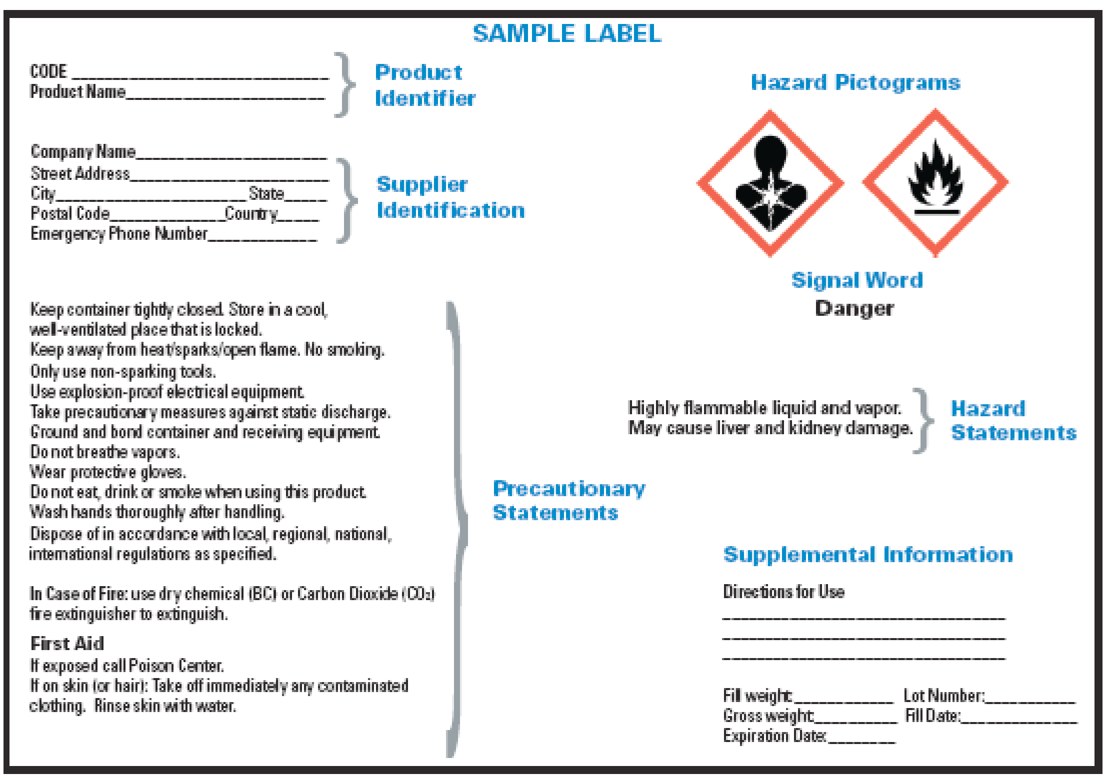

Figure 4.4 Sample label

Single words are used to emphasize hazard and to discriminate between levels of hazard

Another item that must appear in the labels is the signal word.

A signal word refers to a word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label.

“Danger” is used for the more severe hazard categories.

For example, “Danger” is used for Acute toxicity Category 1, 2 and 3, while “Warning” is used for Category 4. The precedence also applies for signal word. If the signal word “Danger” applies, the signal word “Warning” should not appear.

A single harmonized hazard statement for each level of hazard within each hazard class is used

The text of all applicable hazard statements shall appear on the label, except as otherwise specified. Hazard statements may be combined where appropriate to reduce the information on the label and improve readability, as long as all of the hazards are conveyed as required.

Figure 4.5 Veronica Thomas, a sheet metal mechanic, de-burrs an inconel steel part for installation on the C-130 IRSS. U. S. Air Force photo by Chad Langston.

These are the hazard statements for Acute toxicity:

- Category 1 “ Fatal if swallowed “
- Category 2 “Fatal if swallowed ”
- Category 3 “ Toxic if swallowed”
- Category 4 “Harmful if swallowed”
- Category 5 “Maybe harmful if swallowed”

The chemical manufacturer, importer, or distributor shall ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged or marked

HCS 2012 requires that labels on shipped containers contain much more information than required by Hazcom 1994, such as:

- the product identifier,
- signal word,
- hazard statement(s),
- pictogram(s),
- precautionary statement(s),
- and the name, address, and telephone number of the chemical manufacturer, importer, or other responsible party.

Labels are to be updated within 3 months of getting new and significant information about the hazards, or ways to protect those exposed. However, much of this additional information is already included on labels by manufacturers, particularly for those following the ANSI standard Z129 for precautionary labeling. These elements are intended to be the minimum information to be provided on labels by manufacturers and importers.

So, if chemical manufacturers and importers want to provide additional information regarding the hazards of a chemical as well as precautions for safe handling and use, they are free to do so as long as:

- the information is accurate, and
- does not conflict with the required label elements.

All of the label requirements by hazard class and category can be found in Appendix C

- OSHA is maintaining the current approach to allowing alternatives to labels on each stationary process container
- The exception for portable containers under the control of the person who filled them with the chemical remains the same.
- Labels on incoming containers are not to be removed or defaced unless immediately replaced by another label
- Workplace labels are to be prominently displayed and in English, although other languages are permitted as well
- Employers are responsible for maintaining the labels on the containers, including, but not limited to, tanks, totes, drums, and for training their employees on the hazards listed on the labels in the workplace.

Labels must continue to be:

- legible,
- contain the pertinent information (such as the hazards and directions for use),
- not able to be defaced, (i.e., fade, get washed off,) or removed in any way as stated in revised Hazard Communication Standard, 29 CFR 1910.1200(f)(9).

Figure 4.6 Labels must be legible, contain pertinent information, and not able to be defaced.

One of eight standard hazard symbols is used in each pictogram

There are 9 hazard symbols are used in the GHS (8 mandatory): flame, flame over circle, exploding bomb, corrosion, gas cylinder, skull and cross bones, exclamation mark, health hazard and environmental hazard (non-mandatory under OSHA HCS).

With the exception of the symbols depicting exclamation mark, health hazard and environmental hazard, all are part of the standard symbols set used in the UNRTDG.

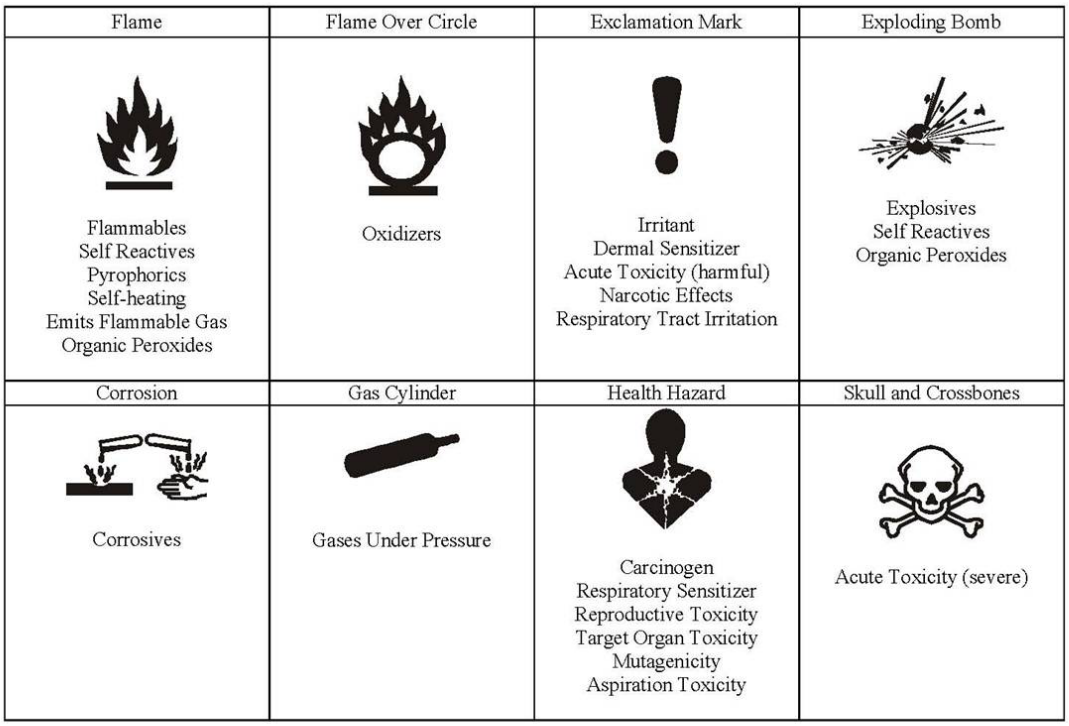

Figure 4.7 With the exception of the symbols depicting exclamation mark, health hazard and environmental hazard, all are part of the standard symbols set used in the UNRTDG.

Pictograms must have a black symbol, white background and red boarder frame

There are 9 pictograms in the GHS and only 8 under HCS 2012. The ninth pictogram (environmental) is not used under OSHA. Each pictogram is assigned to the hazard or its category or division.All pictograms should be in the shape of a square set at a point. For labels of products being supplied or distributed to clients, the pictograms have a black symbol on a white background with a red frame.

A competent authority may choose to give suppliers and employers discretion to use a black border for domestic use. The requirements for making GHS-based label include symbols or pictograms, signal words, hazard statements, precautionary statements, product identifiers/ declaration of ingredients and supplier identification.

Pictograms shall be in the shape of a square set at a point and shall include a black hazard symbol on a white background with a red frame sufficiently wide to be clearly visible. A square red frame set at a point without a hazard symbol is not a pictogram and is not permitted on the label.

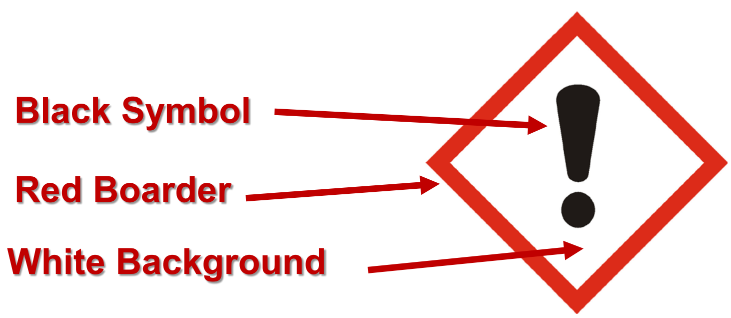

Figure 4.8

Figure 4.9

The Health Hazard pictogram looks like this and warns of:

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

Figure 4.10

The Flame pictogram looks like this and warns of:

- Flammables
- Pyrophorics
- Self-heating
- Emits flammable gas
- Self-reactives
- Organic peroxides

Figure 4.11

The Exclamation Mark pictogram looks like this and warns of:

- Irritant (skin and eye)
- Skin sensitizer
- Acute toxicity (harmful)
- Narcotic effects
- Respiratory tract irritant
- Hazardous to ozone layer (non mandatory)

Figure 4.12

The Gas Cylinder pictogram looks like this and warns of:

- Gases under pressure

Figure 4.13

The Corrosion pictogram looks like this and warns of:

- Skin corrosion/ burns
- Eye damage
- Corrosive to metals

Figure 4.14

The Exploding Bomb pictogram looks like this and warns of:

- Explosives
- Self-reactive
- Organic peroxides

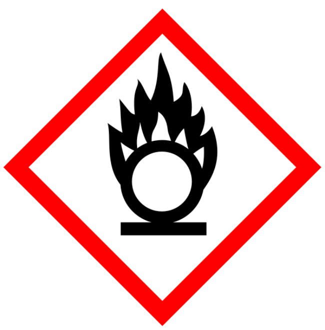

Figure 4.15

The Flame over a Circle pictogram looks like this and warns of :

- Oxidizers

Figure 4.16

The Skull and Crossbones pictogram looks like this and warns of:

- Acute toxicity (severe)

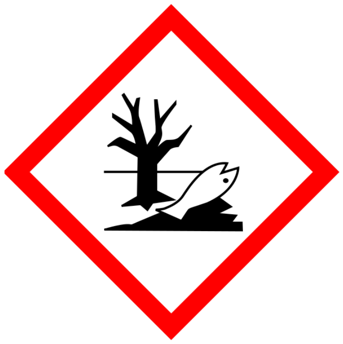

Figure 4.17

The Environment pictogram looks like this and warns of:

- Aquatic toxicity
- Chronic aquatic toxicity
- Degradation
- Bioaccumulation

This pictogram is Non-mandatory under HCS. While the GHS includes criteria on classifying chemicals for aquatic toxicity, these provisions were not adopted in the GHS Final Rule because OSHA does not have the regulatory authority to address environmental concerns. However, the "building block approach" is utilized here to provide classification and labeling guidance to support the goals of harmonization that are useful to other regulatory authorities (e.g. EPA).

Label element allocation is based severity

For the GHS, the assigned pictogram, signal word and hazard statement are given in that order for each category of the hazard class. This slide is one example of allocation of label elements for acute toxicity. Pictogram "Skull and cross bones" is assigned to Category 1, 2 and3, "Exclamation mark" Category 4, none for Category 5. Signal Word "Danger" is assigned to Category 1, 2 and 3, "Warning" Category 4 to Category 5. Hazard statement "Fatal if swallowed" is used for Category 1 and 2. Precautionary statements are not described in this table.

Category 1	Category 2	Category 3	Category 4	Category 5
				No Symbol
Danger	Danger	Danger	Warning	Warning
Fatal if swallowed	Fatal if swallowed	Toxic if swallowed	Harmful if Swallowed	May be harmful if swallowed

Figure 4.18 Label element allocation is based severity.

Chapter 5
Safety Data Sheet

Issues and topics for discussion:

- Should employees read complex SDS material if the general and specific training provided by the employer is sufficient?
- Where can employees find SDSs at specific work sites?
- How accessible are MSDSs?
- Discuss the engineering controls that may be used to eliminate or reduce the hazards of the chemicals in a workplacasd

Introduction

Safety Data Sheets (SDSs) provide information necessary for employees to safely use chemicals that can cause illness, injury, or death. Under the Hazard Communication Standard, an employer must obtain an SDS for each hazardous chemical in the workplace before it can be used.

Does providing SDSs for workers fulfill an employer's responsibility regarding chemical hazard information?

Although SDSs are extremely useful, just making them available does not discharge the employer's responsibility to provide hazard communication, information, and general and specific training to minimize a worker's exposure to hazardous chemicals

What is the employee's responsibility regarding chemical hazard information?

Employees have the right to request SDSs from their employers. The employee must learn what a SDS is, as well as where it should be located or how to obtain it. Highly visible Right-To-Know Centers give workers instant access to important chemical hazard information. At the worksite, the employee should read each appropriate SDS and understand it, and know who to speak to if he doesn't understand. Because many SDSs are difficult to read, workers should learn the appropriate questions to be answered for each chemical hazard

Why is the SDS one of the best ways for employees to find out about hazardous chemicals?

SDS information is written in a regimented format, precise, and easy to access and understand. An MSDS describes a chemical in terms of:

- What makes it dangerous.
- How it is dangerous to the worker.
- What level of personal protective equipment is needed.
- How to respond to spills and accidents.
- How to get more information.

Reading an SDS

The fastest way to read an SDS is to ask questions

Workers should look for answers to the following questions:

Is this the SDS for the product being used on the job?

What company makes this product?

How can the manufacturer be contacted for more information?

How up-to-date is this SDS?

What hazardous chemicals does the product contain and how much?

How can a worker be exposed to the chemical?

What kind of PPE is needed?

Do the vapors of this chemical sink or rise?

Is the product or chemical flammable? Combustible? Explosive?

If the product is burned or heated, does it give off other chemicals that can harm a worker?

Is the chemical reactive?

Are there other chemicals or substances that should be kept away from this chemical?

Will it cause harm right away? Will it cause harm in the long run?
(Acute or chronic)

Are there any medical conditions which this product can aggravate?

What should be done if this chemical is spilled?

What kind of engineering controls are needed?

The Hazard Communication Standard 2012 Safety Data Sheet

The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) (formerly MSDSs or Material Safety Data Sheets) for each hazardous chemical to downstream users to communicate information on these hazards. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format. This brief provides guidance to help workers who handle hazardous chemicals to become familiar with the format and understand the contents of the SDSs.

The SDS includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. The information contained in the SDS must be in English (although it may be in other languages as well). In addition, OSHA requires that SDS preparers provide specific minimum information as detailed in Appendix D of 29 CFR 1910.1200. The SDS preparers may also include additional information in various section(s).

Sections 1 through 8 contain general information about the chemical, identification, hazards, composition, safe handling practices, and emergency control measures (e.g., fire fighting). This information should be helpful to those that need to get the information quickly. Sections 9 through 11 and 16 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information, toxicological information, exposure control information, and other information including the date of preparation or last revision. The SDS must also state that no applicable information was found when the preparer does not find relevant information for any required element.

The SDS must also contain Sections 12 through 15, to be consistent with the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS), but OSHA will not enforce the content of these sections because they concern matters handled by other agencies.

A description of all 16 sections of the SDS, along with their contents, is presented below:

Section 1: Identification

This section identifies the chemical on the SDS as well as the recommended uses. It also provides the essential contact information of the supplier. The required information consists of:

- Product identifier used on the label and any other common names or synonyms by which the substance is known.
- Name, address, phone number of the manufacturer, importer, or other responsible party, and emergency phone number.
- Recommended use of the chemical (e.g., a brief description of what it actually does, such as flame retardant) and any restrictions on use (including recommendations given by the supplier).

Section 2: Hazard(s) Identification

This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards. The required information consists of:

- The hazard classification of the chemical (e.g., flammable liquid, category1).
- Signal word.
- Hazard statement(s).
- Pictograms (the pictograms or hazard symbols may be presented as graphical reproductions of the symbols in black and white or be a description of the name of the symbol (e.g., skull and crossbones, flame).
- Precautionary statement(s).
- Description of any hazards not otherwise classified.
- For a mixture that contains an ingredient(s) with unknown toxicity, a statement describing how much (percentage) of the mixture consists of ingredient(s) with unknown acute toxicity. Please note that this is a total percentage of the mixture and not tied to the individual ingredient(s).

Section 3: Composition/Information on Ingredients

This section identifies the ingredient(s) contained in the product indicated on the SDS, including impurities and stabilizing additives. This section includes information on substances, mixtures, and all chemicals where a trade secret is claimed. The required information consists of:

Substances

- Chemical name.
- Common name and synonyms.
- Chemical Abstracts Service (CAS) number and other unique identifiers.
- Impurities and stabilizing additives, which are themselves classified and which contribute to the classification of the chemical.

Mixtures

- Same information required for substances.
- The chemical name and concentration (i.e., exact percentage) of all ingredients which are classified as health hazards and are:
    - Present above their cut-off/concentration limits or
    - Present a health risk below the cut-off/concentration limits.
- The concentration (exact percentages) of each ingredient must be specified except concentration ranges may be used in the following situations:
    - A trade secret claim is made,
    - There is batch-to-batch variation, or
    - The SDS is used for a group of substantially similar mixtures.

Chemicals where a trade secret is claimed

- A statement that the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret is required.

Section 4: First-Aid Measures

This section describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical. The required information consists of:

- Necessary first-aid instructions by relevant routes of exposure (inhalation, skin and eye contact, and ingestion).
- Description of the most important symptoms or effects, and any symptoms that are acute or delayed.
- Recommendations for immediate medical care and special treatment needed, when necessary.

Section 5: Fire-Fighting Measures

This section provides recommendations for fighting a fire caused by the chemical. The required information consists of:

- Recommendations of suitable extinguishing equipment, and information about extinguishing equipment that is not appropriate for a particular situation.
- Advice on specific hazards that develop from the chemical during the fire, such as any hazardous combustion products created when the chemical burns.
- Recommendations on special protective equipment or precautions for firefighters.

Section 6: Accidental Release Measures

This section provides recommendations on the appropriate response to spills, leaks, or releases, including containment and cleanup practices to prevent or minimize exposure to people, properties, or the environment. It may also include recommendations distinguishing between responses for large and small spills where the spill volume has a significant impact on the hazard. The required information may consist of recommendations for:

- Use of personal precautions (such as removal of ignition sources or providing sufficient ventilation) and protective equipment to prevent the contamination of skin, eyes, and clothing.
- Emergency procedures, including instructions for evacuations, consulting experts when needed, and appropriate protective clothing.
- Methods and materials used for containment (e.g., covering the drains and capping procedures).
- Cleanup procedures (e.g., appropriate techniques for neutralization, decontamination, cleaning or vacuuming; adsorbent materials; and/or equipment required for containment/clean up).

Section 7: Handling and Storage

This section provides guidance on the safe handling practices and conditions for safe storage of chemicals. The required information consists of:

- Precautions for safe handling, including recommendations for handling incompatible chemicals, minimizing the release of the chemical into the environment, and providing advice on general hygiene practices (e.g., eating, drinking, and smoking in work areas is prohibited).
- Recommendations on the conditions for safe storage, including any incompatibilities. Provide advice on specific storage requirements (e.g., ventilation requirements).

Section 8: Exposure Controls/Personal Protection

This section indicates the exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure. The required information consists of:

- OSHA Permissible Exposure Limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available.
- Appropriate engineering controls (e.g., use local exhaust ventilation, or use only in an enclosed system).
- Recommendations for personal protective measures to prevent illness or injury from exposure to chemicals, such as personal protective equipment (PPE) (e.g., appropriate types of eye, face, skin or respiratory protection needed based on hazards and potential exposure).
- Any special requirements for PPE, protective clothing or respirators (e.g., type of glove material, such as PVC or nitrile rubber gloves; and breakthrough time of the glove material).

Section 9: Physical and Chemical Properties

This section identifies physical and chemical properties associated with the substance or mixture. The minimum required information consists of:

- Appearance (physical state, color, etc.);
- Odor;
- Odor threshold;
- pH;
- Melting point/freezing point;
- Initial boiling point and boiling range;
- Flash point;
- Evaporation rate;
- Flammability (solid, gas);
- Upper/lower flammability or explosive limits;
- Vapor pressure;
- Vapor density;
- Relative density;
- Solubility(ies);
- Partition coefficient: n-octanol/water;
- Auto-ignition temperature;
- Decomposition temperature; and
- Viscosity.

The SDS may not contain every item on the above list because information may not be relevant or is not available. When this occurs, a notation to that effect must be made for that chemical property. Manufacturers may also add other relevant properties, such as the dust deflagration index (Kst) for combustible dust, used to evaluate a dust's explosive potential.

Section 10: Stability and Reactivity

This section describes the reactivity hazards of the chemical and the chemical stability information. This section is broken into three parts: reactivity, chemical stability, and other. The required information consists of:

Reactivity

- Description of the specific test data for the chemical(s). This data can be for a class or family of the chemical if such data adequately represent the anticipated hazard of the chemical(s), where available.

Chemical stability

- Indication of whether the chemical is stable or unstable under normal ambient temperature and conditions while in storage and being handled.
- Description of any stabilizers that may be needed to maintain chemical stability.
- Indication of any safety issues that may arise should the product change in physical appearance.

Other

- Indication of the possibility of hazardous reactions, including a statement whether the chemical will react or polymerize, which could release excess pressure or heat, or create other hazardous conditions. Also, a description of the conditions under which hazardous reactions may occur.
- List of all conditions that should be avoided (e.g., static discharge, shock, vibrations, or environmental conditions that may lead to hazardous conditions).
- List of all classes of incompatible materials (e.g., classes of chemicals or specific substances) with which the chemical could react to produce a hazardous situation.
- List of any known or anticipated hazardous decomposition products that could be produced because of use, storage, or heating. (Hazardous combustion products should also be included in Section 5 (Fire-Fighting Measures) of the SDS.)

Section 11: Toxicological Information

This section identifies toxicological and health effects information or indicates that such data are not available. The required information consists of:

- Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact). The SDS should indicate if the information is unknown.
- Description of the delayed, immediate, or chronic effects from short- and long-term exposure.
- The numerical measures of toxicity (e.g., acute toxicity estimates such as the LD50 (median lethal dose)) - the estimated amount [of a substance] expected to kill 50% of test animals in a single dose.
- Description of the symptoms. This description includes the symptoms associated with exposure to the chemical including symptoms from the lowest to the most severe exposure.
- Indication of whether the chemical is listed in the National Toxicology Program (NTP) Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions) or found to be a potential carcinogen by OSHA.

Section 12: Ecological Information (non-mandatory)

This section provides information to evaluate the environmental impact of the chemical(s) if it were released to the environment. The information may include:

- Data from toxicity tests performed on aquatic and/or terrestrial organisms, where available (e.g., acute or chronic aquatic toxicity data for fish, algae, crustaceans, and other plants; toxicity data on birds, bees, plants).
- Whether there is a potential for the chemical to persist and degrade in the environment either through biodegradation or other processes, such as oxidation or hydrolysis.
- Results of tests of bioaccumulation potential, making reference to the octanol-water partition coefficient (Kow) and the bioconcentration factor (BCF), where available.
- The potential for a substance to move from the soil to the groundwater (indicate results from adsorption studies or leaching studies).
- Other adverse effects (e.g., environmental fate, ozone layer depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and/or global warming potential).

Section 13: Disposal Considerations (non-mandatory)

This section provides guidance on proper disposal practices, recycling or reclamation of the chemical(s) or its container, and safe handling practices. To minimize exposure, this section should also refer the reader to Section 8 (Exposure Controls/Personal Protection) of the SDS. The information may include:

- Description of appropriate disposal containers to use.
- Recommendations of appropriate disposal methods to employ.
- Description of the physical and chemical properties that may affect disposal activities.
- Language discouraging sewage disposal.
- Any special precautions for landfills or incineration activities.

Section 14: Transport Information (non-mandatory)

This section provides guidance on classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea. The information may include:

- UN number (i.e., four-figure identification number of the substance)[2].
- UN proper shipping name[2].
- Transport hazard class(es)[2].
- Packing group number, if applicable, based on the degree of hazard2.
- Environmental hazards (e.g., identify if it is a marine pollutant according to the International
- Maritime Dangerous Goods Code (IMDG Code)).
- Guidance on transport in bulk (according to Annex II of MARPOL 73/78[3] and the International
- Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (International Bulk Chemical Code (IBC Code)).
- Any special precautions which an employee should be aware of or needs to comply with, in connection with transport or conveyance either within or outside their premises (indicate when information is not available).

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2 Found in the most recent edition of the United Nations Recommendations on the Transport of Dangerous Goods.
3 MARPOL 73/78 means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, as amended.

Section 15: Regulatory Information (non-mandatory)

This section identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS. The information may include:

- Any national and/or regional regulatory information of the chemical or mixtures (including any OSHA, Department of Transportation, Environmental Protection Agency, or Consumer Product Safety Commission regulations).

Section 16: Other Information

This section indicates when the SDS was prepared or when the last known revision was made. The SDS may also state where the changes have been made to the previous version. You may wish to contact the supplier for an explanation of the changes. Other useful information also may be included here.

Chapter 6

Monitoring and Instrumentation

Issues and topics for discussion:

- Discuss the types of monitoring instruments, their advantages and limitations.
- Explain the differences between general site monitoring, monitoring for IDLH, and personal monitoring.
- When must specific sites be monitored?
- Discuss engineering controls, work practices and PPE that are used to protect an employee from hazardous substances in monitored situations.
- What training is required for personnel that use direct-reading instruments?
- Most direct-reading instruments are handheld; even under normal conditions they can become out of adjustment. Discuss this subject and why constant monitoring of instruments is important.
- How does monitoring affect the HASP? What determines the need to upgrade or downgrade ensembles?

Introduction

Airborne chemicals can be a major threat to workers' health and safety. Therefore, monitoring the air to identify the contaminant and the amount of contamination is an important part of a HASP.

What are accurate measurements of airborne chemicals useful for?

Air monitoring is crucial to:

- Select personal protective equipment,
- Determine where protection is needed,
- Analyze health effects,
- Determine medical monitoring,
- Select and maintain control zones,
- Record data while analyzing possible health effects from exposure.

How are measuring instruments used to gather data?

Measuring instruments identify contaminants and determine their location and concentration. There are two ways to gather this information: direct-reading instruments and laboratory analysis.

Direct –Reading Instruments	
Instrument	**Hazard Monitoring**
Combustible Gas Indicator (CGI)	Combustible gases and vapors
Flame Ionizing Detector (FID) with Gas Chromatography	Many organic gases and vapors
Portable Infrared (IR) Spectrophotometer	Many gases and vapors
Ultraviolet (UV) Photoionization Detector (PID)	Many organic and some inorganic gases and vapors
Colorimetric Indicator Tubes	Specific gases and vapors
Oxygen Meter	Oxygen (O2)

Table 6.1

When are direct-reading instruments used?

Direct-reading instruments, developed as early warning devices, are the main tools of initial site reports, as well as continuous and on-going site surveys. They give the worker instant readout for proper protection. Direct-reading instruments can quickly detect:

- A leak from an accident that could cause the release of a large amount of a known chemical into the air.
- Flammable or explosive atmospheres, oxygen deficiency, specific gases, vapors, and ionizing radiation.

Are direct-reading instruments always the best method to identify and measure contaminants?

No. Direct-reading instruments detect only a few specific contaminants and are rarely sensitive enough to measure smaller concentrations.

Limitations include**:**

- If an instrument uses a calibration gas, the only accurate reading is for that specific gas.
- Usually detect and/or measure only specific classes of chemicals.
- May detect more than one substance; therefore, may give false readings.
- Weather conditions (including temperature, wind speed, rainfall, and humidity) may affect the accuracy.
- Work-site activities may physically disturb the contaminants, thus changing the concentration and their rate of emission.

When is laboratory analysis required?

When direct-reading instruments are not sensitive enough or able to detect special hazards, laboratory analysis is necessary. Long-term or “full-shift” air samples may be collected with passive dosimeters, a pump which draws air through a filter or sorbent, gas sampling bag, or wet collection methods.

Long-term air monitoring, especially when the laboratory is not on site, may take hours, days, weeks, or even months to get results. Careful planning and the use of portable laboratories may help control these problems. A mobile lab, a trailer truck with gas chromatographs, spectrofluorometers, and infrared spectrophotometers, can quickly identify hazardous chemicals.

What is the most important reason for monitoring air?

The most important purpose of air monitoring is to gather initial information. As a first step, air monitoring should be done to identify any immediately dangerous to life and health (IDLH) and other dangerous conditions. Large accumulations of contaminants may remain in confined spaces and low-lying areas, such as between hills, tall buildings, or tanks, for long periods of time. Appropriate precautions need to be taken when a site study determines there are hazardous substances in the air.

Air Monitoring must always be done in this sequence for each of the following hazardous conditions:

1. Oxygen,
2. Flammable atmosphere,
3. Toxic atmosphere.

General on-site monitoring should be performed in areas where the contaminant is known or suspected to be located, worker areas, and perimeters.

How often should air monitoring be performed?

Periodically when:

- Work begins on a different part of the site,
- Different contaminants are being handled,
- A different type of operation is started,
- Workers are handling leaking drums or working in areas with an obvious liquid contamination,
- Spills or lagoons are encountered,
- An emergency occurs.

Describe personal monitoring methods.

Personal monitoring, to identify exposure to workers engaged in specific activities, should reflect the concentration presented within the workers' breathing zone. Sampling ports should be placed on the upper chest of the worker. Or, by placing several sampling devices on pieces of heavy equipment, a variety of equipment samples can produce as much information as several personal samples.

Workers closest to the source of contamination need personal air monitoring devices to ensure their protection as well as other workers. If the PPE fails, there is also the possibility of overexposure.

Notes

Chapter 7
Medical Surveillance Program

Issues and topics for discussion:

- What are the legal requirements of a Medical Surveillance Program?
- When are employers responsible for instituting a medical surveillance program?
- List the employees covered by a medical surveillance program.
- When and what are employers required to provide to HAZMAT team members and hazardous material specialists under this program?
- Discuss OSHA Standard 29 CFR 1904: “Recording and Reporting Occupational Injuries and Illness.”
- OSHA’s recordkeeping rule requires employers to provide access to the injury Log to any employee on request. Discuss how employees could abuse this provision.
- OSHA’s recordkeeping rule requires that “lost time” and “restricted work” will now be recorded based on the number of days that a health care professional prescribed, rather than what actually took place; what the health professional says is what has to be recorded on the OSHA Log. How will this affect the relationship employers have with local doctors, hospitals, and clinics?

Introduction

Workers handling hazardous wastes can experience high levels of stress. Their daily tasks may expose them to toxic chemicals, safety hazards, biologic hazards, and radiation. Along with adequate protection from exposures

Who is responsible for writing the Medical Surveillance program?

Part of the overall site HASP, a medical surveillance program should be designed by an experienced occupational health physician or another qualified consultant with the Site Safety Officer.

What is the purpose of the Medical Surveillance?

It is essential to:

- Assess and monitor the worker's health and fitness both before employment, and during the course of work, and for possible overexposure.
- Provide emergency and other treatment as needed.
- Keep accurate records for future reference and comparison.

What should a Medical Surveillance Program include?

A Medical Surveillance Program should be developed for each site based on the specific needs, location, and potential exposures of employees. As a minimum, it must include:

- Employees covered,
- Frequency of medical examinations and consultations,
- Content of medical examinations and consultations,
- Information provided to the physician,
- Physician's written opinion, and
- Record keeping.

Which employees are covered under this program?

- Workers who may be or are exposed to concentrations above the PEL or the TLV without regard to the use of respirators for 30 or more days per year.
- Workers who wear a respirator for 30 or more days per year or those who wear a respirator as a result of OSHA requirements.
- Workers who exhibit signs or symptoms of injury, illness, or possible overexposure to hazardous substances or health hazards.
- Members of HAZMAT teams.

When and how often should medical exams be conducted?

The employer must provide medical exams performed by or under the supervision of a licensed physician, at no cost to employee, at a reasonable time, and without loss of pay, using the following schedule:

- Prior to assignment (Pre-employment screening) to:
  - Determine the worker's "fitness for duty": occupational and medical history, physical examination, and ability to work while wearing PPE.
  - Record baseline medical data to later check the effectiveness of worker protection programs.
- Periodically (usually once per year, although the physician may increase interval to no more than once per two years).
- At termination or reassignment.
- If the worker exhibits signs or symptoms of over exposure, injury, or is exposed to excessive concentrations during an emergency; off-site medical professionals should also investigate and treat non-job-related illnesses that may put the worker at risk.
- At the determination of the physician for medical necessity.

What are medical record-keeping requirements?

Medical record-keeping must include:

- Employee name and social security number;
- Physician's opinion (provided to the employee in writing);
- Employee's medical complaints;
- Employee information provided by the employer to the physician.

What are the employer's responsibilities regarding medical records?

OSHA regulations require the employer to:

- Maintain and preserve medical records on exposed workers for 30 years after they leave employment (if they worked on the site one-year or more. If employment was less than one year, the employer may give the record to the employee.)
- Make available to workers, their authorized representatives, and authorized OSHA representatives the results of the medical testing, full medical records, and analysis.
- Maintain the records of occupational injuries and illnesses and post a yearly summary report.

How often must the medical surveillance program be re-evaluated or reviewed?

Maintenance and review of the medical records and test results assist in rating the effectiveness of the HASP. At least annually the Site Safety Officer, medical consultant, and/or management should:

- Verify that each accident or illness was promptly investigated.
- Evaluate the efficiency of specific medical testing.
- Add or delete medical tests.
- Review the potential exposures.
- Review emergency treatment procedures.

Recommended Medical Program		
Component	**Recommended**	**Optional**
Pre-Employment Screening	• Medical history • Occupational history • Physical examination • Determination of fitness • to work using PPE. • Baseline monitoring for specific exposures.	• Freezing pre-employment serum for later testing.
Periodic Medical Examination	• Yearly update of medical and occupational history. • Yearly physical examination • Testing based on examination results, exposures, job class and task.	• Yearly testing with routine medical tests
Emergency Treatment	• Provide emergency first aid onsite. • Develop a liaison with local • hospital and medical specialists. • Arrange for decontamination of victims. • Arrange, in advance, for the • transport of victims. • Transfer medical records. Give details of the incident and medical history to the next care provider.	
Non-Emergency Treatment	• Develop a mechanism for non-emergency health care.	
Recordkeeping and Review	• Maintain and provide an access to the medical records in accordance with OSHA and state regulations. • Report and record the occupational injuries and illnesses. • Review the Site Safety Plan regularly to determine if additional testing is needed. • Review the program periodically. Focus on current site hazards, exposures and industrial hygiene standards.	
Exit Exam		

Table 7.1

Chapter 8
Respiratory Protection

Issues and topics for discussion:

- Why is it important to have a site-specific Respiratory Protection Program?
- What is the employer required to provide to the employee concerning respiratory protection?
- How can workers be sure they have a safe and effective facepiece seal?
- What type of respirators can be used for IDLH atmospheres?
- Why are medical evaluations necessary for respiratory protection?
- How do respirators sometimes allow employees to work with a false sense of security?
- What are the criteria for Air-Purifying Respirators? What are their limitations?

Introduction

Inhalation of toxic substances is a major route of entry into the body. The Occupational Safety and Health Association (OSHA) sets the standards for where respirators can be worn, as well as worker exposure.

It is a complex standard. This brief overview demonstrates the importance and need for further, specific training regarding respiratory protection.

What is the employer's responsibility for protecting workers from airborne contamination?

According to the OSHA respiratory standard, the employer shall provide "engineering controls" if feasible in order for the employee to avoid respirator use. When engineering controls can not eliminate the hazard, a Respiratory Protection Program shall be implemented. The employer is responsible for establishing and maintaining the Respiratory Protection Program as part of the Personal Protective Equipment section of the Health and Safety Plan. As with other personal protective equipment, respirators must be provided by the employer when they are necessary to protect the health of the workers.

What is the purpose of a Respiratory Protection Program?

The Respiratory Protection Program must protect workers from specific hazards at the job site, and prevent injury from incorrect use or malfunction of the respirator. Using respirators incorrectly can in itself cause injury or allow the wearer to work unprotected with a false sense of security. The employer must ensure that workers understand and follow procedures for using respirators safely and effectively in hazardous environments.

Why is training one of the most important program components?

Before respirators are used in a hazardous environment, workers must be trained in their proper selection, maintenance, and use, including donning and doffing. Training allows workers to handle respirators, and become familiar, comfortable, and confident with the equipment in a safe setting.

How do employers and employees know if a particular respirator is adequate?

The National Institute of Occupational Safety and Health (NIOSH) approves the design, manufacturing criteria, and responsible practices for respiratory protection.
NIOSH certifies respiratory protection equipment to assure it meets minimum guidelines for worker protection.

What does the "assigned protection factor" mean?

NIOSH assigns protection factors to specific respiratory protective ensembles that have been approved through their testing and certification program. A full-face Air Purifying Respirator (APR) has an assigned protection factor (APF) of 50. This means that a worker would be protected to chemical concentrations of 50 times that of the allowable limit set by OSHA, provided that the Maximum Use Concentration (MUC) is not exceeded. The MUC is the product of the protection factor of the respiratory protection equipment and the permissible exposure limit. The American National Standards Institute (ANSI) is also a source of information for these values.

How are the appropriate respirators chosen for a specific work site?

Respirators must be NIOSH-certified and selected with regard to the hazards present or anticipated in the work atmosphere. An analysis of these hazards is performed as part of the site HASP. Chemical concentration, oxygen content, and other factors must be taken into consideration in the selection of respiratory protective equipment.

Asbestos: Maximum Use Level (MUL)
Assigned Protection Factor of Full-face Air-purifying Respirator (50) x Permissible Exposure Level for Asbestos (01. f/cc) = Maximum Use Level (5 f/cc) APF x PEL = MUC **50 x 0.1 f/cc = 5 f/cc**

Table 8.1

TABLE OF APFs FOR VARIOUS TYPES OF RESPIRATORS			
RESPIRATOR CLASS AND TYPE	OSHA	NIOSH	ANSI Z88.2
Air Purifying			
Filtering Facepiece	10[3]	10	5
Half-face Mask	10[3]	10	10
Full-Facepiece	50	50	100
Powered Air Purifvlna			
Half-face Mask	50	50	50
Full-Facepiece	1,000	50	1,000
Loose Fitting Facepiece	25	25	25
Hood or Helmet	25/1,000[4]	25	1,000
Supplied Air			
Half-face mask-Demand	10	10	10
Half-face mask-Continuous	50	50	50
Half-face mask-Pressure Demand	50	1,000	10
Full-Facepiece Demand	50	50	100
Full-Facepiece Continuous Flow	1,000	50	1,000
Full Facepiece Pressure Demand	1,000	2,000	1,000
Loose Fitting Facepiece	25	25	25
Hood or Helmet	25/1,000[4]	25	1,000
Self Contained Breathing Apparatus (SCBA)			
Demand	50	50	100
Pressure Demand	10,000	10,000	10,000

Notes:

[1] Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

[2] The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.

[3] This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

[4] The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

Table 8.2

How do respirators work?

Respiratory devices are divided by the type of airflow supplied to the facepiece:

- Negative-pressure respirators draw air into the facepiece by the negative pressure created by the user breathing in. Disadvantage: If any leaks develop in the system, the user inhales contaminated air.
- Continuous-flow respirators (including some supplied-air respirators and all powered air-purifying respirators) receive a continuous stream of air into the facepiece at all times. Disadvantage: This does not guarantee positive pressure; contaminants may still enter the mask.
- Positive-pressure/pressure-demand respirators maintain a positive pressure in the facepiece during both inhalation and exhalation. Advantage: These respirators have a pressure regulator and a spring-loaded exhalation valve to maintain the positive pressure in the mask. If a leak develops in a positive-pressure/pressure-demand respirator, the regulator maintains a positive pressure within the facepiece, preventing inhalation of toxic air.

What are the different kinds of respirators?

A closed-circuit breathing apparatus recirculates exhaled air though a series of filters, chemicals, and added oxygen; the air is then re-breathed. Very few are used in hazardous waste operations.

The following types of respirators are all examples of open-circuit respirators; exhaled air is allowed to pass to the atmosphere outside the facepiece.

- **Air-purifying respirators (APRs)** consist of a facepiece and an air filtering device, such as particulate filters, cartridges and canisters, or combination devices. APRs remove contaminants from the air by filtration, absorption, or chemical reactions.
  - Advantage: enhance mobility and are light weight.
  - Disadvantage: operate only in negative-pressure mode and are approved for use in atmospheres containing specific chemicals up to a specific amount.
- **Powered air-purifying respirators (PAPRs)** are APRs that have a battery-powered fan that forces ambient air through the air-purifying filter, cartridge and canister and reduces the restriction of air.
  - Advantage: The PAPR makes the task of breathing easier for the wearer. However, PAPRs are not positive-pressure devices nor do they generate their own oxygen supply.

Filters are usually attached to the cartridge/canister to add particulate protection. Filters are classified by NIOSH as follows:

- **N** (**n**ot resistant to oil) for use in atmospheres containing non-oil-based particulates.
- **R** (**r**esistant to oil).
- **P** (oil **p**roof).

Cartridges for PAPRs are attached to the respirator facepiece or to an attached battery supply box. Cartridges should be discarded after one use.

Canisters are usually larger and heavier and are worn on the back, chest, or hip of the wearer. The primary means of identifying a gas mask canister should be properly worded labels that indicate the name of the atmospheric contaminant that it protects against. Identifying a gas mask canister by color code should be secondary. Most chemical sorbent canisters are imprinted with an expiration date. Gas masks must have special canisters that absorb specific chemicals.

Classes of Particulate Filters		
N	R	P
100	100	100
99	99	99
95	95	95

Table 8.3

Color Coding for Gas Mask Canisters	
Atmospheric Contaminants To Be Protected Against	**Colors Assigned[1]**
Acid gases	White
Hydrocyanic acid gas	White with 1/2-inch green stripe completely around canister near the bottom
Chlorine gas	White with 1/2-inch yellow strip completely around canister near the bottom
Organic vapors	Black
Ammonia gas	Green
Acid gases and ammonia gases	Green with 1/2-inch white strip completely around canister near the bottom
Carbon Monoxide	Blue
Acid gases and organic vapors	Yellow
Hydrocyanic acid gas & chloropicrin vapor	Yellow with 1/2-inch blue strip completely around canister near the bottom.
Acid gases, organic vapors, ammonia gas	Brown
Radioactive materials, except tritium and noble gases	Purple (magenta)
Particulates (dusts, fumes, mists, fogs or smokes in combination with any of the above gases or vapors)	Canister color for contaminant, as designated above with 1/2-inch gray stripe completely around canister near the top.
All of the above atmospheric contaminants	Red with 1/2-inch gray stripe completely around canister near the top.

[1] Gray should not be assigned as a main color for a canister designed to remove acids or vapors.

NOTE: Orange should 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.

Table 8.4

APRs should be used only with those contaminants for which they are approved. The following is a list of situations where an air-purifying respirator is not recommended:

- Oxygen-deficient atmospheres - less than 19.5% oxygen by volume.
- Immediately dangerous to life or health (IDLH) atmospheres.
- Above maximum use concentration (MUC)
- Possibility of unknown contaminants.
- Identified chemicals have inadequate warning signs, the sorbent service life is not known and the unit has no end-of-service-life indicator (ESLI). High relative humidity may reduce the protection offered by the sorbent.
- **Supplied-air respirators (SARs; also known as airline respirators)** direct air into a face piece or hood by a supply line from a fixed source. SARs are suitable for use with compressed air and are classified as “type C” SARs. They are available in positive-pressure, continuous-flow modes and negative pressure modes. SARs are used as part of Level C ensembles.

    - Disadvantage: the SAR airline restricts worker movement. The length of the hose must not exceed 300 feet or the manufacturer’s specifications. The airline is vulnerable to punctures, permeation, degradation, and penetration. Workers must retrace their steps when leaving area to check airlines. SARs cannot be used if any or all of the following conditions exist:

        - IDLH atmospheres (or likely to become IDLH),
        - Unknown atmospheres,
        - Oxygen-deficient atmospheres,
        - Atmospheres containing concentrations higher than that recommended for this device.

- **Supplied-air respirators with escape (SAR-Es)** are equipped with an escape bottle (rated for 5, 10, or 15 minutes) that provides air in the event of an emergency or loss of primary air supply. During emergency egress, it is extremely important that the escape bottle is turned on and the supplied air hose is disconnected after the bottle is turned on. Some types of SAR-Es have a dual hookup which has at least two ports on the regulator that connect separate air supply sources (carry-out bottle and air-supply hose located in the work area). The carry-out bottle may be used to gain entry to the site. SAR-Es and SCBA’s are the only SARs recommended for use at hazardous waste sites due to the level of protection afforded to the worker.

- Advantage: provide a high level of protection against airborne contaminants, oxygen deficiency, and strenuous work conditions. SAR-Es enable longer work periods due to the smaller and lighter size in comparison to SCBAs.

- **A self-contained breathing apparatus (SCBA)** usually consists of a facepiece connected by a hose and regulator to an air source that is carried by the wearer. Positive-pressure/ pressure-demand SCBAs are required for entry into atmospheres that are IDLH. The duration of the air supply is limited to a rated capacity of 30 to 60 minutes. A warning alarm signals when 20-25% of the rated capacity of the air supply remains. SCBAs are used as part of the Level A or B ensemble.

  - Advantage: SCBAs offer the highest respiratory protection against unknown, IDLH, and oxygen-deficient atmospheres as well as greater mobility to the worker.
  - Disadvantage: SCBAs are bulky and weigh up to 35 pounds, increasing the likelihood of heat and physical stress, and impairing movement in confined spaces.

Maximums For Gaseous Grade "D" Breathing Air	
Limiting Characteristics	**Grade "D" Air**
Percent O^2 balance predominantly N_2	atm [1]/19.5-23.5
Oil (condensed) (mg/m^3 at NTP)	5[2]
Carbon monoxide	10 [3,4]
Odor	No pronounced order
Carbon dioxide	1000[4]

[1] The term "atm" (atmospheric) denotes the oxygen content normally present in atmospheric air; the numerical values denote the oxygen limits for synthesized air.

[2] Not required for synthesized air whose oxygen and nitrogen components are produced by air liquefaction.

[3] Not required for synthesized air when nitrogen component was previously analyzed and meets National Formulary (NF) specifications.

[4] Not required for synthesized air when oxygen component was produced by air liquefaction and meets United States Pharmacopeia (USP) specficication.

Table 8.5
Source: Compressed Gas Association

Are oxygen tanks used as an air source?

No. Air sources for SARs, SAR-Es, and SCBAs may be supplied by compressed air cylinders or by other means that deliver purified, filtered ambient air to the facepiece. Breathing oxygen must never be used with air-line respirators; **Grade "D" breathing air** must be used. All supplied air-respirator SARs/SCBAs couplings must be incompatible with the outlets of other gas systems used on a site to prevent a worker from connecting to the wrong compressed gas source or other non-respirable worksite air supplies.

Why is respirator fit testing so critical?

An incorrect fit can allow the wearer to work in a hazardous environment with a false sense of security. Fit testing is conducted to assure that the proper facepiece is used to provide the worker with the most comfortable and effective fit. The employer must supply a sufficient number of respirator models and sizes to allow the employee to select one with the appropriate fit. Fit testing must be performed before a worker is required to wear a tight-fitting facepiece; when a different facepiece is used; in the case of a physical body change such as weight loss, scarring, wearing dentures, etc.; and at least annually.

How is fit testing performed?

There are specific fit-test procedures that workers must undergo prior to wearing respiratory protection equipment. To find further, specific requirements regarding this issue, refer to **OSHA Regulations: 29 CFR 1910.134 Appendix A.**

Before being fit tested, workers must have a **medical evaluation** (required by 29 CFR 1910.134 (e)(1) and 29 CFR 1910.134 (e)(7) (iv)) to determine their ability to use respirators in the workplace. The employer is required to provide medical evaluations, training, and respirators at no cost to the employee, as well as initial and annual fit testing for the same make, model, style, and size that will be used while working.

A qualitative fit test is used to check the "quality" of the respirator seal with the worker's face. The worker is subjected to specific materials that are detected by the worker's senses. If the worker detects the test material while the test is being conducted, this indicates the respirator fit is not effective.

A quantitative fit test is performed with sophisticated equipment that provides a numerical value or "quantity" for any material that is leaked into the facepiece through the seal surface. The ratio of concentration outside to inside is called the fit factor.

How should workers check themselves for a proper fit?

User seal checks need to be performed successfully *each and every time* a respirator is donned.

Positive Pressure Check: The exhalation valve is covered while the worker exhales slightly to create a slight pressure inside the facepiece for 10 seconds.

Negative Pressure Check: The air inlet openings are covered while the worker inhales slightly to hold the facepiece slightly collapsed for 10 seconds.

Why do workers need to check the facepiece seal every time?

The facepiece seal may be compromised if conditions exist that would interfere with the face-to-facepiece seal or valve functions:

- Facial hair,
- Wearing goggles or glasses,
- Absence of teeth or dentures,
- Scars,
- Loss or gain of weight, or
- Temperature.

Allow the respirator to warm up on your face before your positive and negative pressure seal checks

Are workers responsible for the maintenance and care of respirators?

Employers must provide for the inspection, repair, cleaning and disinfecting, and storage of respirators used by workers.

Which parts of a respirator must be inspected?

Inspections must include checking the respirator function, tightness of connections, and the condition of various parts, such as head straps, facepiece, valves, connecting tube, and cartridges, canisters, or filters. Elastic/rubber and electrometric parts must also be inspected for pliability and signs of deterioration.

How often should respirators be inspected?

- Respirators used for routine situations: during cleaning and before each use.
- Respirators used for emergency situations: at least monthly, and before and after each use. The employer must document and certify the respirator has been inspected by placing a tag/label on the storage compartment for the respirator.
- Emergency escape-only respirators: before being carried into the workplace.
- SCBAs: monthly. Air cylinders must be maintained in a fully charged state and must 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.

What if respirators are defective?

Respirators that fail an inspection or are otherwise found to be defective are to be removed from service, discarded, repaired, or adjusted in accordance with manufacturer's recommendations. Repairs are to be made only by appropriately trained technicians, and must use only the respirator manufacturer's NIOSH-approved parts.

How often are respirators cleaned and disinfected?

The employer must provide each worker with a respirator that is clean, sanitary, and in good working order. Respirators must be cleaned and disinfected as often as necessary to maintain a sanitary condition, but at least before being worn by different individuals. Emergency respirators and those used for fit testing and training must be cleaned and disinfected after each use.

What are the requirements for storage?

Respirators must be stored to protect and keep them clean. They must be packed or stored in a way that prevents deformation of the facepiece and exhalation valve. Emergency respirators must be stored similarly, and kept accessible to the work area in compartments or in covers marked "Emergency Respirators."

Are there special procedures for IDLH atmospheres?

For all IDLH atmospheres, the employer must ensure that:

- Workers wear positive pressure/pressure demand SCBAs or SAR-Es.
- At least one worker is outside IDLH atmosphere, trained to provide emergency rescue, and equipped with:
    - positive-pressure/pressure-demand SCBA or SAR-E.
    - appropriate retrieval equipment or equivalent means for rescue.
- Communication is maintained between workers.

Emergency rescue must be available before workers enter atmosphere, and necessary assistance available.

Are there special procedures for emergency response operations?

Yes. For example, for interior structural firefighting situations, in addition to the above requirements for all IDLH atmospheres, the employer must ensure that:

- At least two workers enter IDLH atmosphere and remain in visual or voice contact with each other at all times.
- At least two attendants are located outside IDLH atmosphere.

Chapter 9
Personal Protective Equipment

Issues and topics for discussion:

- Why is it important to have a site-specific Personal Protective Equipment Program?
- Why are equipment inspection, maintenance, repair, and storage of PPE important considerations?
- What role does the employee play in selecting and using PPE?
- Discuss the physical limitations and hazards of wearing PPE.

Introduction

Protective equipment is necessary when encountering hazardous materials that are capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact. Personal protective equipment (PPE) may include chemical-protective clothing, anti-C suits for radiation, flame/fire retardant coveralls, flotation gear, and/or safety helmets. Face shields, safety glasses, ear plugs, headphones, gloves, safety boots, and safety belts, harnesses, and lifelines are also PPE. Respiratory protection, a specific type of PPE, is discussed in greater detail in another section.

What is the employer's responsibility for protecting the workers?

When engineering and/or administrative controls are not feasible or effective, PPE shall be used. The employer must establish a specific written PPE program for work at each hazardous waste site. The program, as per 29 CFR 1910.120 (g)(ii), includes:

- Hazard identification;
- Medical monitoring;
- Environmental surveillance;
- Selection, use, maintenance, and decontamination of PPE; and
- Training.

The PPE program should be reviewed at least annually, and if questions on program effectiveness arise. The results of the program evaluation should be made available to the employees and all levels of management so that revisions may be made as necessary. In all cases, the employer is responsible for making sure that the PPE is adequate and safe for the work to be done.

Basic Objectives for the PPE Program
• Protect the wearer from safety and health hazards • Prevent injury to the wearer from incorrect use/malfunction of PPE

Table 9.1

What is the purpose of a PPE program?

As part of the Health and Safety Program, a PPE program must protect the wearer from safety and health hazards, and prevent injury from incorrect use or malfunction of the PPE. It must also identify when, where and which PPE to be used.

According to 29 CFR 1910.120 (g)(5) the PPE program should address the elements listed below:

- PPE selection based on site hazards;
- PPE use and limitations of the equipment;
- Work mission duration;
- PPE maintenance and storage;
- PPE decontamination and disposal;
- PPE training and proper fitting;
- PPE donning and doffing procedures;
- PPE inspection procedures prior to, during and after use;
- Evaluation of the effectiveness of the PPE program;
- Limitations during temperature extremes, heat stress and other appropriate medical considerations.

How is appropriate PPE selected for a specific work task and site?

The selection of appropriate PPE is the most important part of the employer's responsibilities.

Considerations include:

- The specific contaminant(s) present, as well as its form, and concentration;
- The type and duration of work to be done;
- Working conditions.

Further, specific information and training is required for the selection of respiratory protective equipment. Proper chemical-protective clothing (CPC) is selected with regard to the clothing material type, thickness, and manufacturing method.

Protective Clothing and Accessories (BODY)		
Clothing Type	**Type of Protection**	**Use Considerations**
Totally encapsulating suit	• Splashes • Dusts • Gases • Vapors	• Heat stress problems; Cooling suit might be required • Impairs mobility, vision, and communication • Compatible with hazards present
Splash suit	• Splashes • Dust • Little protection for parts of the head or neck	• Not gas-tight • Not for excessive splashing • Heat stress problems • Compatible with hazards present
Aprons, leggings, and sleeve protectors	Splash protection for chest, forearms, and legs	• Use over a splash suit • Use for sampling, labeling, and analysis • Use when containment contact is minimal • Compatible with hazards present
Firefighter's protective clothing	Heat, water, and some particles	• Decon is difficult • Primarily used for structural fire fighting • Limited chemical protection
Proximity garment	• Brief exposure to radiant heat • May be customized for some chemical use	• Worn over CPC of firefighter's garment • Cooling and an SCBA are needed if toxic atmospheres are encountered • Limited chemical protection
Blast and fragmentation suit	Very small detonation	• Use hearing protection • Limited chemical protection
Anti-C suit (radiation)	Alpha and Beta particles	• Prevent skin contamination • If radiation is detected, consult radiation expert and evacuate personnel
Flame/fire retardant coveralls	Flash fires	• Add bulk • Heat stress problems • Impair mobility • Limited chemical protection

Protective Clothing and Accessories (BODY)		
Clothing Type	**Type of Protection**	**Use Considerations**
Flotation gear	Adds buoyancy	• Adds bulk and restricts mobility • Must meet Coast Guard specifications • No chemical protection
Cooling garment	Removes excess heat generated by activity, equipment, or environment	• Cool-air systems utilize large quantities of air • Jacket or vets pose ice-storage and recharge problems • Pumps circulating chilled water pose storage problems; add bulk and weight • No chemical protection

Table 9.2

Protective Clothing and Accessories (HEAD)		
Clothing Type	**Type of Protection**	**Use Considerations**
Safety helmet (hardhat)	Protects the head from impact	Helmet should meet safety specifications
Helmet liner	Insulates against cold	Compatibility with hazards present
Hood	• Protects against chemical splashes, particulates, and rain • Thermal protection	Compatibility with hazards present

Table 9.3

Protective Clothing and Accessories (EYE AND FACE)		
Clothing Type	**Type of Protection**	**Use Considerations**
Face shield	Protects against chemical splashes	• Must be supported to prevent shifting and exposing portions of face or obscuring vision • Limited eye protection • Limited chemical protection
Splash hood	Protects against chemical splashes	• Must be suitably supported to prevent shifting and exposing portions of face or obscuring vision • Limited eye protection • Compatibility with hazards present
Safety glasses or Goggles	Protect against large particles and projectiles	• Wear special protective lenses if lasers are used to survey site • Must have side shields • Compatibility with hazards present

Table 9.4

Protective Clothing and Accessories (EARS)		
Clothing Type	**Type of Protection**	**Use Considerations**
Ear plugs and muffs	Protect against physiological damage and psychological disturbance	• Compatibility with other safety equipment • Both can interfere with communication • Chemical contamination can be introduced into ear by ear plugs • Limited to no chemical protection
Headphones	Enable communication	• Highly desirable, particularly in emergency conditions or high hazardous occupations • Limited to no chemical protection

Table 9.5

Protective Clothing and Accessories (HANDS AND ARMS)		
Clothing Type	**Type of Protection**	**Use Considerations**
Gloves and sleeves	Protect hands and arms from chemical or physical contact	• Wear jacket cuffs over glove cuffs to prevent liquid from entering the glove • Compatibility with hazards present
Over gloves	• Provide supplemental protection • Protect more expensive undergarments from abrasions, tears, and contamination	Compatibility with hazards present
Disposable gloves	Reduce decontamination needs	Compatibility with hazards present

Table 9.6

Protective Clothing and Accessories (FEET)		
Clothing Type	**Type of Protection**	**Use Considerations**
Safety boots	• Protect from contact with chemicals • Protect from compression, crushing, or puncture by falling, moving, or sharp objects • Limited electrical protection	• Must meet safety specifications • Provide good traction • Compatibility with hazards present
Disposable shoe/boot covers	Protect safety boots from contamination	May be disposed of after use, facilitating decontamination

Table 9.7

Protective Clothing and Accessories (GENERAL)		
Clothing Type	**Type of Protection**	**Use Considerations**
Flashlight or lantern	Enhance visibility in buildings, enclosed spaces, and dark areas	• Must be intrinsically safe • Seal in plastic bag to facilitate decontamination
Personal dosimeter	Measures worker's exposure to ionizing radiation and certain chemicals	Place inside suit to estimate actual body exposure
Personal locator	Enables emergency personnel to locate a victim	Must be intrinsically safe
Two-way radio	Enables communication	• Must be intrinsically safe • May be placed in plastic liner to facilitate • decontamination
Safety belts, harnesses, and lifelines	Enable personnel to work in elevated areas, enter confined areas, or prevent falls	• Must be constructed of spark-free hardware and chemical-resistant materials • Must meet safety specifications

Table 9.8

Does the proper chemical-protective clothing (CPC) always protect the wearer?

A chemical may permeate (move through the clothing material) or penetrate through zippers, seams, or imperfections. Use, age, or exposure can cause the material to degrade and lose or change its chemical resistance. Five major factors affect chemical permeation, penetration, and degradation:

- Contact time,
- Concentration,
- Temperature,
- Size of contaminant molecules, and
- Physical state of the wastes.

No one material can protect against all chemicals.

Mixtures of chemicals can be more aggressive towards CPC materials than a single chemical. No one material can protect against all chemicals, but ideally, the materials selected should resist permeation, penetration, and degradation.

What are the different levels of chemical-protective ensembles?

There are four levels of protection:

Figure 9.1
The four levels of PPE range from Level A, offering the most protection, to Level D, which offers the least protection.

- **Level A** - provides the highest level of skin, eye, and respiratory protection; a totally-encapsulating positive pressure suit.
- **Level B** - provides the highest level of respiratory protection and the appropriate level of skin protection from the hazards.
- **Level C** - consists of the appropriate suit for the expected chemical exposure and appropriate air-purifying respiratory protection.
- **Level D** - minimal skin protection, and no respiratory protection; normal safety equipment.

What is the criteria for selecting a specific level of protection?

PPE should provide adequate protection for the situation, but not over-protection. The full protective ensemble must protect the worker from site-specific hazards and, at the same time, minimize the hazards of the PPE ensemble itself. The type of equipment used and the level of protection should be re-evaluated as new information is available and as workers are required to perform different tasks.

Criteria for Selecting Personal Protective Equipment (PPE)

Recommended Equipment	Optional Equipment	Used When . . .	Limitations
Level A Ensemble			
• Pressure-demand, full-face piece SCBA or ressure-demand SAR-E/ SCBA • Totally-encapsulating chemical-resistant suit • Inner chemical-resistant gloves • Chemical-resistant safety boots/shoes • Two-way radio communications • Hardhat	• Cooling unit • Coveralls • Long cotton underwear • Disposable gloves and boot covers	• Substance requires highest level of protection for skin, eyes, and respiratory system • Measured (or potential for) high airborne concentrations • High potential for exposure to materials harmful to skin or capable of absorbing through intact skin • Operations in confined, poorly ventilated areas until need for Level A protection is ruled out	• Suit material must be compatible with substances involved

Table 9.9

Criteria for Selecting Personal Protective Equipment (PPE)			
Recommended Equipment	**Optional Equipment**	**Used When . . .**	**Limitations**
Level B Ensemble			
• Pressure-demand, full-face piece SCBA or pressure-demand SAR-E/SCBA • CPC (overalls and long-sleeved jacket; hooded, one-or two-piece chemical splash suit; disposable, chemical-resistant one-piece suit) • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots/shoes • Hardhat • Two-way radio communications	• Coveralls • Disposable boot covers • Face shield • Long cotton underwear	• Atmospheric concentration of substances requires a high level of respiratory protection, but less skin protection • Do not meet the criteria for use of airpurifying respirators	• Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through intact skin • Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, particulates, or splashes of material that will affect any exposed skin.

Table 9.9 (Continued)

Criteria for Selecting Personal Protective Equipment (PPE)			
Recommended Equipment	**Optional Equipment**	**Used When . . .**	**Limitations**
Level C Ensemble			
• Full-face piece, air-purifying, canister-equipped respirator • CPC (overalls and long-sleeved jacket; hooded, disposable, chemical-resistant one-piece suit) • Inner and outer chemical-resistant safety boots/shoes • Hardhat • Two-way radio communications	• Coveralls • Disposable boot covers • Face shield • Escape mask • Long cotton underwear	• Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin • All criteria for the sue of air-purifying respirators are met	• Atmospheric concentrations of chemicals must not exceed IDHL levels or MUC of respirator • Atmosphere must contain at least 19.5% oxygen
Level D Ensemble			
• Coveralls • Safety boots/shoes • Safety glasses or chemical splash goggles • Hardhat	• Gloves • Escape mask • Face shield • Hearing protection	• Atmosphere contains no known hazard • Work functions preclude potential for unexpected inhalation of, or contact with, hazardous levels of any chemicals	• Hazards present must be below PELs • Atmosphere must contain at least 19.5% oxygen

Table 9.9 (Continued)

How does PPE selection affect the duration of work?

PPE limitations can limit the mission length, which should be planned in advance. For example, when workers wear CPC, the required task must be accomplished before chemical breakthrough occurs, or degradation of CPC becomes significant. Air supply consumption, ambient temperature, and, in heat stress environments, the use of ice vests and chilled air, are other factors to be considered before work begins.

What type of training is required?

At a minimum, the training portion of the PPE program should outline the employer and employee responsibilities. Training must be done before PPE is used in a hazardous environment, and repeated at least annually. Employees required to wear PPE must be trained to know at least the following:

- When PPE is necessary.
- What PPE is necessary.
- How to don, doff, adjust and wear PPE.
- Limitations of PPE.
- Proper care, use and maintenance.

Why is worker training one of the most important requirements of a PPE program?

PPE does not protect against all hazards. Workers must understand the limits, proper use, and care of PPE. If not, they may work unprotected with a false sense of safety.

The use of PPE itself can create worker hazards, such as heat stress; physical and psychological stress; and impaired movement, vision, and communication.

In general, the greater the level of PPE protection, the greater the associated risks. For any given situation, PPE should be an adequate level of protection. Overprotection can be hazardous and should be avoided.

Training:

- Allows workers to become familiar with equipment in a safe situation;
- Instills worker confidence dealing with the equipment;
- Makes the user aware of the limitations and capabilities of the equipment;
- Increases the effectiveness of PPE use;
- Allows worker to become comfortable in PPE before use in hazardous atmospheres;
- Must be repeated annually.

What is the most important factor to consider when doffing PPE?

During doffing (removing a protective ensemble), always assume the PPE is contaminated. Proper doffing and decontamination procedures must be established to prevent the contaminant from moving through the decontamination line.

Why is it important to store PPE properly?

Many equipment failures can be directly linked to improper storage. Clothing and respirators must be stored properly to prevent damage or malfunction due to the exposure of dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Procedures must be specified for pre- and post-use storage.

Are there procedures to ensure that PPE is properly maintained?

Inspection, maintenance, and repair should be done in accordance with the manufacturer's recommended procedures.

Most CPCs currently available are intended for single use. Decisions about reuse must consider the penetration rates and the toxicity of the contaminants. In fact, the reuse of clothing is not advisable unless extreme care is taken to make sure that the clothing is properly decontaminated and that the decontamination does not degrade the material.

Chemicals that have begun to penetrate the clothing may not be removed during decontamination and may continue to move through the material toward the inside surface. This is a possible hazard (direct skin contact) to the next person using the clothing. Where such hazards may develop, clothing should be checked inside and out for discoloration or other evidence of contamination.

What is the employees' responsibility for protecting themselves?

PPE depends completely on the worker for its correct use. If it fails or is used improperly, the worker is exposed to the full force of the hazard. Employees must understand all aspects of the equipment functions and limitations.

Workers should report any perceived problems or difficulties while wearing PPE to their supervisors, including:

- Degradation of the protective ensemble.
- Perception of odors.
- Skin irritation.
- Unusual residues.
- Discomfort, rapid pulse, nausea, or chest pain.
- Resistance to breathing, fatigue due to respirator use.
- Interference with vision or communication; restriction of movementt

Notes

Chapter 10
Decontamination

Issues and topics for discussion:

- Discuss the elements of a decontamination plan.
- Discuss the decontamination line.
- What procedures should be followed for emergency decontamination?
- Discuss methods for testing for effectiveness.

Introduction

Decontamination is the process of removing or neutralizing contaminants that have collected on the workers and equipment.

Why is the decontamination process important?

- Reduces workers' potential exposure to hazardous materials upon removing PPE.
- Reduces the transfer of harmful materials into clean areas.
- Helps to prevent the mixing of incompatible chemicals.
- Protects the community by preventing the movement of contaminants from the site.

When should a Decontamination Plan be established?

A Decontamination Plan should be developed as part of the Health and Safety Plan and set up before any workers/equipment enter areas where the potential for hazardous exposure exists.

What is the purpose of the decontamination plan?

The plan should identify site-specific and hazard-specific procedures, and determine:

- Number and layout of stations.
- Equipment needed.

The plan should also establish appropriate procedures and methods:

- To prevent contamination of clean areas;
- To reduce worker contact with contaminants during removal of PPE;
- For disposing of clothing and equipment that is not completely decontaminated.

How do Standard Operating Procedures prevent contamination?

The first step in decontamination is to establish Standard Operating Procedures (SOPs) that reduce contact with waste and thus the potential for contamination.

Typical SOP's are:

- Stress work practices that reduce contact with hazardous materials.
- Use remote sampling, handling, and container-opening techniques.
- Protect monitoring and sampling instruments by bagging.
- Wear disposable outer garments and use disposable equipment.
- Cover equipment and tools with strippable coating which can be removed during decontamination.
- Encase source of contaminants with protective materials.

What are general methods of decontamination?

All workers, clothing, equipment, and samples leaving the contaminated area must be decontaminated.

Decontamination methods include:

- Physical removal involves dislodging/displacement, rinsing, evaporation, scraping, brushing, and wiping;
- Chemical removal involves neutralizing the contaminant with chemicals;
- or a combination of both.

What are some procedures for testing the effectiveness of decontamination?

Decontamination methods vary in their effectiveness for removing different materials. The effectiveness of any method should be evaluated at the beginning of a program and periodically. The following are methods to detect contamination:

- **Visual observation** - Contaminant may be visible and/or discoloration or other physical damage to the suit material
- **Ultraviolet light** - Fluorescent contaminants can be visually detected when exposed to ultraviolet light
- **Wipe sampling** - Both the inner and outer surfaces of protective clothing are physically wiped with a collection swab and then analyzed in a laboratory. Skin may also be tested using wipe sampling.
- **Cleaning solution analysis** - Abnormal levels of contaminants in the final rinse solution may mean that additional cleaning and rinsing are needed, or indicate the need to change rinse water more frequently
- **Testing for permeation** - Requires pieces of clothing to be sent to laboratory for analysis.

What is a decontamination line?

At a hazardous waste site, decontamination facilities should be located in the **contamination reduction zone (CRZ),** the area between the exclusion and support zone. To provide an organized way to reduce contamination, the Health and Safety Plan (HASP) must establish decontamination procedures performed in a specific order. Decontamination procedures are always site-specific as well as chemical specific.

Each procedure should be performed at a separate station. The sequence of stations is called the **decontamination line.**

Heavy equipment, personnel, and hand tools should have separate decontamination lines.

What are the parameters for establishing stations?

The number of stations should be determined by the physical state of the contaminants, the ease of removal, and the level of protection worn by site workers. The number of stations must be included in the health and safety plan.

- Stations should be separated to prevent cross contamination, and
- Arranged in order of decreasing contamination, preferably in a straight line.
- Separate lines should be provided to prevent cross contamination of workers from different contamination zones containing incompatible materials.
- Entry and exit areas should be separate and clearly marked.
- Dressing stations should be separate from redressing areas.
- Workers who wish to enter clean areas, such as locker rooms, should be completely decontaminated.

What special decontamination arrangement is made for workers wearing heavily insulated protective clothing or those who work in hot environments?

It is usually a location in a shaded area in which the wind can help to cool the workers and may require the use of cooling devices such as water hoses, ice packs, wet towels, etc. For additional information, refer to ACGIH for work and rest breaks.

Should workers on the decontamination line all wear the same level of protection?

Decontamination workers at the beginning of the line (nearer the contaminated work area) may require more PPE protection than the workers at the end of the line. In some cases, decontamination workers would wear the same level of PPE as the worker in the **exclusion zone**. In other cases, decontamination workers may be sufficiently protected by wearing one level lower of protection. Decontamination workers should never be dressed in a higher level of protection than the worker he is decontaminating.

What determines the level of protection required for decontamination workers?

The level of protection required will vary with the type of equipment used and the nature of the specific contaminants. For example, workers using a steam jet may need a different type of respiratory protection than other decontamination workers because of the high moisture levels produced. A qualified health and safety expert should select the appropriate equipment and clothing for protecting decontamination personnel.

All decontamination workers are in a contaminated area and must themselves be decontaminated before entering the clean area. The extent of their decontamination should be determined by the types of contaminants they may have contacted and the type of work they have performed.

Example of equipment used in the decontamination process
• Drop cloths • Collection containers • Lined box with absorbents • Large galvanized tubs, stock tanks, or children's wading pools • Wash solutions • Rinse solutions • Long-handled, soft-bristled bushes • Paper or cloth towels • Lockers and cabinets • Metal/plastic cans or drums • Plastic sheeting, sealed pads with drains • Shower facilities, personal wash sinks • Soap or wash solution, washcloths, and towels • Lockers or closets

Table 10.1

What are examples of procedures that may be used to decontaminate heavy equipment?

- Establish a decontamination pad with tools, sprayers, and a containment system for the collection and treatment of the waste.
- Evaluate the type(s) of contamination.
- Remove covers, guards, shields, panels, and plates.
- Scrape, brush, or shovel to remove any loose material.
- Collect and contain all hazardous materials.
- Scrub, wash, and rinse.
- Determine the extent of contamination remaining.
- Check restricted areas, such as frames and voids.
- Check fluid levels (engine oil, hydraulic oil, coolant, transmission oil, differential, winch, fuel, windshield washer fluid, etc.).
- Sample fabrics, paint, tires, rubber products, and plastics.
- Wipe sample ground engaging components, buckets, tracks, etc.
- Remove all appropriate fluids, tires, hoses, fabrics, insulation, etc.
- Perform final decontamination as required by results of samples taken.
- Replace any fluids or components removed for decontamination.

Are high-powered jet sprays the best way to decontaminate heavy equipment?

The use of high-powered jet sprays can be effective, but has two potential drawbacks: contamination may be spread in the mist of water droplets produced, or the pressure of the water may embed contaminants more deeply into equipment or materials. The use of low-pressure wash-down lines and/or the use of protective enclosures may be warranted to reduce the needless spread of contamination.

What are some ways to properly decontaminate/dispose of decontamination equipment and materials?

- Buckets, brushes, clothing, tools, and other contaminated equipment should be collected, placed in containers, and labeled, if not decontaminated
- All previously used solutions and wash water should be collected and disposed or recycled properly.
- Clothing that is not completely decontaminated should be placed in plastic bags for further decontamination and/or disposal.

In case of an emergency, should the victim be decontaminated or treated first?

Emergency decontamination procedures must be established. **In an emergency, the primary concern is to prevent the loss of life or severe injury to site personnel.**

If immediate medical treatment is required to save a life, decontamination may need to be delayed until the victim is stabilized. However, gross decontamination of the area of the suit/PPE that must be opened to start life-saving procedures should be attempted. Protect the victim from being exposed to chemicals.

If decontamination can be performed without interfering with essential life-saving techniques or first aid, or if a worker has been contaminated with an extremely **toxic** or **corrosive** material that could cause severe injury to loss of life, decontamination must be performed immediately.

Do we want to live through the emergency to die from overexposure?

Chapter 11
Radiation

Issues and topics for discussion:

- What are the types and sources of each type of radiation?
- Discuss the radiation units of measurement.
- Why is it important that employees read and sign the radiation work permit (RWP) before entering a contaminated area?
- Discuss ALARA and SOPs that employees should use to reduce exposure to radioactive contamination.

Introduction

his chapter was written as a basic guide to prepare workers for an environment containing ionizing radiation. Any worker assigned to a radiological area will require more training. Each worker is responsible for following procedures, using good radiological work practices, and following all federal and state laws concerning ionizing radiation.

What is radiation?

Radiation is energy in motion in the form of particles or rays. There are two types of radiation - **ionizing** and **nonionizing.** Nonionizing radiation includes radar waves, microwaves, and visible and ultraviolet light. Workers at certain hazardous waste sites must be protected from ionizing radiation.

What is ionizing radiation?

Ionizing radiation is particles or rays of energy produced by radioactive material or radiation-producing devices. It cannot be detected by any of the natural senses (sight, hearing, feeling, etc.) but can be detected with instruments.

What are the four types of ionizing radiation?	
Alpha	• Quite large particles: (2) protons and (2) neutrons • Least penetrating • Stopped by clothing, sheet of paper, or outer layer of skin • Cannot cause problems unless it gets inside the body
Beta	• High-speed particles, like an electron • Penetrate only about 1/8-inch into tissue • Stopped by plastic face shields, thin plywood, or sheet metal
Gamma and X-ray	• Rays, not particles • Can penetrate the body • Stopped by lead, steel, or concrete shields
Neutron	• Particles without electrical charge • Encountered at nuclear reactors and with nuclear explosions • Can penetrate into and through the body • Deposit some energy into the body

Table 11.1

What is "background radiation"?

Background radiation is always present in the environment. Roughly 80% of the radiation to which we are exposed comes from natural sources.

Natural sources include:

- Solar and cosmic radiation,
- Radon,
- Terrestrial, and
- Internal emitters (food we eat)

Because background radiation is a part of the environment, the body is able to cope with normal levels. Man-made sources of radioactive materials account for the remaining 20% of our exposure:

- Medical uses (x-rays),
- Consumer products (color television),
- Nuclear facilities.

What is the "half-life" of a radioactive material?

A fire burns itself out over time, and atoms become stable over time. One term used to describe how long radioactive materials remain "hot" is the half-life. This is the time it takes for one-half (T-1/2) of the atoms of the radioactive material to decay and release their energy. This can vary from a millionth of a second to billions of years depending on the particular radioactive substance, just as some types of woods burn faster than others. The shorter the half-life, the more active the material.

What is the difference between contamination and radiation?

Contamination is radioactive material in an unwanted place. It can enter the body by the mouth, nose, open wounds, and occasionally through the skin, accumulating in the body.

Radiation is a type of energy. Unlike contamination, radiation cannot be accumulated in the body; the exposure cannot be given to anyone else.

How is radiation exposure measured?

We cannot see or feel ionizing radiation like we can see and feel the fire's light and heat, but we can measure radiation with instruments and see the effects of radiation at high dose levels.

The **RAD** is a unit used to measure a quantity called "radiation absorbed dose." This relates to the amount of energy actually absorbed in some material, and is used for any type of radiation and any material. However, the RAD unit does not describe the biological effects of the different radiations.

Exposure to radiation is measured in units called "**roentgens**." Therefore a measuring unit called a **REM,** short for "**R**oentgen **E**quivalent **M**an," is used. This unit indicates the damage potential of an exposure based on the type of radiation.

Since the roentgen and the rem are relatively large units, the prefix "milli", meaning 1/1000, is commonly used.

1000 millirem (mrem) = 1 rem
1000 milliroentgen (mR) = 1 roentgen

What is the difference between "dose" and "dose rate"?

A "dose" of radiation is the amount received over a certain period of time. The "dose rate" is how quickly it is received at any given time.

What is the measurement used for radiation contamination?

Radiological contamination is measured in units of disintegration per minute (dpm). This unit of contamination refers to the number of radioactive atoms which decay (emit radiation) each minute.

What is the unit of measurement of radioactivity in the air?

Airborne Radioactivity Units. Airborne radioactivity is contamination that is dispersed in the air in the form of dust, vapor, or gas. Airborne radioactivity is commonly expressed as microcuries per milliliter (mCi/ml) or the amount of radioactive material in each unit volume of air. Each isotope (type of radioactive material) has an annual internal exposure limit established. The limiting value for inhaled radionuclides is a Derived Air Concentration (DAC) and is also given in units of mCi/ml. Use the DAC value to compare to air sample results to determine if an overexposure occurred.

What are the effects of radiation exposure?

Biological effects can occur from both external sources of radiation and radiation emitted by internal sources of radiation in the body. Internal sources of radiation result from contamination that has become deposited in the body by inhalation, ingestion, absorption, or injection.

A radiation dose greater than 100 rem can make you sick. The nuclear industry average for dose-to-radiation-workers is about 650 mrem in a year. Established dose limits are well below the level where damages are observed; the annual radiation dose limit of 5 rem is rarely exceeded in the workplace.

An acute dose of 500 rem (500,000 mrem) could be fatal. No health effects have been observed statistically from low levels of radiation exposure, called chronic exposure, since it occurs over a relatively long period of time.

What agencies regulate the occupational dose limits for workers?

Occupational dose limits are established for worker exposure by the regulatory agency responsible for worker health and safety at that site: Occupational Safety and Health Administration (OSHA), the Nuclear Regulatory Commission (NRC), or the US Department of Energy (DOE).

Radiation Exposure	Agency	Dose Limit
Whole body (head, trunk of body, arms down to elbows inclusive, legs down to knees inclusive)	DOE	5.0 rems/yr*
	NRC	5.0 rems/yr
	OSHA	5.0 rems/yr
Extremities (arms past elbows including hands, legs past knees including feet and ankles)	DOE	50.0 rems/yr
	NRC	50.0 rems/yr
	OSHA	75.0 rems/yr
Whole body skin and individual organs (any particular organ at one time)	DOE	50.0 rems/yr
	NRC	50.0 rems/yr
	OSHA	30.0 rems/yr
Eyes	DOE	15.0 rems/yr
	NRC	15.0 rems/yr
Member of public (visitor)	DOE	.1 rems/yr
	NRC	.1 rems/yr
Declared pregnant worker	DOE	.5 rems/gestation period
	NRC	.5 rems/gestation period

Table 11.2

What are the principles that guide workers in keeping radiation exposure as low as possible?

Radiation protection organizations operate under the **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA) concept. The basis for ALARA is that there should not be any occupational radiation exposure to workers without an overall benefit from the activity.

Even though the risk for exposure to low levels of radiation is small, the worker should make every effort to keep exposure as low as reasonably achievable (ALARA) to further reduce risks.

What are the basic practices used to reduce/minimize exposures?

Source reduction is the best way to reduce exposure. Source reduction includes flushing components; removing stored radiological material; and mechanical, chemical, and electrochemical decontamination methods. Only if source reduction is not feasible, then:

- Time: reduce the time spent near a radiation source,
- Distance: stay as far away from the source as possible,
- Shielding: place shielding material between you and the source.

What is the purpose of the radiation work permit (RWP)?

The radiation work permit (RWP), also called a special work permit (SWP) or the radiation exposure permit (REP), is a method used to control work in areas involving exposure to radiation and other radiation hazards. The RWP lists job-specific instructions, dress-out requirements, dosimetry requirements, and radiation and/or contamination levels. Employees must read and sign the RWP before entering the work area.

What general work practices can employees use to assure their safety in the workplace?

- Obey the posted, oral, written health physicist's (HP's) instructions and procedures.
- Obey instructions on RWPs.
- Keep track of personal radiation exposure; avoid exceeding exposure limits.
- Be alert that the work of others may change surrounding radiological conditions.

What should employees do to reduce the spread of radioactive contamination?

- Do not take breaks, eat, drink, or use tobacco products in radiation controlled areas.
- Do not touch a contaminated surface or allow clothing to do so.
- Use tools and other equipment dedicated to contamination work whenever possible.
- Perform frisking (use a radiation-detecting device to search for contamination of personal) properly.
- Be especially careful when removing protective clothing, especially gloves and shoe covers.

What special precautions should be taken when workers handle contaminated materials?

- Contaminated materials must be placed in containers, yellow bags, or wrapping materials before leaving the contaminated area. This may include tagging and/or labeling.
- Immediately notify the HP if damaged and/or torn containers/wrappings of radioactive materials are noticed.

What should employees do to reduce radioactive waste?

To avoid compounding the situation and creating more contaminated waste, workers must <u>NOT</u>:

- Mix hazardous waste with radioactive waste,
- Mix non-contaminated waste with contaminated wastes,
- Mix waste that cannot be compacted with compacted wastes.

What should be the first priority when a serious injury occurs in a restricted area?

In most cases, treating a serious injury is more important than concerns about radiation. It is better to leave the area if necessary and clean up contamination later than to delay needed treatment.

What is the employer's responsibility for warning employees of radiation hazards?

The employer must inform the employee of any radioactive materials or radiation occurring in the working area. Posting signs and/or barriers informs the radiation worker of the radiological hazards in the area, possible PPE requirements, or if respirators are required.

What type of radiation monitoring instruments should be used and why?

Alpha radiation can only be detected by certain instruments. Most beta instruments can also detect gamma radiation. The worker should have an understanding as to the different instruments used and assure that the proper ones are used. Knowing and understanding the radiation instruments is both vital and necessary in the area of radioactivity. Radiation instruments include:

- Dose Rate Meter - measures the dose rate in an area and reads in mrem/hr and/or rem/hr.
- Portal Monitor - checks the worker’s whole body for contamination at exit areas.
- Hand and Foot Monitor - checks the worker’s hands and feet for contamination at exit areas.
- Frisker - is placed in different areas in a building to check the workers and equipment for contamination when they exit an area.
- Dosimeters - determine the exposure a worker has received.

What type of devices are used to gather information regarding worker radiation exposure?

Facilities are required to keep records of worker radiation exposures and provide copies of records to the employee annually.

Two Types of devices are used to gather this information:

- Thermoluminescent Dosimeter (TLD) - records the radiation dose received by the worker. The results are the worker’s official radiation dose record and are normally read quarterly for routine radiological work and monthly for higher dose potential jobs.
- Pocket Dosimeter - gives an estimate of radiation received by the worker and is easily read by pointing one end toward a light source and looking through the other.

Chapter 12
Heat Stress

Issues and topics for discussion:

- What is the body core and it's relationship to heat stress?
- How dangerous is heat stress?
- What steps can employers take to prevent heat stress?
- What are the signs of heat stroke and what treatment should a victim receive?

Introduction

Operating heavy equipment or working in hot environments is stressful. If it feels hot to the worker, it probably is too hot. Heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites. Regular monitoring and other preventive measures are vital to safety and health.

What is heat stress?

Heat-related illnesses occur as a result of overexposure to a heat source and the body's response. A worker's clothing, workload, and individual characteristics are factors that can contribute to heat stress. Heat stress disorders include cramps, heat exhaustion, and heat stroke.

Is heat stress dangerous?

Heat stress can cause illness and even death. Although some workers are more susceptible than others, it is critical that each worker be able to recognize signs of heat stress, and know the appropriate steps to treat and prevent it.

What specific factors contribute to heat stress disorders?

Direct sunlight's rapid heating of the human body is a serious factor, but even when workers are shaded, high ambient air temperatures and high humidity increase heat stress. Even routine work raises the worker's metabolic rate, which increases the generation of heat.

The amount and type of PPE directly affects the increased risk of a heat-related illness occurring. PPE adds weight, bulk and severely reduces the body's ability to lose heat through:

- Evaporation - takes place when sweat evaporates from the skin. High humidity reduces the rate of evaporation and reduces the effectiveness of the body's primary cooling mechanism.
- Radiation - the transfer of heat energy through space. A worker whose body temperature is greater than the temperature of the surrounding surfaces radiates heat to these surfaces.
- Convection - the transfer of heat in a moving fluid. Air flowing past the body can cool the body if the air temperature is cool. If the air exceeds 95ºF, it can increase the heat load on the body.

Personal protective clothing, designed to protect the worker from chemical hazards, is a significant part of the heat stress problem. Since most chemical-protective clothing (CPC) is virtually impermeable to moisture, evaporative cooling is limited. Plastic-like materials do not allow for heat exchange, and layers of material have an insulating effect.

Workers wearing CPC that has low heat transfer characteristics have suffered from heat stress disorders even during cold weather.

What are the early warning signs that a worker may be suffering from heat stress?

Painful muscle spasms, usually in the legs or abdomen, warn that heat stress is developing. Heat cramps can be caused by heavy sweating with inadequate electrolytes replacement. Although heat cramps are not especially dangerous, they may be an early sign that the body's ability to cope with heat is being exceeded. When heat cramps occur, rest in a cool place and drink water or a sports beverage. Get medical attention if there is no improvement in one hour.

What is heat exhaustion? Is it serious?

Heat exhaustion is the most common form of heat stress. It often occurs in an otherwise fit worker who is involved in extreme physical exertion. Signs and symptoms may appear after only 15 minutes of work in hot environments or when wearing chemical protective clothing in warm climates. Heat exhaustion should not be taken lightly. A worker suffering from heat exhaustion is very sick and in need of quick treatment. Untreated, heat exhaustion not only makes the worker feel bad, it may lead to worse problems such as heat stroke.

What are the signs and symptoms of heat exhaustion?

Heat exhaustion is actually a mild form of shock, brought on by the pooling of blood in vessels near the surface of the skin, and away from vital body organs; this causes:

- **Headache**, **dizziness**, and **weakness.**
- Lack of oxygen to the brain can cause **fainting.**
- **Loss of appetite** and **nausea** result from lack of blood flow to the stomach and digestive tract. Food in this area is not digested any further and becomes irritating to the lining of these organs.
- Due to reduced circulating blood volume, tissues are starved of oxygen. A **pale to ashen skin color** results.
- **Profuse sweating** is part of the body's natural response, trying to cool itself by releasing heat. Body temperature remains normal to below normal, as the body does what it can to "exhaust" heat.

WATER. REST. SHADE.

The work can't get done without them.

OSHA's Campaign to Prevent Heat Illness in Outdoor Workers

http://www.osha.gov/SLTC/heatillness/index.html

This website is part of OSHA's nationwide outreach campaign to raise awareness among workers and employers about the hazards of working outdoors in hot weather. The educational resources page gives workers and employers information about heat illnesses and how to prevent them. There are also training tools for employers to use and posters to display at their worksites. Many of the new resources target vulnerable workers with limited English proficiency. OSHA will continue to add information and tools to this page throughout the summer.

OSHA is also partnering with the National Oceanic and Atmospheric Administration (NOAA) on weather service alerts. NOAA's Heat Watch page now includes worker safety precautions when extreme heat alerts are issued.

We invite you to join in this effort by helping to reach workers and employers in your community with the resources you will find on this site.

What first aid should be given to a victim suffering from heat exhaustion?

To treat obvious heat exhaustion:

- Help the worker to a cool shaded area to rest.
- Loosen or remove unnecessary clothing, and cool the skin with a mist of water or wet cloth.
- Give a small cup of water or other prepared electrolyte solutions every 15 minutes.
- Have the victim lie down and elevate their feet 8 to 12 inches to increase blood flow to the brain, improve consciousness, and reduce dizziness from heat exhaustion.
- Call for emergency help if the person does not feel better in a few minutes. Recovery from heat exhaustion may be quicker for some than others. Often the victim will feel significantly better before the ambulance arrives. The worker should continue on to the hospital for evaluation and treatment. If they refuse, their condition should be monitored closely. They may relapse into a worsened state or experience complications. Pre-existing medical problems, such as heart disease, high blood pressure, asthma, and diabetes, may be further aggravated by heat-related disorders.

Heat-related Illnesses	
Heat cramps	Painful muscle cramps usually in legs or abdomen Early warning sign leading to heat exhaustion Heavy sweating
Heat exhaustion	Pale skin Fatigue Nausea and vomiting Headache and blurred vision Dizziness and fainting
Heat stroke	Red, hot, dry skin Oral temperature over 103˚F Nausea Throbbing headache Dizziness Unconsciousness No sweating

Table 12.1

What is heat stroke and how does it differ from heat exhaustion?

Heat stroke is the most dangerous form of heat stress. It can cause permanent brain damage or death. It is critical that heat stroke be recognized and treated immediately. Heat exhaustion commonly occurs before heat stroke develops fully; but heat stroke differs from heat exhaustion in that the body's cooling system has quit working. Approximately 50% of all heat stroke victims die even if they receive medical attention.

What are the signs and symptoms of heat stroke?

Sweating stops and the **skin** becomes **red** and **dry**.

- The body is now transformed into a pressure cooker with no outlet for the heat. Heat increases, causing damage to the brain and vital organs. **Body temperature** may reach 105 degrees and even **exceed 105 degrees Fahrenheit**.
- **Pulse rate increases** as the body sends more and more blood to the skin surface for cooling.
- **Mental confusion** occurs, and answering even the simplest questions becomes difficult. Walking becomes **staggering**. A tired feeling progresses to **lapses of consciousness**.
- **Breathing**, initially deep, becomes **shallow and weak**. **Convulsions** and twitching are common, as damage to the brain increases and body control decreases.
- Internal organs, such as the liver and kidneys, may undergo unseen damage.

What first aid should be given to a victim suffering from heat stroke?

Heat stress is deadly serious. Untreated, all heat stroke victims die. Emergency treatment must start as soon as possible to stop or reverse the deadly effects. In all cases of heat stroke:

- Call for help immediately.
- Make sure the victim is breathing and has a heart beat. If not, CPR is needed.
- Never give the heat stroke victim anything by mouth.
- Transport the victim as soon as possible, preferably by ambulance, where more definitive care can be given.
- If heat stroke has developed and transportation is delayed, rapid cooling by continued cold water wraps and even immersion may be necessary. Someone with advanced first-aid training should do this.

What are the steps for treating a heat stroke victim who has been working in protective clothing?

Workers can develop heat stroke while working in chemical protective clothing. Although cooling the victim is of greatest importance, it is critical that steps are taken to reduce the worker's chances of becoming contaminated. Be quick and purposeful:

- Decontaminate the victim by the most efficient means.
- Carefully remove the protective ensemble, keeping the contamination away from the worker; then
- Pass the worker to others outside the contamination zone to initiate treatment.

What training is needed to prevent heat stress disorders?

Training enables workers to better protect themselves and each other. Employees should be trained to:

- Recognize early warning signs of heat stress in themselves and fellow workers.
- Become acclimated to the temperatures and conditions that they will be working in. It takes time for the body to adjust to sudden temperature changes. This is especially true when workers are assigned personal protective equipment that they have previously worn very little, if at all. This may be something as simple as taking a short rest.
- Follow personal heat stress hygiene practices. To prevent dehydration, workers should drink water and other commercially available solutions to replace lost fluids. Coffee, colas, iced tea, and other caffeinated beverages may actually bring on the effects of heat stress and increase complications.

A healthy life style can lower the risk of heat-related disorders: enough sleep, a well-balanced diet, and avoiding drugs and alcohol. Normal diets provide a significant amount of salt, making salt tablets unnecessary. Workers should be aware that certain medications, protein supplements, and diuretics may put them at increased risk when working in hot environments. Likewise, many diet plans (such as “Slimfast”) leave the body in a dehydrated state or lacking essentials to combat the effects of heat. Those who have had a heat-induced illness in the past are also more susceptible to heat stress at work.

How does monitoring help to prevent heat stress disorders?

Monitoring of personnel working in heat stress situations should be planned and reviewed by an occupational medicine physician, and actively administered. Physical examinations, to evaluate past work- and medical history, will guide the physician’s need for further tests and any specific limitations or directions for that worker. Pulse, respiration, temperature, electrocardiogram, fluid replacement, and work/rest regimens can be monitored on-site. New technologies, such as the CoreTemp Capsule, are being developed and assessed to do this faster and better.

Monitoring helps to determine what controls or special equipment is needed. Recommendations for monitoring requirements and suggested work/rest schedules are in the current ACGIH threshold limit values for heat stress. This standard does not apply to workers wearing semi-permeable or impermeable encapsulating ensembles. Workers should be monitored when the temperature is above 70º.

What are examples of effective engineering and administrative controls?

- Engineering controls, such as air-conditioned operator cabs, may reduce the physical stress
- Administrative controls may include short-duration work schedules or scheduling jobs involving heat stress during a cooler part of the day.
- PPE. The use of specialized personal protective equipment to reduce the effects of heat stress is receiving a great deal of attention. Cooling vests, for example, have specially designed, strategically located pockets that can be filled with ice packs. Because heat stress during PPE use is such a serious problem, developers are working on new cooling and monitoring devices which would allow workers wearing PPE to work more comfortably and safely for longer periods.

Notes

Chapter 13
Cold Stress

Issues and topics for discussion:

- What contributing factors make it possible for workers to suffer from cold stress even at relatively warm temperatures?
- How does the human body naturally protect itself from cold stress?
- How can employees consciously protect themselves from cold stress?
- What are the early warning signs of cold stress? Severe hypothermia?
- Should CPR be performed on a hypothermia victim?

Introduction

Workers are often required to operate heavy equipment or perform other duties in cold weather. Because so much emphasis is placed on heat stress, many times the dangers of cold exposure are overlooked.

What is cold stress?

The body's initial defense to protect itself from cold is to reduce the amount of blood flowing to the surface of the skin and the extremities. Constricting the capillaries to the extremities reduces further cooling and keeps more blood close to the body core. When the body core loses so much heat that normal functioning of muscles and the brain is affected, it is called hypothermia, a term which combines "hypo" (too little) with "thermia" (heat).

What are the early warning signs that a worker may be suffering from cold stress?

Shivering is the body's natural response to cold. It increases the body's metabolism, and the muscular activity generates some warmth. Uncontrollable shivering is a sign that cold stress is significant and that hypothermia may be present. As hypothermia progresses, the central nervous system becomes severely depressed. This causes slurred speech and sluggish, unsafe behavior.

Is cold stress dangerous?

Yes. Serious injuries can occur when a worker, whose hands have become too cold, loses dexterity. With every one-degree drop in body temperature below 95˚, the cerebral metabolic rate falls off by 3 to 5%. When a worker suffering from even the early symptoms of cold stress cannot think clearly, impaired judgement can and does cause accidents. Moreover, victims of moderate hypothermia may display apathy; they appear indifferent to their worsening condition. This apathy is dangerous because victims may neglect to try to re-warm themselves. Allowed to progress, hypothermia can cause death: more than 750 Americans die every year from hypothermia.

What first aid should be given to a victim suffering from mild to moderate hypothermia is experienced?

Stop heat loss by moving to shelter, changing from wet to dry clothing, adding layers of clothing, or wrapping in a blanket. Add fuel to replace what the body is burning by giving hot liquids containing sugar, protein, and/or fat.

Typical Signs of Hypothermia	
Mild Hypothermia	• Core temp of 96˚F to 98.6˚F. • Controllable shivering. • Problems performing complex functions. • Mentally alert. • Can walk and talk.
Moderate Hypothermia	• Core temp of 93˚F to 95˚F. • Uncontrollable shivering. • Appears dazed. • Loses fine motor coordination. • Irrational behavior - apathetic to worsening condition. • Cannot walk or speak clearly.
Severe Hypothermia	• Core temp below 92˚F. • Shivering in waves. • Muscles rigid. • Pulse rate and breathing very slow or undetectable. • Unconscious or in a stupor.

Table 13.1

What are the signs of severe hypothermia?

During severe hypothermia, the body-core temperature falls below 92 degrees Fahrenheit, a condition that is immediately life threatening. Continued cooling of the body will cause:

- Loss of consciousness;
- Reduced blood pressure;
- Faint pulse;
- Decreased respiratory rate.

Sometimes severe hypothermia mimics death: the victim is cold, blue, rigid, and unresponsive to stimuli; the pupils are fixed and dilated; and there is no discernible pulse or breathing. The body, though still alive, may be in a "metabolic icebox."

Stages of Severe Hypothermia	
Core Temperature	**Symptom**
97°	neck/shoulder muscles tighten, hands/feet ache
95°	mild hypothermia, violent trembling
93°	amnesia
91°	apathy
90°	stupor
88°	body quits trying to warm itself
87°	lose ability to recognize familiar faces
86°	arrhythmic heart, hallucinations

Table 13.2

What first aid should be given to a victim suffering from severe hypothermia?

Even in a case of "death" from hypothermia, it is important to remember that the hypothermic victim is never "cold and dead," only "warm and dead." Warm the victim before giving up! In all cases of severe hypothermia, call for emergency help.

To reverse the effects of hypothermia, the body needs to be re-warmed:

- Gently move the hypothermia victim to a warm place. A cold heart has its rhythm disrupted easily; performing CPR, moving victims briskly, or allowing them to walk could cause death.
- Remove cold, wet clothing and replace with warm, dry clothing.
- Cover the victim with blankets and use heat packs or hot compresses to transfer heat to major arteries at neck, armpits, groin, and palms of hands.
- If the victim is conscious, offer warm fluids. Do not give alcohol to a hypothermic worker - it is a system depressant, and will make matters worse.

Are there other forms of cold stress?

Frostbite, frostnip, and other similar disorders most often effect toes, fingers and hands, the nose, ears, cheeks, and other exposed or poorly-protected skin surfaces. Blood flow to these areas decreases as the body tries to keep its core warm.

Cases of frostbite range from mild, where the skin is pale and has a stinging sensation, to severe, where tissue is actually frozen, with blistering and redness, or even black due to tissue death.

Cold-related Illness and Injury		
Frostnip	• Affects top skin layers • Skin is white and waxy • Top skin feels hard, but deeper tissue is soft • Some numbness • Occurs mostly on cheeks, nose, ear lobes, fingers, and toes • Do not rub affected area	
Frostbite	• Worse than frostnip • Skin is white • Tissue is hard – wooden all the way through • Numb • Can include freezing of muscle or bone • Difficult to re-warm without some damage occurring	
Trench Foot	• Caused by prolonged exposure to cool, wet conditions • Blood vessels constrict, cutting-off circulation • Some numbness, tingling, and discoloration • If circulation is impaired for more than 6 hours permanent damage will occur	
Eye Injury: Freezing cornea	• Freezing cornea occurs when forcing eyes open in strong, cold winds	
Eye Injury: Snow-blindness	• Snow-blindness occurs from intense brightness of sun reflecting on snow • Occurs 8 to 12 hours after exposure • Eyes feel painful, are red, and will tear excessively	

Table 13.3

What first aid should be given to a frostbite victim?

Do not rub the affected part. Immerse the frostbitten area in cold water, or carefully apply warm, not hot, compresses. Continue to re-warm the victim with additional clothing or blankets.

How can employers and employees protect against cold stress?

The best protection from cold stress disorders is prevention using the following:

Engineering controls

- Use insulated tools and chairs.
- Redesign equipment.

Administrative controls

- Schedule work at warmest times.
- Set up work/re-warm cycles.
- Avoid long periods of little physical activity.
- Provide time for workers to get acclimated, especially when weather conditions change abruptly.
- Provide general or spot heating and warming shelters when temperatures drop below 19˚ Fahrenheit.

Personal protection

- Educate workers about the value of protective clothing and its limitations.
- Select clothing for insulating ability; cotton fleece, wool, polypropylene, and many new, man-made materials have excellent properties that make them good choices.
- Wear protective clothing in layers. This allows a worker to regulate body temperature by adding or removing a layer at a time.
- Include wind and water barriers.

How does "wind chill" affect cold stress?

The effects of wind compound the threat from cold temperatures. On a cool, windless day, with a temperature of 40˚ F, a worker may be comfortable with a medium-weight jacket. But if the wind begins to blow at only 20 mph, it has the same cooling effect as if the temperature were 18˚. The worker could change from being reasonably comfortable to developing hypothermia. The outer layer of cold weather protective clothing should be a wind barrier.

Why is it important for workers to stay dry?

Prolonged exposure to cool, wet conditions can cause trench foot. Wet clothing, in contact with the body, causes heat to be lost more than 25 times faster than normal. Workers who have gotten wet, or perspired heavily while working, have experienced severe cases of hypothermia requiring hospitalization. It is critical that protective water barriers be worn, both as outer layers to keep moisture out, and as under layers to wick perspiration away from the skin.

When is eye protection needed?

Workers should wear safety and/or sunglasses to:

- Shield the eyes from flying ice and other materials.
- Protect from strong cold wind, which could freeze the cornea.
- Prevent snow blindness. The signs of snow blindness, which include red, burning eyes, may not occur for 8-12 hours after exposure. Damage to eyes may be compared to that of a flash burn from arc welding.

What other factors contribute to cold stress disorders?

Severe cold stress situations occur when workers ignore preventive work practices, protective clothing suggestions, and early warning signs of the effects of cold. Worker fatigue, dehydration, hunger, and alcohol intake can all contribute to cold stress even at relatively warm temperatures. The colder the weather, the more likely hypothermia is to occur.

The cold can also affect respirators and chemical protective clothing (CPCs). At very low temperatures, the respirator's exhalation valve and regulator may become clogged with ice due to moisture in the exhaled air. The cold may also cause degradation of the protection and flexibility characteristics of CPC fabric.

Chapter 14
Bloodborne Pathogens and Biosafety

Issues and topics for discussion:

- Under what circumstances might operating engineers be exposed to bloodborne pathogens a job site?
- Should all employees ask to receive the free hepatitis B virus (HBV) vaccinations?
- Does the employee have the right to refuse vaccinations, medical evaluations, and follow-up exams?
- What are bloodborne pathogens?
- What is the employer's responsibility for educating employees regarding occupational exposure to bloodborne pathogens?
- What must an employer do if an employee is exposed to a bloodborne pathogen?
- What are universal precautions?
- Is Lyme disease present in your part of the country? If you are not sure, how could you find out?
- What other biological hazards — waterborne, airborne, tick-borne, or animal-borne diseases — may be present at specific sites where you have worked at?

Introduction

Operating engineers and hazardous material workers can be exposed to biological hazards, including HBV or HIV, while giving first aid or while handling infectious waste or other contaminated material.

Although this issue obviously pertains to medical personnel, employers in most trades are required to have a plan to protect workers from occupational exposure to bloodborne pathogens.

What Are Bloodborne Pathogens?

Bloodborne pathogens are microorganisms that can be present in human blood and body fluids and can cause and spread disease in humans. They include Human Immunodeficiency Virus (HIV) and Hepatitis B Virus (HBV).

What Is Human Immunodeficiency Virus (HIV)?

HIV is the virus that attacks the body's immune system and causes AIDS. As of 2011, 1.5 million people are living with HIV in the United States, one fifth of which are unaware of their condition.

Initial symptoms of AIDS are mild. Only 50% have symptoms at initial infection, and these most often involve constant fatigue, white spots or unusual blemishes in the mouth, and unexplained weight loss. As the disease progresses, it destroys the body's immune system, eventually causing death.

What Is Hepatitis B Virus (HBV)?

The symptoms of HBV are flu-like: fatigue and weakness, diarrhea and vomiting, loss of appetite, joint pains, and fever. Patients can also develop jaundice, which causes yellowing of the skin and whites of the eyes. Hepatitis B can cause severe liver damage, liver cancer, or death.

Most people who have HBV recover with treatment, but some become carriers. In the United States, over 12 million people have been infected (that's 1 out of 20 people). Almost 100,000 new people are infected with hepatitis B each year. An estimated 5,000 Americans die each year from hepatitis B and its complications.

How are bloodborne pathogens spread?

Bloodborne pathogens can be found in any body fluid that is contaminated with blood, and can enter the body through mucous membranes (eyes, nose, and mouth) or broken skin.

Both HIV and HBV can be transmitted sexually, and can be passed to unborn children.

- The HIV virus is fragile, and does not live long outside the human body.
- The HBV virus is tough - it can live outside the body for about a week on contaminated surfaces. HBV can be transmitted by touching a contaminated object and then the eyes, nose, or mouth. HBV can also pass through broken skin, for example, by being stuck with a contaminated hypodermic syringe. Because the virus survives drying, it is a far greater risk on the job than HIV.

Can workers be vaccinated against bloodborne pathogens?

There is no vaccination against HIV. The HBV vaccine is safe, and almost everyone can be vaccinated. Vaccination is recommended for anyone who is at increased risk on the job. Employers must provide HBV vaccinations free of charge to all employees within 10 days of assignment to jobs involving exposure to blood. Employees may decline to be vaccinated; however, they must be offered free vaccination if they change their minds.

Under OSHA regulations, what is the employer's responsibility for protecting employees from the hazards of bloodborne pathogens?

Employers having employees with occupational exposure (reasonably anticipated skin, eye, mucous membrane or parenteral contact with blood or other potentially infectious materials) must have a written Exposure Control Plan. The plan must describe:

- Jobs and tasks where exposure can occur.
- Methods of eliminating or reducing exposure.
- How exposure incidents are to be handled.

How can employers eliminate or reduce exposure?

Employers must:

- Use engineering and work practice controls (needle disposal containers).
- Provide suitable PPE (gloves, face and eyewear).
- Provide toilet and washing facilities.
- Communicate hazards using warning labels or color coding on hazardous materials.
- Provide training.

What specific training is required?

Employers must provide initial training when assigning jobs that involve a risk of exposure, and provide annual follow-up training. In order to protect themselves, employees must be trained in and required to practice good housekeeping, cover broken skin, and wash hands. Procedures for initiating first aid must be covered in each company's Emergency Response Plan. Under OSHA regulations, employers must require the "universal precautions" approach to infection control.

What is the required "universal precautions" approach to infection control?

In general, all human blood and body fluids must be treated as if known to be infectious. "Universal precautions" include using resuscitation devices for mouth-to-mouth breathing, and wearing latex gloves to protect from contact with blood or body fluids contaminated with blood.

What is the employer's responsibility if an employee is exposed to HIV or HBV on the job?

The employer must offer an exposed employee a medical evaluation, testing, and vaccination. A healthcare professional must provide a written evaluation and follow-up treatment plan. The company should also have a program for clean up of any contamination after the incident. Employers are required to maintain a log of occupational injuries and illnesses, and, as of April 2001, under the Needle Stick Prevention Rule, a "sharps injury log".

Are there other biological hazards?

Besides bloodborne diseases, operating engineers and hazardous material workers may be exposed to waterborne, airborne, and animal-borne diseases. Employees working outdoors must also be aware of the possibility of bee stings, snake and spider bites and know proper treatment procedures for their region.

Partial List of Work-Site Hazards	
Sewage	• Gastrointestinal diseases • Hepatitis A and Hepatitis B
Emergency Response	• Human Immunodeficiency Virus (HIV) • Hepatitis B Virus (HBV)
Landfills	• Hepatitis B Virus (HBV)
Cooling towers or air conditioning systems	• Legionnaires' Disease
Clearing brushy areas	• Animal-borne diseases such as Lyme Disease
Decontamination and/or demolition of buildings	• Animal-borne diseases such as Psittacosis, Rabies (bats)

Table 14.1

What are Common Waterborne Illnesses?

People get waterborne diseases by swallowing food or dirty water contaminated by human or animal stools containing disease germs. An estimated 940,000 Americans become ill with a waterborne disease every year; 900 of them die. Common waterborne illnesses include:

Hepatitis A is a serious liver disease that may be waterborne, bloodborne, or spread by close personal contact. The symptoms include jaundice, fatigue, abdominal pain, loss of appetite, intermittent nausea, and diarrhea. There are about 125,000 to 200,000 cases per year in the United States. Hepatitis A is preventable by vaccine.

Salmonella causes 2 - 4 million illnesses a year in the United States. Symptoms include abdominal pain, diarrhea and vomiting, fever and chills, and headache. Typhoid fever, which has virtually been eradicated in the United States, is caused by a specific strain of salmonella.

Cholera is an infection of the small intestine that causes a large amount of watery diarrhea. Cholera is caused by the bacterium Vibrio cholerae and kills about 50% as many as Hantavirus The bacteria releases a toxin that causes increased release of water from cells in the intestines, which produces severe diarrhea.

Cholera occurs in places with poor sanitation, crowding, war, and famine. Common locations for cholera include Africa, Asia, India, Mexico, and South and Central America. Risk factors include exposure to contaminated or untreated drinking water or living in or traveling to areas where there is cholera. Symptoms include abdominal cramps, dry mucus membranes or mouth, dry skin, excessive thirst, glassy or sunken eyes, lack of tears, lethargy, low urine output, nausea, rapid dehydration, rapid pulse (heart rate), sunken “soft spots”, (fontanelles) in infants, unusual sleepiness or tiredness, vomiting, and watery diarrhea that starts suddenly and has a “fishy” odor. Symptoms can vary from mild to severe. A type of vibrio bacteria also has been associated with shellfish, especially raw oysters.

Shigella is similar to salmonella and is caused by a group of bacteria called shigella. Most people infected with shigella develop diarrhea, fever, and stomach cramps; diarrhea is often bloody. The elderly and young children are more susceptible. In worse cases, Shigellosis can usually be treated with antibiotics. Anti-diarrheal agents such as Imodium or Lomotil are likely to make matters worse.

E. Coli is another very common cause of diarrhea. Infection often leads to bloody diarrhea. Most illness has been associated with eating undercooked, contaminated ground beef. Infection can also occur after drinking unpasteurized milk and juice. Precautions include cooking all ground beef and hamburger thoroughly (no pink at all or thickest part reads 160º). Occasionally some strains result in kidney damage.

Giardiasis, also called “backpacker’s disease” or “beaver fever”, may be carried by humans and animals. It is caused by a one-celled, microscopic parasite that lives in the intestine of people and animals and passed in the stool. Giardia is found in every region of the United States and throughout the world. It is not spread by contact with blood but can spread by recreational water. Symptoms include persistent diarrhea, weight loss, and fatigue.

How are waterborne illnesses prevented?

Always wash hands carefully with soap and warm water before eating or handling food. Do not eat, drink, smoke, or touch the face in a contaminated area.

What are Common Airborne Illnesses?

Legionnaires' Disease is spread by inhaling airborne water droplets containing bacteria causing the illness. The symptoms include pneumonia, fever, and muscle aches. There are about 10,000 to 15,000 cases per year in the United States. The bacteria are found in air conditioning cooling towers, plumbing systems, hot water tanks, and whirlpool spas. Chest x-rays of people with Legionnaires' disease often show pneumonia. Without knowing of a worker's occupational exposure, doctors might mistake Legionnaires' disease for simple pneumonia. About 5% to 30% of people who have this disease die. Erythromycin is the antibiotic currently recommended for treatment. In severe cases, a second drug, Rifampin, may be used in addition.

Tuberculosis (TB) is an example of an "old" disease that used to be a significant public health problem, faded with the advent of modern medicine, and is making a comeback. Tuberculosis damages the lungs and other parts of the body, and is a potentially fatal but treatable illness. Tuberculosis, especially drug-resistant TB, is most prevalent in the New York City area. In the year 2000, more than 16,000 cases were reported in the United States. The disease is spread when a TB carrier coughs or sneezes near someone. The risk of being exposed to TB is greater in hospitals, nursing homes, jails, prisons, and facilities for the homeless.

Histoplasmosis is caused by a fungus that is most prevalent in states bordering the Mississippi and Ohio Rivers. The fungus can be inhaled when the earth is contaminated with bat or bird droppings and disturbed during construction or farming. Histoplasmosis usually appears as a mild respiratory infection, but it sometimes becomes severe.

Cocciodomycosis is caused by a fungus that is found in the soil of the American Southwest. Inhaling the spores in airborne dust spreads it. The symptoms include chest pain, fever, and weight loss.

What are Common Animal-Borne Illnesses?

Rabies is a fatal infection of the central nervous system caused by the bite of a rabid animal, or by the animal's saliva contaminating an open wound. Any mammal can carry rabies. Wild raccoons, bats, foxes, coyotes, and skunks are the most common carriers. Raccoon rabies is a problem in the East; bat rabies is a problem in the West. Only about two people per year die of rabies in the United States, but more than 22,000 are given rabies post-exposure treatment. Anyone bitten by a strange animal not available for examination must take anti-rabies treatment. The treatment is effective, but involves a series of injections over several weeks' time or 6 shots given over 30 days, is expensive, and can cause some side effects.

Hantavirus is a rare disease carried by wild rodents. An outbreak in the American Southwest in 1993 attracted attention to the disease, which is usually spread when humans inhale airborne material contaminated by the urine, feces, and saliva of infected mice. These are primarily the deer mouse (Peromyscus maniculatus), cotton rat, and the white-footed mouse in the Northeast. Because the disease is flu-like in its first symptoms, it is difficult to diagnose. Hantavirus generally progresses rapidly to a type of pneumonia that is frequently fatal. If hantavirus is known to be present in the area, state and local health departments can provide information about the extent of the problem and necessary preventive measures. Use of an N-100 filter should provide the same protection as the HEPA filter. Due to the nature of the virus, no studies have been able to test the efficacy of either the HEPA or N-100 filters in protecting against its transmission.

What are Common Insect-Borne Illnesses?

Lyme disease is spread by ticks of the genus *ixodes*; usually deer ticks generally the size of a poppy seed between larva and adult. Early symptoms include fatigue, chills and fever, and muscle and joint pain. Many people with Lyme disease show a characteristic rash that looks like a bulls-eye: a red, raised center, a clear area, circled by a red ring. The outer ring can be several inches in diameter. In a study of 118 patients that had early Lyme disease and developed a rash, only 9% developed a bull's eye rash. The rash was red throughout in 59% of patients and was redder in the center in 32%. The late symptoms of Lyme disease include arthritis and nervous system abnormalities.

Lyme disease is increasing rapidly in the number of cases reported yearly, and the geographic area in which those cases are occurring is expanding. It occurs most frequently in the Northeast (from Massachusetts to Maryland), the Northcentral states (especially Wisconsin and Minnesota), and the West Coast (particularly northern California). Since Lyme disease occurs in some parts of the country and not others, obtain local information about the risk in the surrounding area.

To prevent Lyme disease, in tick areas, tuck pant legs into boots, tuck shirt into pants, and spray insect repellent containing DEET on clothes and exposed skin. A tick must be attached for about 24 hours to feed enough to spread the disease. Remove attached ticks as soon as possible - grasp the head with tweezers and pull straight back. Save the tick in a jar or sealed plastic bag. If any illness develops during the following weeks, a laboratory can analyze the tick. Treatment with antibiotics is usually effective, but the earlier treatment is begun the better.

Rocky Mountain Spotted Fever is the most severe and most frequently reported rickettsial illness in the United States. The disease is caused by rickettsia rickettsii, a species of bacteria that is spread to humans by ixodid (hard) ticks. Initial signs and symptoms include sudden onset of fever, headache, and muscle pain, followed by development of rash. The disease can be difficult to diagnose in the early stages, and without prompt and appropriate antibiotic treatment it can be fatal. Tetracycline and Chloramphenicol are used to treat this illness.

West Niles Virus is a mosquito-borne viral infection. It is frequently asymptomatic but can cause flu-like symptoms or, in the most severe cases, lead to central nervous system infection (causing encephalitis or meningitis). First isolated in Uganda in 1937, outbreaks have recently occurred in the Northeast United States. There is no specific therapy to eliminate the virus. In severe cases, intensive supportive therapy, often involving hospitalization, intravenous fluids, and respiratory support, is used to treat symptoms and prevent secondary infections.

Chapter 15
Emergency Response

Issues and topics for discussion:

- Discuss specific incidents where preparation, training, and practice allowed workers to handle various types of emergencies?
- At what point should employees become involved in a site's Emergency Response Plan?
- What are the most important elements of an Emergency Response Plan?
- Discuss workers' limitations during an emergency response based on their level of training.
- Why are standard operating procedures important when emergencies occur?
- What is the employee's responsibility in preventing emergencies?
- Are all site personnel expected to participate in drills and practices?
- Which employees should be designated and trained to assist in emergencies?

Introduction

The nature of work at hazardous waste sites makes emergencies a continual possibility. Emergency planning is so important that work at a new site cannot start until an Emergency Response Plan is in place. One mistake many construction and general industry employers make is creating a useless plan- a lot of words without a lot of detailed information. In emergency planning, "who does what" is crucial. Up-to-date names and numbers of emergency contacts must be included.

Top 10 Reasons that Emergency Response Plans Fail

1. No upper management support.
2. Lack of employee buy-in.
3. Poor or no planning.
4. Lack of training or proper practice.
5. No designated leader.
6. Failure to keep the plan up to date.
7. No method of communication to alert employees.
8. OSHA regulations are not part of the plan.
9. No procedures for shutting down critical equipment.
10. Employees are not told what actions to take in an emergency.

Provided by National Safety Council

Emergency Response Plan

Emergency planning is so important that work at a new site CANNOT start until an Emergency Response Plan is in place.

After an emergency, normal work CANNOT resume until preparation is completed for the next incident.

Figure 15.1

What is the employer's responsibility for emergency planning?

Under the HAZWOPER Standard, every site Health and Safety Plan (HASP) must have a section on emergency response. The Emergency Response Plan, or the Contingency Plan, must be site-specific and include training for all employees. Training of employees is probably the most important aspect of implementing the emergency plan.

Exactly what is an "emergency"?

An emergency may be as minor as a worker with heat stress, or as major as an explosion that spreads toxic fumes throughout a community. Chemicals, biologic agents, radiation, or physical hazards may act separately or together to create explosions, fires, spills, toxic atmospheres, or other dangerous situations.

What are the required elements of a site-specific Emergency Response Plan?

Pre-Emergency Planning.
Consider and decide, in advance:

- Potential emergencies;
- How they would impact the surrounding area;
- How site personnel would relate to responding agencies;
- How all responders will work together.

Personnel Roles, Lines of Authority, and Communication. Clearly spell out:

- The chain of command;
- The position and authority of every member of that chain;
- Their roles and responsibilities.

Emergency Recognition and Prevention. Workers need to know the warning signs of potentially hazardous situations. These should be covered in initial training and periodic briefings.

Emergency Alerting and Response Procedures. Every employee needs to be familiar with the protocol for what to do when they realize that an emergency exists.

Notification. When notifying response personnel, it is important to provide information that will aid in determining what should be done next. Basic facts include:

- The location of the occurrence;
- A description of what occurred;
- Whether there are injuries.

Evaluation of the Situation.
The Emergency Response Plan should assist the initial responders to determine:

- what happened;
- what equipment is needed;
- whether there are casualties, injured or missing workers;
- what could happen next;
- what can be done.

Types of Emergencies		
Environmental Occurrences	**Hazardous Material**	**Illnesses and Injuries**
• Hurricane, tornado, severe storm • Earthquake • Large excavation collapse • Flood	• Leakage of hazardous liquid • Release of toxic vapors • Fire or explosion • Collapse of containers • Discovery of radioactive materials	• Minor accident or illness requiring first aid only • Sudden critical illness • Serious accident involving one or more workers • Chemical exposure

Table 15.1

Rescue/Response Action. Site-specific plans need to be made so that in emergencies the responders know what they are to do. In addition, emergency response has its own standard operating procedures (SOPs). These include using the buddy system and remaining in communication with the Command Post. The more that tactics to be used are understood and practiced, the more efficient the response will be.

PPE and Equipment. Necessary equipment must be kept ready to go at all times. For example:

- SCBAs must be filled to 90% of their capacity, inspected, and replaced in their storage spaces immediately after use.
- Heavy equipment should be refueled and maintained.

Safe Distances and Places of Refuge. How far away from the emergency is far enough to be out of harm's way? This can be partially determined during pre-emergency planning. If on-site refuges are necessary, they should be appropriately identified and stocked with the necessary supplies.

Site Security and Control. It is important to know who is on site during an emergency, and where they are. Check points should be set up to track everyone who enters or exits.

Evacuation Routes and Procedures. Plans needs to be made and clearly understood for:

- Primary and alternate evacuation routes. There should be at least two routes, and they should be separated from each other. It is not unusual for an emergency to take place in the main evacuation route. Unless people are trained to use their alternate route, their first response is to try to evacuate through the main evacuation-route emergency site.
- Assembly points.
- Safe distances.

Decontamination Procedures. Emergency decontamination must be planned so that ill or injured workers are taken care of as quickly as possible, and medical personnel are protected. Local hospitals and emergency medical service providers should be made aware of site-specific hazards during the planning stages.

First Aid and Emergency Medical Treatment. First-aid stations should be kept stocked at all times, and first-aid and CPR training conducted. Once again, cooperation with local medical facilities is important. Actual medical treatment may have to be delayed until the victim and rescuers are relocated to an area of reduced risk.

Reporting Requirements. Determine who needs to know about what happened. All federal, state, and local reporting requirements must be fulfilled.

Critique of Response. When an emergency is over, all those involved should review it in order to:

- change procedures;
- revise the response plan;
- discover and communicate the lessons to be learned.

Emergency Response Plan Elements
• Pre-Emergency Planning • Personnel Roles, Lines Of Authority And Communication • Emergency Recognition And Prevention • Emergency Alerting And Response Procedures • Notification • Evaluation Of The Situation • Rescue/Response Action • PPE And Equipment • Safe Distance And Place Of Refuge • Site Security And Control • Evacuation Routes And Procedures • Decontamination Procedures • First Aid And Emergency Medical Treatment • Reporting Requirements • Critique Of Response

Table 15.2

Why is it critical for outside agencies to be involved in emergency planning and drills?

When outside agencies respond, either they take charge or site personnel tell them what to do. At Federal facilities, usually site personnel retain command. At other facilities, unless arrangements are made in advance, the fire department, state police, or other outside responders assume command. Often when there is a sizable fire or multiple casualties, more than one fire department or other agency will respond. In order to eliminate confusion, all involved must understand their roles and responsibilities.

Why is employee training and practice critical as part of the Emergency Response Plan?

All employees must receive initial training, and participate in periodic reviews, practices, and drills in order to understand what they are to do during emergencies. If the Emergency Response Plan is not practiced, it's almost certain to fail!

Employees who are responsible for responding to an emergency must be trained for that collateral duty. If a worker's responsibility is to follow the appropriate alerting procedure and evacuate, they need to know the route and assembly point.

Emergency Response: Evaluation of the Situation

FIGHT?	or	FLIGHT?
If you are responsible for responding to an emergency, you should be trained for that collateral duty, and respond accordingly.		If your responsibility is to follow the appropriate alerting procedure and evacuate, you need to know the route and assembly point.

Figure 15.2

Training Requirements – Emergency Response Operations	
Emergency Responders [1910.120(q)(6)]	
First Responder Awareness Level (Witnesses or discovers a release of hazardous substances and is trained to notify the proper authorities)	• Sufficient initial training and competencies • Annual refresher
First Responder Operations Level (Responds to the releases of hazardous substances in a defensive manner, without trying to stop the release)	• 8 hours initial training and competencies • Annual refresher
Hazardous Materials Technician (Responds aggressively to stop the release of hazardous substances)	• 24 hours initial training and competencies • Annual refresher
Hazardous Materials Specialist (Responds with and in support of HAZMAT technicians, but who have specific knowledge of various hazardous substances)	• 24 hours initial training and competencies • Annual refresher
On Scene Incident Commander (Assumes control of the incident scene beyond the first responder awareness level)	• 24 hours initial training and competencies • Annual refresher
Other Employees [1910.120(q)(4)-(q)(5)]	
Skilled Support Personnel (temporarily perform immediate emergency support work)	• Safety and health briefing at response site
Specialist Employees (provide technical advice/assistance on specific hazardous substances	• Annual demonstration of specialized competencies

Table 15.3

Notes

Chapter 16
Drum Handling

Issues and topics for discussion:

- Discuss the different types of hazards associated with drum handling.
- What are the procedures for inspecting and moving drums?
- Discuss opening, sampling, and handling precautions.
- What are the advantages and disadvantages of the different types of drum handling equipment?
- What are some examples of ways drums are shipped and the procedures associated with them?

Introduction

Drums must be handled during inspection, characterization, excavation, opening, sampling, and removal of their contents. Because drum handling is dangerous, every step of the operation should be carefully planned.

While these hazards are always present, the proper work practices reduce the risks.

What types of hazards are associated with drum handling?

Fires and explosions can occur. Drums may leak hazardous vapors and liquids. Physical injury can happen from moving heavy containers by hand and working around stacked drums, heavy equipment, and deteriorated drums.

What should an initial inspection determine?

- Which hazards are present,
- Necessary precautions, and
- Which drums need to be moved in order to be opened and sampled.

The proper steps for handling drums depend on the drum contents. Information from the initial inspection is used to draft a Drum Handling Plan. This plan should be reviewed and revised as new information becomes available during operations.

What should crews look for when inspecting drums?

The inspection crew should look for:

- Clues of contents, such as symbols (radioactive, explosive, corrosive, toxic, flammable, etc.)
- Indications of discarded laboratory chemicals, or small containers.
- Conditions around the drums that may give information about the drum contents and their hazards.
- Containers that are rusty, deteriorated, or collapsed.
- Contaminated soil which indicates leaking containers.
- Swelling, bulging, and devices designed for pressure cylinders.
- Shape of drumhead.

The Type of Drum and the Drumhead Will Help With Identification	
1.	Whole lid removal - designed to contain solid material.
2.	Drum with a bung - designed to contain a liquid.
3.	Drum with a liner - may contain a highly corrosive or otherwise hazardous material.
4.	Polyethylene or PVC Lined Drums - often contain strong acids or bases. If the lining is punctured, the substance usually quickly corrodes the steel, resulting in a significant leak or spill.
5.	Exotic Metal Drums - very expensive drums made of aluminum, nickel, stainless steel, or other unusual metals; usually contain an extremely dangerous material.
6.	Single-Walled Drums used as Pressure Vessels - have fittings for both product filling and the placement of an inert gas, such as nitrogen. May contain reactive, flammable or explosive substances.

Table 16.1

What precautions should be followed if crews suspect that drums are buried at a site?

- Before starting subsurface excavation, use ground-penetrating systems to determine the location and depth of the drums.
- Remove soil with great caution to reduce the chance for drum rupture.
- Avoid using tools and attachments with sharp edges that could cut into drums.
- Have a dry chemical fire extinguisher on hand to control small fires.

What are the general categories of possible drum hazards?

Radioactive
If the drum has radiation levels above normal, immediately contact a health physicist (HP). Do not handle any drums that are radioactive until an expert has been consulted. (*See Radiation*.) Additional training is required before working with radioactive waste.

Leaking/deteriorated
If a drum containing a liquid cannot be moved without rupture, immediately move its contents to a stable drum using a pump designed for transferring that liquid.

Using a drum grappler, immediately place the following in overpack containers:

- Leaking drums that contain sludges or semi-solids.
- Open drums that contain liquid or solid waste.
- Decaying drums that can be moved without rupture.
- Bulging

Bulging or swelling can identify drums that are under pressure and therefore very hazardous. DO NOT move drums that are bulging. If a pressurized drum has to be moved, handle the drum with a grappler unit made for this type of situation. Either move the drum to firm ground or carefully overpack the drum. Use extreme caution when working with or around drums that may be under pressure.

Explosive/shock-sensitive
Seek a specialist before handling.

Laboratory Pack
Contains small containers of laboratory wastes or other dangerous materials. Lab packs sometimes contain shock-sensitive materials. Consider such containers to be explosive or shock-sensitive until you know otherwise. Specially trained personnel must handle these drums.

What steps must be taken to safely open drums?	
1.	When respiratory protection is necessary, airline respirators allow workers to operate in relative comfort for longer periods of time.
2.	Workers should remain at a safe distance from the drums being opened. If possible, use remote-controlled devices for opening drums.
3.	If workers must be near the drums, shields should be placed between workers and the drums for protection. Controls for drum- opening equipment, monitoring equipment, and fire equipment should be placed behind the shield.
4.	If possible, monitor the drum continuously during the opening. Place sensors of monitoring equipment as close as possible to the source of the contaminant, such as at the drum opening.
5.	Hang and balance the drum opening equipment to reduce worker exertion.
6.	If the drum shows signs of swelling or bulging, perform all steps slowly.
7.	Relieve excess pressure before opening. If possible, do so from a remote location. If pressure must be relieved manually, there should be a barrier between the worker and plug to deflect any gas, liquid, or solids which maybe expelled as the plug is loosened.
8.	Open exotic metal drums and polyethylene or polyvinyl chloride lined (PVC lined) drums by removing or drilling the plug. Exercise extreme caution with these containers.
9.	Reseal open plugs and drill an opening as soon as possible with new plugs to avoid explosions and/or vapor generation.
10.	Do not open or sample individual containers within the laboratory packs.

Table 16.2

What steps must be taken before sampling drums?

Drum sampling is a very hazardous activity because it often involves direct contact with unknown wastes. Before any drums are sampled, a plan should be developed to:

- Determine which drums should be sampled.
- Select the appropriate sampling device(s) and container(s).
- Include the number, volume, and locations of the samples to be taken.
- Develop SOPs for opening the drums, sampling, sample packaging, and transportation to lab.
- Determine the proper personal protection needed.

What are the general categories used for waste characterization?

Standard tests should be used to place the wastes into general categories:

- Auto-reactives.
- Water-reactives.
- Inorganic acids.
- Organic acids.
- Heavy metals.
- Pesticides.
- Cyanides.
- Inorganic oxidizers.
- Organic oxidizers.

What are the steps to follow when manually sampling from a drum?

- Keep workers at a safe distance while the drums are being opened.
- Sample only after the opening operations are complete.
- Do not lean over other drums to reach the drum being sampled.
- Cover the drum tops with plastic sheeting or other materials to avoid excessive contact with the drum tops.
- Never stand on the drums.
- Obtain samples with either glass rods or vacuum pumps.
- Use shovels, scoops, or spoons to sample solid material. Never use gloved hands.
- Avoid contact with contaminant.

How are waste materials specifically identified?

In some cases, further studies should be done to identify the waste materials. It is preferable to use an on-site laboratory to identify materials to:

- Provide data quickly and reduce the time lag,
- Help to reduce problems related to moving samples to an offsite laboratory (example: sample packaging, waste incompatibility, and fume generation.)

If samples must be analyzed offsite, they should be packed on site according to the Department of Transportation (DOT) regulations and shipped to the laboratory for study.

What precautions should be taken when handling drums?

All workers should be warned about the hazards of drum handling and be instructed to reduce handling as much as possible. In all phases of drum handling, workers should be aware of information concerning possible hazards during the procedures. The following precautions should be in place:

- Overpack drums and a supply of sorbent should be kept near areas where minor spills can occur.
- Where major spills can occur, a containment dike large enough to contain the entire volume of liquid in the drums should be constructed before any handling takes place.
- In the event of a spill, trained workers should isolate and contain the spill.

What types of equipment are used to handle barrels and drums?

Examples of drum-handling equipment include:

- A drum grappler attached to a hydraulic excavator.
- A small front-end loader, which can be either loaded manually or equipped with a bucket sling.
- A rough terrain forklift.
- A roller conveyor equipped with solid rollers.
- Drum carts designed specifically for drum handling.

Drum Handling Equipment Drum Grappler Attached To Hydraulic Excavator	
Limitations	**Hazards**
Older models have restricted vision.	Possibility of damaging other buried things.
Some older models have no squeeze limiters.	Can rupture drum, releasing contents sometimes violently.
A signal person may be needed.	Places additional people in harm's way.
Upkeep.	Hydraulic swivels sometimes leak and need maintenance to keep from adding hydraulic oil to a chemical mix.
Some units are made for 55 gallon drums only.	• Smaller drums can be dropped. • No good grip on overpacks may require additional personnel.

Table 16.3

What is the best piece of equipment to use for drum handling?

The drum grappler keeps the workers away from the drums so there is less chance of injury if the drums explode or rupture. If a drum is leaking, the worker can stop the leak by rotating the drum and immediately placing it into an overpack. In case of an explosion, the grappler assembly helps protect the worker by partially deflecting the force of the explosion, as well as keeping the worker further away from the point of contamination.

Drum Handling Equipment Small Front-End Loader	
Limitations	**Hazards**
Small size not able to handle big loads.	More trips required into exclusion zone area, causing more exposure.
Manual loading is limited to ability of team that loads bucket.	• Much greater exposure possible due to physical contact. • Heavy hazards can cause muscle strains, sprains, slips, falls, etc. • Additional training required for personnel in exclusion zone and lifting.
Bucket slings extremely limited vision; signal person needed.	Puts additional workers in harms way.
Bucket sling can rub on bucket-cutting edge and be cut.	Barrel can be dropped (and run over due to limited vision by operator.)
Bucket sling hooks can become disengaged.	Barrel can be dropped.
To prevent slings from being rubbed and not broken, roll the bucket ahead.	This will almost definitely cause a barrel to rupture as loader cannot see.
Small loader can be easily overloaded.	
Cannot determine weight of barrel.	

Table 16.4

Drum Handling Equipment Rough Terrain Forklift	
Limitations	**Hazards**
Limited visibility (although zoom boom is better.)	Mishandling drums (spearing, not getting drums far enough on forks, tipping over, broken pallets, etc.)
Barrels need to be secured to truck or pallet before traveling.	Additional workers in contaminated area.
Most have inflated rubber tires.	May be metal shards, high speed operation could result in an overturned vehicle.
Cannot determine weight of barrel.	

Table 16.5

Roller conveyor equipped with solid rollers	
Limitations	**Hazards**
Set up is time consuming.	Personnel exposed to contaminants.
Difficult to change feed locations.	Requires additional exposure time to reroute the roller conveyors.
Barrel may fall if track is not level.	Additional exposure for personnel.
Personnel required to push barrels.	Ergonomics of side pushing, additional exposure for personnel.
Downhill slopes may cause runaway.	Ruptures, detonations, large spills, etc.

Table 16.6

Drum carts designed specifically for drum handling	
Limitations	**Hazards**
Cost – how to decontaminate in event of a leak.	Leak of incompatibles.
Many are needed to keep down the number of times the barrel must be handled.	• Storage in accessible location. • Risks traveling in contaminated area.
If carts have wheels, a good road is required.	• Personnel may have direct contact with barrels, rising exposure. • Ruptures, detonations, leaks, etc.

Table 16.7

Why is drum staging occasionally required?

Drums must sometimes be staged, or moved in an organized manner to another area, despite attempts to reduce handling. Staging may be necessary to aid with identification and to protect the drums from hazardous conditions. Staging is a trade-off between the increased hazards involving the movement and the reduced hazards by performing the move.

What factors influence how staging areas are established?

The extent of staging should be kept to a minimum. The number of staging areas is decided based on the circumstances at each site:

- The extent of the operation,
- The accessibility of drums in their original locations, and
- The possible hazards.

Should wastes ever be mixed together?

Identified wastes are often mixed together and placed in bulk containers, storage tanks, or vacuum trucks to consolidate the shipment to a treatment, storage, or disposal (TSD) plant. Bulking should be done only after the wastes have been determined to be compatible by a trained and experienced worker.

How are materials transferred to off-site treatment, storage or disposal?

Shipment of materials to off-site TSD plants requires waste-hauling vehicles to enter and exit the site. Shipments of hazardous materials must follow DOT regulations.

What are the safe procedures for opening tanks and vaults?

- When opening a tank or vault, follow the same procedures as for a sealed drum.
- If necessary, vent excess pressure if unstable materials are stored.
- When the tank is opened, place shields between the workers and the opening to prevent direct contamination.
- Empty and decontaminate the tank or vault before disposal.
- If it is necessary to enter a tank or vault for any reason, permit-required confined-space entry procedures should be followed.

Observe the safety precautions for elevated tanks. Fall protection, ladders, and scaffolding precautions may also apply.

What precautions should be taken when workers use vacuum trucks to remove chemicals or clean up emergency spills?

- Provide a quick and effective means to remove chemicals, especially during emergency spills.
- PPE should be worn when opening the hatch.
- If possible, use mobile steps or scaffolding; avoid climbing the ladder and walking across the tank catwalk.

Minnesota workers are required to have an appropriate filtering system so that the collected contaminants will not be inadvertently dispersed into the environment.

What special precautions must be taken when handling compressed gas cylinders?

Obtain professional help in moving and disposing of compressed gas cylinders, and handle with extreme caution. The rupture of a cylinder may result in an explosion and the cylinder may become dangerous. Record the identification numbers on the cylinders to help with content identification.

What specific hazards are associated with wastes in ponds and lagoons?

Wastes in ponds and lagoons present a problem, not only because of their inherent contamination, but also due to the potential for traditional water-related accidents. Wherever possible, stay on the shore. Some solid wastes may float and give the appearance of solid mud. Caution should be exercised when working along the shoreline.

Notes

Chapter 17
Confined Space

Issues and topics for discussion:

- Define a confined space.
- What training is required for entry into permit-required confined spaces?
- Discuss the types of hazardous atmospheres and give examples.
- What are the hazards associated with confined spaces?

Introduction

This chapter is an overview, and is not intended to replace a confined space entry program.

Examples of Confined Spaces

Septic tanks
Storage bins
Hoppers
Vaults
Process vessels

What is a confined space?

A confined space is one which is large enough to enter, is not designed for continuous occupancy, and has limited means to enter and exit.

What is a permit-required confined space?

A "permit-required confined space" has one or more of the following characteristics:

- Contains, or has a potential to 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.

What is a "non-permit-required" confined space?

Confined spaces can be classified as "non-permit-required" if the only hazard posed by the space is a hazardous atmosphere which can be remedied by continuous forced air ventilation alone.

What type of employee training is specifically required by OSHA's confined space standard?

Training must establish employee proficiency in the duties required and introduce new or revised procedures, as necessary, for compliance with the confined space standard. The employer is required to certify that the required training has been completed.

When must employers provide confined space training to employees?

- Before employee is first assigned duties.
- Before there is a change in assigned duties.
- Whenever there is a change in permit space operations that present a hazard about which an employee has not previously been trained.
- Whenever the employer has reason to believe that there are deviations from the permit space entry procedures, or that there are inadequacies in the employee's knowledge or use of these procedures.

What are the different types of hazardous atmospheres associated with confined space?

Oxygen-Deficient Atmospheres contain less than 19.5% oxygen. Any atmosphere with less than 19.5% oxygen should not be entered without a positive-pressure/pressure-demand SCBA or SAR-E. The oxygen level in a confined space can decrease:

- During burning, welding, cutting, or brazing; certain chemical reactions (rusting); and bacterial action (fermentation).
- If oxygen is displaced by another gas, such as carbon dioxide or nitrogen.

If inert gases (for example, argon) are used in a confined space, the space should be well ventilated and tested before a worker enters.

Oxygen-Enriched Atmospheres have an atmospheric oxygen content above 23.5%, and may contribute to a fire or explosion. Leaking oxygen equipment or the use of oxidizing chemicals can create oxygen-enriched atmospheres.

Flammable Atmospheres occur when a flammable gas, vapor, or mist in excess of 10% of its lower explosive limit (LEL) is detected. Two things make an atmosphere flammable:

- The oxygen content.
- A flammable gas, vapor, or dust in the proper mixture.

Different gases have different flammable ranges. An explosion may result if a source of ignition (such as a sparking electrical tool) is brought into a flammable atmosphere. When flammable gases or vapors have displaced the oxygen level, and exceeded the upper explosive limit (UEL), ventilation may dilute them until they have reached an explosive concentration.

Toxic Atmospheres
Guidelines for assessing and describing toxic atmospheres:

- Liquids, residues, or sludges from material previously stored.
- Toxic materials absorbed into the walls, which give off toxic gases or vapors when they are removed or cleaned.
- Hazardous gases produced by decay or accumulation because they are heavier than air.
- Materials used or produced by the work being performed (cleaning solvents, paints, welding fumes).
- Materials used or produced by working near a confined space which can enter and accumulate in the space.

When should air testing be done in a confined space?

Testing the air is the most important part of a confined space entry procedure. The proper tests must be conducted before anyone enters the space or before an entry permit to work in any confined space is received. If there is any chance that the air inside a confined space could change because of the work being done, continue to retest during the operation.

Describe the steps in testing the atmosphere in a confined space.

The air of a confined space is always tested first from **outside** the confined space. It is necessary to test all areas (top, middle, and bottom) of a confined space with the proper equipment to determine what gases are present.

Tests should be performed:

- Outside the space;
- Just inside the space;
- One foot down;
- And every four feet thereafter.

If the testing shows oxygen deficiency and/or the presence of toxic gases/vapors, the space must be ventilated and retested before workers can enter. If ventilation is not possible and entry is necessary, workers must use positive-pressure/pressure demand SCBA or SAR-E.

What is the air in a confined space tested for?

- Oxygen level - this must always be done first.
- Presence of flammable or explosive materials.
- Presence of toxic gases and vapors.
- Obvious physical hazards.

If the air in a confined space has been tested safe before workers enter, can employees assume it will remain a safe atmosphere to work in?

The air may change during work. Hot work, such as welding, cutting, and burning, can change the air and

- Fill a confined space with toxic welding fumes;
- Reduce the oxygen supply;
- Replace the oxygen with flammable gases;
- Create an oxygen-enriched environment.

What precautions must be taken while working in a confined space?

Continuous monitoring must be done while workers are in a confined space; senses are never to be trusted in a confined space. Many toxic gases and vapors cannot be seen or smelled, nor can the level of oxygen present be determined. In addition:

- Always ventilate.
- Welders should wear air-supplied respirators or APRs with appropriate cartridges to prevent breathing toxic welding fumes.
- Keep oxygen/fuel gas tanks outside the confined space (tanks, valves, and regulators may leak gas or pure oxygen into the confined space).
- Always remove the torch from the confined space as soon as the work is finished, during breaks, at lunch, etc. Always turn off the torch at the tank because a small leak in the hose could quickly fill the confined space with flammable gases or pure oxygen.

The worker must leave the space if continued monitoring shows that the air has become unsafe. The confined space must be ventilated until testing shows the air is safe for re-entry. Notify the proper authorities for their evaluation and control.

What precautions must be taken when forced air ventilation is used to control hazardous atmospheres in a confined space?

Forced air ventilation by an approved ventilation unit may be necessary to remove harmful gases and vapors from a confined space. The method and equipment depends on the size of the openings, the gases, and available means to vent air.

Care should be taken to assure that the exhausted air is not recirculated into the ventilation current. Intake and exhaust points should be well separated and monitored.

When forced ventilation is used, the atmospheric air should be periodically tested. If hazardous air is detected, all workers must leave immediately until the situation is remedied. In this case, the space can be isolated.

How is isolation of a confined space accomplished?

Isolation of a confined space is a process where the space is removed from service by:

- Locking out/tagging out electrical sources, preferably at disconnect switches away from equipment;
- Blanking, tagging, and bleeding air, gas, and hydraulic lines;
- Disconnecting belt and chain drives, and mechanical linkages on shaft-driven equipment;
- Securing mechanical moving parts with latches, chains, chocks, blocks, or other devices.

What are some additional hazardous conditions that may occur inside a confined space?

Engulfment - loose, granular material (such as grain, coal, or sand) stored in bins and hoppers can entrap and suffocate a worker. The loose material can “crust” or bridge over” in a bin and break loose under the weight of a worker. Lockout/tagout all equipment or supply lines.

Falling Objects - are especially hazardous in spaces which have topside openings and where work is being done above the worker.

Temperature Extremes - work areas may be extremely hot; working in full protective clothing in these conditions increases the risk of heat stress.

Noise - may be amplified because of the design and acoustic properties of the space.

Moving or Driven Equipment - all movable parts are removed from service before entry and work begins.

Electrical Hazards - may cause a worker to be electrocuted if the circuits are not locked and tagged out. All temporary lights should be protected against damage, and the cords should be heavy-duty and kept clear of working spaces. Only low voltage, battery operated, or ground-fault protected equipment should be used near liquids.

Process Liquids and Steam - water and other liquids create the potential for drowning, toxic exposure, and slips and falls.

Notes

Chapter 18
Hazard Control

Issues and topics for discussion:

- Discuss the Hierarchy of Controls.
- List examples of general hazards on a hazardous waste site.
- Why is worker training the most important facet of a hearing conservation program?
- What are some electrical hazards that can occur in the workplace?
- Discuss the methods of protection for different parts of the body.
- How can new technologies be utilized on a hazardous cleanup site?

Introduction

Hazardous waste sites pose a multitude of health and safety concerns, any one of which could result in serious injury or death.

For example, heavy equipment creates an additional hazard for the workers using the equipment. Protective equipment can reduce a worker's movement, hearing, and vision. One important factor is the unpredictable nature of the site.

Hierarchy of Controls

You face many hazards in your work as an operating or stationary engineer. Those hazards can multiply when you're assigned to a hazardous waste operation. While there are many options you have to protect yourself, safety experts and organizations such as the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) recommend following a hierarchy of controls. The hierarchy establishes an order in which hazards are dealt with logically.

The logic behind the hierarchy is simple— controlling your exposure to the hazard in the first place provides you the best protection. Think about it. It's far better to eliminate a hazard if you can. Barring that, then reducing your exposure to it is a good alternative.

Here's the hierarchy of controls used in this training:

- Elimination
- Substitution
- Engineering controls
- Administrative controls
- Personal protective equipment

The idea behind this hierarchy is that the control methods at the top of the list are potentially more effective and protective than those at the bottom, and they also can be cheaper. Following the hierarchy normally leads to the implementation of inherently safer systems, ones where the risk of illness or injury has been substantially reduced.

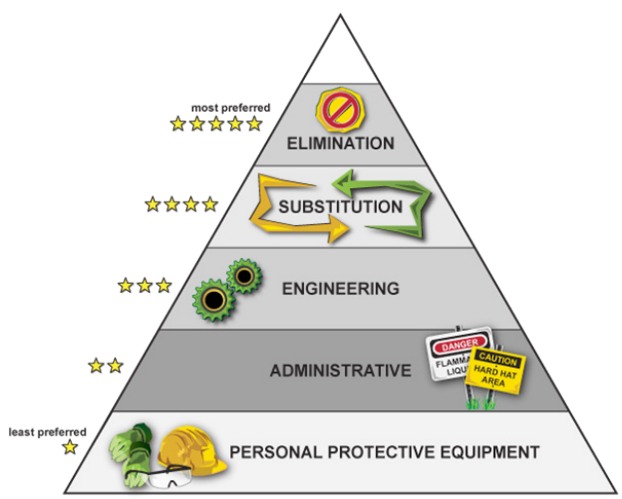

Figure 18.1
The hierarchy of controls for hazard control.

Elimination and Substitution

Elimination and substitution are most effective at reducing hazards, but they also tend to be the most difficult to implement in an existing process. If the process is still at the design or development stage, elimination and substitution of hazards may be inexpensive and simple to implement. For an existing process major changes in equipment and procedures may be required to eliminate or substitute for a hazard.

Here are some examples of elimination or substitution:

- Substitute safe materials for hazardous ones.
- Reduce energy, speed, voltage, sound level, or force.
- Change process to eliminate noise.
- Perform task at ground level.
- Automate material handling.

Engineering Controls

Engineering controls are used to remove a hazard or place a barrier between you and the hazard. Well-designed engineering controls can be highly effective in protecting you. Their initial cost can be higher than the cost of administrative controls or personal protective equipment, but over the longer term operating costs are frequently lower and in some instances can provide a cost savings in other areas of the process.

Here are some examples of engineering controls:

- Barriers
- Ventilation systems
- Machine guarding
- Sound enclosures
- Circuit breakers
- Platforms and guard railing
- Lift tables, conveyors

Administrative Controls

Administrative controls involve managing how the work is done and the jobsite operates. Those in charge of safety at a site can create processes and manage workers to reduce the hazards you face.

Here are examples of administrative controls:

- Health and safety plan
- Emergency response program
- Decontamination plan
- Hearing conservation program
- Safe job procedures
- Rotation of workers
- Safety equipment inspections
- Worker training
- Lockout/Tagout

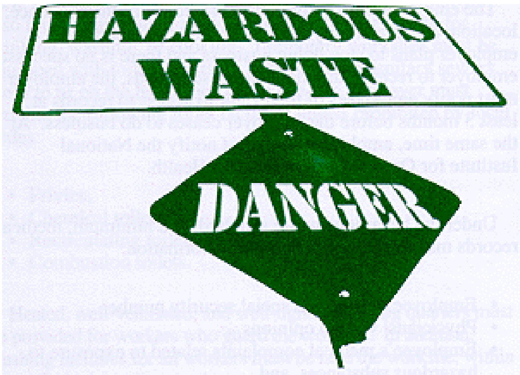

Figure 18.2
A warning sign is an example of an administrative control.

Personal Protective Equipment

This training program handles PPE specifically in Chapter 9. However, for hazard control consider PPE your last option after engineering and administrative controls. PPE will often be necessary at hazardous waste operations. The level of PPE you wear will depend on the hazards present and what you know about those hazards. Keep in mind, though, that PPE has disadvantages. It's expensive to maintain, it's often unwieldy, and it even can pose its own health risks to you, such as when you might have to wear a fully enclosed Tyvek suit with supplied air, increasing your chance of heat stress and exhaustion.

Here are examples of personal protective equipment:

- Safety glasses
- Ear plugs
- Face shields
- Respirators
- Hardhats
- Gloves
- Steel-toe boots

Figure 18.3
The respirator and hardhat are examples of personal protective equipment.

What are some safety hazards that may exist at a hazardous waste site?

- Holes or ditches.
- Poorly positioned objects (drums, boards) that may fall.
- Sharp objects (nails, metal shards, broken glass).
- Slippery surfaces.
- Steep grades.
- Uneven terrain.
- Unstable surfaces (walls caving in, flooring giving way).

What are electrical hazards that can pose a danger of shock or electrocution to workers?

- Overhead power lines.
- Fallen electrical wires.
- Buried cables.
- Electrical equipment; to help reduce this hazard, low-voltage equipment with ground-fault interrupters and watertight, corrosion-resistant, connecting cables should be used on site.
- Lighting (during outdoor operations). Weather conditions should be monitored and work should be stopped during electrical storms.
- Capacitors that retain a charge.

How do lockout/tagout procedures protect employees from electrical and physical hazards?

Before working in operations involving servicing and maintenance of power equipment or machines, OSHA regulations require lockout/tagout procedures for worker safety.

Lockout is the process of using a lockout device (lock, chain, valve, etc.) that prevents the flow of energy from a power source to power equipment to keep it from operating.

Tagout is the process of placing a tag on the power source that acts as a warning, not a physical restraint.

What is the employer's responsibility regarding lockout/tagout procedures?

Employers are required to establish a program and utilize procedures for affixing appropriate lockout or tagout devices to power sources, and to otherwise disable equipment or machines to prevent unexpected energization, start up, or release of stored energy in order to prevent worker injury. This program must include:

- Lockout/tagout procedures,
- Employee training, and
- Periodic inspections.

What effects can noise have on the worker?

Noise is unwanted sound; work around large equipment often creates excessive noise. The effects of noise can include:

- Workers being startled, annoyed, or distracted.
- Physical damage to the ear, pain, and temporary or permanent hearing loss.
- Fatigue.
- Elevated blood pressure.
- Tension and nervousness.
- Communication problems.

Ototoxicity
Ototoxicity is damage to the hearing or balance functions of the ear by drugs or chemicals.

The effect of noise on workers depends on the length of exposure and how loud the sound is.

What is the unit used to measure sound?

Sound intensity is measured in decibels (dB). For example, a ticking watch at 20 dB is barely audible. A jet engine from 130 to 160 dB is painful.

When must an employer begin a Hearing Conservation Program?

Whenever the worker's noise levels equal or exceed an 8-hour time-weighted average (TWA) sound level of 85 dB, OSHA's Hearing Conservation Standard requires that employers must begin a continuing, effective hearing conservation program. If workers are subject to noise exceeding an 8-hour TWA sound level of 90 dB, engineering controls should be used first, administrative controls should be used second, and finally PPE should be used as a last resort.

What can be done to minimize worker exposure to noise?

- Noise monitoring.
- Audiometric testing.
- Engineering controls (sound-absorbing rooms, substitution, carpet, resilient floors/pads, sound-dampening walls).
- Administrative controls (rotate employees, operate noisy machinery on shifts with fewer employees).
- PPE (earplugs, earmuffs).
- Training.

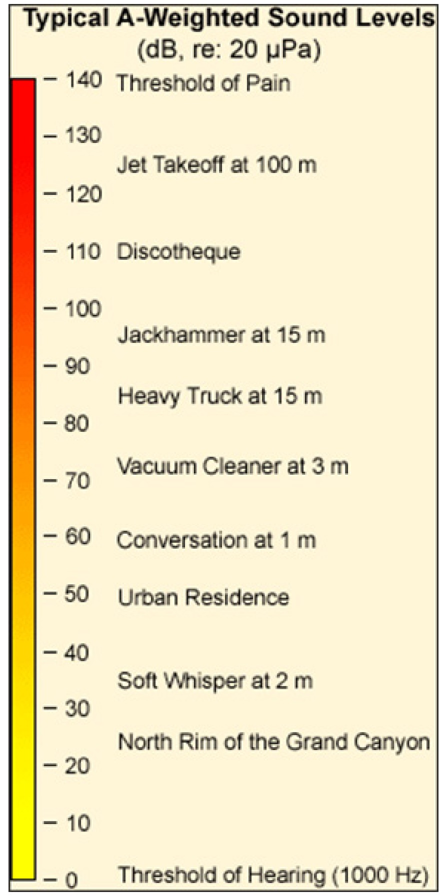

Figure 18.4
Source: OSHA.gov

When is eye and face protection required?

Protective eye and face equipment is required where there is a reasonable probability of injury from flying objects, glare, liquids, injurious radiation, or a combination of these hazards. When projectiles are a potential hazard, workers must use eye protection that provides side protection.

What are the requirements of eye and face PPE's?

Eye and face PPE must be distinctly marked to facilitate identification of the manufacturer. It should also be capable of being disinfected and easily cleaned.

What are the requirements for prescription and contact lens wearers?

Workers who wear prescription lenses need to wear eye protection that incorporates the prescription in its design, or wear eye protection over the prescription lenses without disturbing the proper position of either. The use of contact lenses should be considered carefully and comply with the site-specific HASP.

Describe the correct way to use the eye-wash water solutions.

When chemical hazards are present, eye wash stations should be readily available and accessible to workers. Eye wash stations provide an effective means of treatment when chemicals come in contact with the eyes. Water/eye solutions should not be aimed directly onto the eyeball, but aimed at the base of the nose to prevent particles from being driven further into the eyes.

When must head protection be worn?

Workers in areas where potential hazards are present from impact and penetration of falling and flying objects and from limited electric shock and burn must wear appropriate head protection. Head protection must meet all safety requirements. Caps, elastic bands, or hairnets should be used to prevent long hair from coming in contact with instruments, machinery parts, or flame-producing sources. Fabric hats (for example, baseball caps) should not be worn in areas where the contaminant can be absorbed.

When is protective footwear required?

Workers in areas where potential hazards are present from falling or rolling objects, objects piercing the sole, corrosive chemicals, electrical shock, or wet floors must wear protective footwear that meets all safety requirements.

What are the recommended types of footwear?

- Safety toe shoes (steel-toed).
- Treated shoes.
- Rubber boots or plastic shoe covers.
- Insulated shoes.
- Rubber boots with wooden soles.

When is hand protection required?

Workers exposed to hazards from skin absorption, cuts, abrasions, punctures, chemical or thermal burns, or harmful temperature extremes must use appropriate hand protection. Employers must require employees to use appropriate hand protection that meets all safety requirements. Gloves should be selected on the basis of the material being handled and the hazard involved. Check the gloves before using to make sure they are in good condition and free from holes, punctures, and tears. When removing gloves, keep the contaminated surface from contacting skin.

New Technologies and Human Factor Assessment

In the year 2000, there were nearly 6,000 job-related deaths in the United States, with the largest percentage of these occurring in the construction industry. There is a lot of work to be done at United States Department of Energy (DOE) sites contaminated with hazardous, mixed, and radioactive materials.

Because Hazmat remediation work is particularly dangerous and expensive, much attention is being devoted to technologies that would make the work safer and more cost-effective. The HAZWOPER Standard encourages employers to consider new technologies, but to make sure they are properly evaluated for employee safety.

What are DOE's challenges in cleaning up and managing its former nuclear weapons facilities?

DOE must safely and efficiently:

- Handle, treat, and dispose of hazardous and/or radioactive materials.
- Decontaminate and dismantle contaminated facilities.
- Develop and use innovative/new technologies at clean-up sites.
- Follow the Integrated Safety Management approach throughout its sites.

Why are innovative tools and methods necessary for DOE to meet its goals?

New environmental technologies are needed to:

- Eliminate and/or reduce safety and health risks to workers.
- Clean up hazardous and/or radioactive waste at DOE sites.
- Reduce clean-up costs and waste management compliance costs.

Appendix:
Glossary of Terms

absorption - the movement of a chemical into the bloodstream after its entrance into the body through the skin, lungs, or gastrointestinal tract.

acclimatization - a gradual adjustment process that helps an employee become physically accustomed to work under extreme conditions (e.g., temperature, altitude).

ACGIH - American Conference of Governmental Industrial Hygienists

acute - short-term. In toxicology, refers to a single large exposure to a chemical (acute exposure) or to the development of symptoms of poisoning soon after a single exposure to a substance (acute effect).

administrative controls - methods of limiting employee exposures by job rotation, time period away from the hazard, or similar measures.

AIDS - acquired immunodeficiency syndrome - a disease of the immune system caused by the HIV virus, spread by blood and some other bodily fluids, and which presently is treatable but not curable. The weakening of the immune system caused by AIDS leaves the body vulnerable to numerous infections.

airborne radioactivity units - Airborne radioactivity is contamination that is dispersed in the air in the form of dust, vapor, or gas. Airborne radioactive is commonly expressed as microcuries per milliliter (mCi/ml) or the amount of radioactive material in each unit volume of air.

air-purifying respirator (APR) - consists of a facepiece and an air-filtering device such as a particulate filter, cartridge and/or canister; removes contaminants from the air by filtration, absorption, or chemical reactions.

ALARA - **A**s **L**ow **A**s **R**easonably **A**chievable concept. The basis for ALARA is that there should not be any occupational radiation exposure to workers without an overall benefit from the activity.

alpha radiation particles - are large and carry a positive charge. They can be stopped easily and cannot penetrate a piece of paper or human skin.

alveoli - tiny air sacs of the lungs, formed at the ends of bronchioles. Through the thin walls of the alveoli (about one or two cells thick), the blood takes in oxygen and gives up carbon dioxide.

American Conference of Governmental Industrial Hygienists (ACGIH) - an organization of professional personnel in government agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes the recommended occupational exposure limits for approximately 660 chemical substances and physical agents and is updated regularly.

assigned protection factor (APF) - rating for the level of protection provided by a respirator.

beta radiation particles - electrons that usually penetrate only about 1/8-inch into tissue.

bloodborne pathogens - microorganisms that can be present in human blood and other body fluids and can spread disease. Chiefly HIV, the virus that causes AIDS (acquired immunodeficiency syndrome) and HBV. Bloodborne pathogens can be found in any body fluid that is contaminated with blood, and can enter the body through mucous membranes (eyes, mouth, and nose) or lacerated or punctured skin. See also AIDS, HBV, and HIV.

body core - the deep organs, especially heart, lungs, and other vital organs. Maintaining the body core in the proper temperature range is essential to life. See also body periphery, heat exhaustion, heat stroke, hypothermia.

body periphery - arms, legs, and the tissues close to the skin. Redistributing blood flow between the core and the periphery is one of the major temperature-controlling mechanisms of the body.

buddy system - organization of workers into groups as a safety measure so that each member of the group is observed by at least one other member.

calibration - a process to ensure the accuracy of instrument measurements.

cancer - a disease characterized by a malignant, uncontrolled growth of cells of body tissue.

carcinogen - a substance capable of producing cancer in a living organism. A cancer is characterized by the reproduction of abnormal cells, sometimes in the form of a tumor. Examples of carcinogens: asbestos, benzene, vinyl chloride.

canister - larger volume air filtering device, attaches to respirator facepiece at chin or by a breathing tube.

cartridge - air filtering device, attaches to respirator facepiece.

CAS Registry Number - a number assigned to a material by the Chemical Abstracts Service (CAS) to provide a single unique identifier.

ceiling limit or "C" - the maximum allowable human exposure limit for an airborne substance that is not to be exceeded even momentarily. See also PEL and TLV.

central nervous system (CNS) - the brain and spinal cord. The CNS supervises and coordinates the activity of the entire body.

characterization - a process of defining the nature and hazards present at a particular site.

chemical hazard - the exposure of employees to any form being a solid, liquid, or gas, either natural or man-made, that have the potential to cause harm to a person or property.

chemical name - a proper scientific name for the active ingredient of a product.
combustible liquid - a liquid with a flash point between 100oF and 200oF. See also flammable.

chemical-protective clothing (CPC) - special clothing, such as suits, aprons, gloves, or boots, intended to protect workers from exposure to hazardous chemicals.

chronic - persistent, prolonged, repeated. In toxicology, refers to repeated exposure to a chemical for a long period of time (chronic exposure), or persistence of symptoms or disease over a long period of time (chronic effect).

cirrhosis - a disease of the liver involving formation of excessive scar tissue, which interferes with the normal function of the liver.

closed-circuit breathing apparatus - recirculates exhaled air though a series of filters and chemicals and the air is then re-breathed.

Code of Federal Regulations (CFR) - books of published government standards.

collateral duty - job responsibilities, such as being part of a hazardous materials emergency response team, outside the employee's normal duties. Employees must be properly trained for any collateral duties they are assigned.

Colorimetric Indicator Tubes - Measures concentrations of specific gases and vapors. The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration.

combustible - a liquid with a flash point between 100ºF and 200ºF. See flammable also.

Combustible Gas Indicator (CGI) - Measures the concentration of a combustible gas or a vapor. A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - established federal funding (Superfund) to clean up hazardous waste.

confined space - a space that is large enough and so configured that an employee can bodily enter and perform assigned work, has limited or restricted means for entry/exit or is not designed for continuous employee occupancy.

contaminate - to soil, stain, corrupt or infect or by contact or association; to make unfit for use by the introduction of undesirable elements.

contamination - soiled, stained, corrupted or infected by contact or association; to make unfit for use by the introduction of unwholesome or undesirable elements. Radioactive material in an unwanted place.

contamination reduction corridor (CRC) - the area where decontamination takes place.

contamination reduction zone (CRZ) - the transition area between the exclusion zone and the support zone where decontamination facilities are located..

contamination units - Radiation contamination is measured in units of disintegration per minute (dpm). This unit refers to the number of radioactive atoms which decay (emit radiation) each minute.

Contingency Plan - a document that outlines a course of action prior to unforeseen occurrences; also frequently called an Emergency Response Plan.

continuous-flow respirator - receives a continuous stream of air into the facepiece at all times.

convection - the transfer of heat in a moving fluid. Air flowing past the body can cool the body if the air temperature is cool. If the air exceeds 95ºF, it can increase the heat load on the body.

corrosive - a liquid or solid that causes visible destruction or irreversible damage in the human skin at the site of contact.

dB - decibel

decomposition - the breakdown of a substance, often due to heat, decay or other effect, with the release of other compounds such as vapors or gases that may be flammable or toxic.

decontamination - the removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects.

decontamination line - the sequence of stations in the process of decontamination.

degradation - the loss of or change in a fabric's chemical resistance or physical properties due to chemical exposure, use, age, or exposure to heat, cold, or sunlight. Chemical-protective clothing that is degraded may be partially dissolved, softened, hardened, or completely destroyed.

Department of Energy (DOE) - provides energy and nuclear weapons research and development; runs the largest environmental restoration and waste management program in the world.

Department of Labor (DOL) - develops and administers policies relating to wage earners, working conditions, and employment opportunities.

Department of Transportation (DOT) - develops and coordinates national transportation programs.

derived air concentration (DAC) - the limiting value for inhaled radionuclides given in units of mCi/ml.

dermis - the inner layer of the skin. See also epidermis.

DOE - United States Department of Energy; runs the largest environmental restoration and waste management program in the world. In cleaning up and managing its former nuclear weapons facilities, DOE contractors must safely and efficiently handle, treat, and dispose of mixed and/or radioactive materials and facilities.

DOT - Department of Transportation

doffing - to remove a garment; used to describe taking off personal protective ensembles.

donning - to put on a garment; used to describe putting on personal protective ensembles.

dose - the quantity of a substance to which an organism is exposed. The dose determines whether effects of a substance are toxic, nontoxic, or beneficial.

dose rate - the dose delivered per unit of time.

dose rate meter - measures the dose rate in an area and reads in mrem/hr and/or rem/hr.

dose-response - refers to the amount of substance (dose) that will cause an effect (response). Typically, the greater the dose, the greater the response.

dosimeters - used to determine the exposure a worker has received..

effect - in toxicology, the response produced by the body to a drug or chemical. Local effects occur at the site of first contact. Systemic effects require absorption and distribution of the substance, and affect the body at a site distant from the entry point.

electron - a negative-charged particle forming part of the atom. Electrons orbit the positively-charged nucleus, and determine the chemical properties of the atom.

emergency - a sudden and unexpected event, taking place on the site and requiring urgent action for control or remediation in order to minimize the danger to workers, the public, the environment, or property.

emergency decontamination - chemical reduction performed when it is necessary to rapidly remove the contaminant, for example, if the worker has collapsed.

emergency response - a response by employees or others to an uncontrolled release of a hazardous chemical.

Emergency Response Plan - a document that outlines a course of action prior to unforeseen occurrences; also frequently called a Contingency Plan.

encapsulating suit - an ensemble that is so configured as to completely envelop the worker when used in conjunction with the appropriate respiratory protection.

engineering controls - methods of controlling employee exposure to safety and health hazards by modifying the source of exposure or reducing the quantity of contaminants released into the work areas. Examples include piping, containment, ventilation, filtration, and shielding.

Environmental Protection Agency (EPA) - coordinates government action on behalf of the environment.

ergonomics - the science of fitting workplace conditions and job demands to the capabilities of works and a "body of knowledge about human abilities, limitations, and other characteristics relevant to design."

evacuation route - a designated path of travel to an area of lesser hazard.

evaporation - takes place when sweat evaporates from the skin. High humidity reduces the rate of evaporation and reduces the effectiveness of the body's primary cooling mechanism.

evaporation rate - the rate at which a liquid becomes a vapor.

exclusion zone - the contaminated area

excretion - removal of a substance or its metabolites from the body in urine, feces, sweat, or exhaled air.

exposure - contact with a chemical, biological, or physical hazard. See also acute, chronic.

exposure limits - established concentrations which, if not exceeded, will not generally cause adverse effects to the worker exposed.

filter - attaches to a respirator cartridge/canister, removes additional contaminants as the air passes through it.

Flame Ionizing Detector (FID) with Gas Chromatorgraphy - In the survey mode, it detects the total concentration of many organic gases and vapors. In the gas chromatography (GC) mode, it identifies and measures specific compounds. In the survey mode, all of the organic compounds are ionized and detected at the same time. Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.

flammable - a liquid with a flash point below 100ºF. can readily catch fire and continue to burn vigorously and persistently. See combustible also.

flammable atmosphere - oxygen and a flammable gas, vapor or dust in the proper mixture.

flammable limits - range of vapor concentrations that will burn or explode if an ignition source is present.

flashpoint - the lowest temperature of a liquid at which it gives off enough vapor to form an ignitable mixture of vapor and air immediately above the liquid surface.

frisker - an instrument placed in different areas in a building to check the workers and equipment for contamination when they exit an area.

frostbite - a cold injury caused by the freezing of tissue. Severe frostbite can involve the freezing of muscle and bone, and cause permanent damage.

frostnip - superficial frostbite involving the skin layers only. Frostnip is generally reversible. Frostnipped skin appears waxy and white.

gamma ray - electromagnetic radiation emitted by radioactive substances. Placing lead, steel, or concrete shielding around the source of radiation can reduce these waves of energy.

General Duty Clause - Section 5(a)(1) of the OSH Act - requires that each employer "furnish... a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees."

grade "D" breathing air - compressed air cylinders used for SARs, SAR-Es, and SCBAs.

half-life - Atoms of radioactive material are unstable, emit (eject) radiation and eventually decay and become nonradioactive (stable). The time it takes for a radioactive material to emit its radiation is measured in a quantity called half-life.

hand and foot monitor - an instrument that checks the worker's hands and feet for contamination at exit areas.

HASP - Health and Safety Plan (see definition for Health and Safety Plan below).

hazard - source of danger

hazardous material - any substance damaging to the health and well-being of a person.

Hazardous Materials Information System (HMIS) - a computerized information management system containing data related to the Federal program to ensure the safe transportation of hazardous materials by air, highway, rail, and water; the primary source of national data for the Federal, state, and local governmental agencies responsible for the safety of hazardous materials transportation.

Hazardous materials response (HAZMAT) team - a group of people specially trained to respond to chemical releases or possible releases of hazardous materials. Their purpose is to control or stabilize the incident, usually in an emergency situation.

hazardous substance - any substance damaging to the health and well-being of a person. Any substance when exposed to, results or can result in adverse effects on the health or safety of workers.

hazardous waste operation - any operation done involving the clean up of hazardous waste.

hazardous waste site - any place where hazardous waste operations take place.

HAZMAT - hazardous materials

Health and Safety Plan (HASP) - a plan designed to identify, evaluate, and control the health and safety hazards at any site. It is also needed for emergency response during site operations.

health hazard - any material that has been proven to have acute or chronic health effects.

heat cramps - painful muscle spasms, usually in the legs or abdomen, warn that heat stress is developing.

heat exhaustion - they body's response to the excessive loss of water and salt in sweat. Symptoms include heavy sweating, pale skin, fatigue, nausea and vomiting, headache, and blurred vision. Can lead to heat stroke.

heat stress - the increased burden placed on the body by high external temperatures. See also heat cramps, heat exhaustion, heat stroke.

heat stroke - a life-threatening, heat-related illness in which the body becomes unable to control its temperature. Temperature by mouth can rise above 105ºF in 10 to 15 minutes. Death or permanent injury may occur if treatment is not given promptly. See also heat stress, heat exhaustion, heat cramps.

hepatitis B virus (HBV) - a bloodborne disease which causes inflammation of the liver. This virus is capable of surviving on dried surfaces outside the human body, and is preventable by vaccination.

hot spots - types of machinery that have built-in heaters or generate heat that cause serious burns.

HP - health physicist

human immunodeficiency virus (HIV) - the virus which causes AIDS. HIV is spread most commonly by sexual contact with an infected partner, as well as infected blood or blood-contaminated body fluids, and contaminated needles or syringes. See also AIDS.

hypothermia - the loss of so much heat in the body core that normal functioning of the muscles and brain is impaired. The symptoms of hypothermia range from shivering and clumsiness (mild hypothermia) to coma and death (severe hypothermia). See also body core.

IDLH - immediately dangerous to life or health

immediately dangerous to health (IDLH) - an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

ingestion - swallowing material into the stomach. A route of entry for chemicals when toxic chemicals are eaten or drunk, or are inadvertently swallowed.

inhalation - breathing into the lungs. A common route of entry for chemicals, which then may pass through the walls of the alveoli into the bloodstream. See also alveoli.

injection - physical penetration of the skin, allowing contaminants into the blood flow; a route of entry for chemicals.

International Agency for Research on Cancer (IARC) - part of the World Health Organization, IARC's mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The IARC Monographs series is one of four resources that OSHA uses to list a material as a known or probable human carcinogen.

ionizing radiation - energy in transit in the form of alpha or beta particles, gamma rays, or x-rays. When any of these strike an electron, they contain sufficient energy to remove it from its orbit.

irritant - a substance that acts on the skin, eyes, nose, or respiratory system on contact, producing redness, swelling, inflammation, or coughing.

kidneys - a pair of bean-shaped organs about 4-1/2 inches long lying in the body cavity near the spinal column. Their function is to filter the blood and excrete waste products of metabolism.

lacrimator - a substance which causes the eyes to tear; for example, onion juice.

LC50 - the concentration of a substance in air which causes death in 50% of the test population in a specified amount of time. LC stands for lethal concentration.

LD50 - the dose of a substance which causes death in 50% of the test population; median lethal dose.

Level A PPE - a totally-encapsulating chemical-protective ensemble, including either SCBA or SAR-E, which provides the highest level of skin and respiratory protection.

Level B PPE - a chemical-protective ensemble, including either SCBA or SAR-E, which provides the highest level of respiratory protection and appropriate skin protection against the hazard.

Level C PPE - a chemical-protective ensemble which consists of an air-purifying respirator and the appropriate suit for the expected chemical exposure.

Level D PPE - a protective ensemble consisting of normal work gear only.

liver - the largest organ in the body, situated on the right side of the upper part of the abdomen. It has many important functions, including: regulating the amino acids in the blood; storing iron and copper for the body; forming and secreting bile, which aids in absorption and digestion of fats; transforming glucose into glycogen; and detoxifying foreign substances.

lockout - the process of using a lockout device (lock, chain, valve, etc.) that prevents the flow of energy from a power source to power equipment to keep it from operating.

lower explosive limit (LEL) - the lowest concentration of a chemical which will burn or explode if an ignition source is present. LEL is usually given as a percentage.

maximum use level (MUL) - the product of the assigned protection factor of the respiratory protection equipment and the permissible exposure limit for a chemical.

metabolism - the biochemical changes that a chemical undergoes in the body.

milligrams per cubic meter (mg/m^3) - a unit for measuring the concentration of dusts, gases, or mists in the air.

millirem (mrem) - 1/1000 of a rem; one-thousand millirem equals one rem.

milliroentgen (mR) - one thousand milliroentgen equals one roentgen.

Mine Safety and Health Administration (MSHA) - a branch of the Department of Labor that enforces mining safety and health standards.

miscibility - the ability of two or more liquids to be mixed and remain mixed under normal conditions; see also solubility.

National Institute for Occupational Safety and Health (NIOSH) - the research agency for occupational safety and health.

National Toxicological Program (NTP) - an organization that publishes the Annual Report on Carcinogens. It is a resource document that is used to evaluate the carcinogenicity of a chemical or product as listed on the MSDS.

negative-pressure respirator - draws air into the facepiece by the negative pressure created by the user's inhalation.

negative pressure user seal check - the worker inhales slightly to hold the respirator facepiece slightly collapsed.

neutrons - particles that have no electrical charge. A neutron can penetrate into and through the body, depositing only some energy in the process.

noise - unwanted sound

nonionizing radiation - particles or rays of energy produced by non-radioactive material or radiation-producing devices such as radar waves, microwaves, and visible and ultraviolet light.

NRC - Nuclear Regulatory Commission

Occupational Safety and Health Act of 1970 - established the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).

Occupational Safety and Health Administration (OSHA) - federal agency within the U.S. Department of Labor; develops and enforces mandatory job-safety and health standards.

off-site characterization - researching and gathering information away from the site, and surveying from the perimeter before site entry.

open-circuit respirator - allows exhaled air to pass to the atmosphere outside the facepiece.

OSHA - Occupational Safety and Health Administration

overpack drums - containers which are designed to receive another container of a smaller size for the purpose of containment and/or protection.

oxidizer - a chemical, other than an explosive or blasting agent, that initiates or promotes combustion in other materials by releasing oxygen or other gases.

Oxygen Meter - Measures the percentage of 0_2 in the air. Uses an electrochemical sensor to measure the partial pressure of 0_2 in the air and converts that reading to an 0_2 concentration.

parts per million (ppm) - an expression describing a small concentration; an amount of substance in a million parts of another material. For example, one part (molecule) of salt in a million parts (molecules) of water.

PEL - permissible exposure limit

penetration - the movement of chemicals through a small opening in a chemical- protective garment, for example, zippers, stitched seams, pinholes, or imperfections in the fabric.

permeation - the process by which a chemical dissolves or moves through clothing material.

permissible exposure limit (PEL) - the airborne concentration of a substance permitted by OSHA as a legally enforceable standard, found in 29 CFR 1910.1000. These are time-weighted average concentrations that must not be exceeded during any 8-hour work shift of a 40-hour work week. Approximately 400 substances are regulated by OSHA.

personal protective clothing and equipment (PPE) - clothing and equipment used to shield individuals from chemical, physical, and biological hazards. PPE can protect the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing. A complete ensemble includes chemical-protective clothing (CPC), respiratory protection and other items (such as gloves, ear plugs, boots, etc.). This should be the last resort to reduce exposure to a chemical.

pinch points - danger zones found between a moving object and a stationary object.

pocket dosimeter - device that gives an estimate of radiation received by the worker.

poison - a chemical substance harmful to living things.

polymerization - a process of forming a polymer by combining large numbers of chemical units or monomers into long chains (polyethylene from ethylene or polystyrene from styrene). Uncontrolled polymerization can be extremely hazardous. Some polymerization processes can release considerable heat or can be explosive.

Portable Infrared (IR) Spectrophotometer - Measures the concentration of many gases and vapors in the air. Designed to quantify one or two component mixtures. Passes different frequencies of IR through the sample. The frequencies absorbed are specific for each compound.

portal monitor - an instrument that checks the worker's whole body for contamination at exit areas.

positive-pressure/pressure-demand respirator - has a pressure regulator and an exhalation valve to maintain the positive pressure in the mask during both inhalation and exhalation.

positive pressure user seal check - the worker exhales slightly to create a slight pressure inside the respirator facepiece.

powered air-purifying respirator (PAPR) - uses a battery-powered blower to draw air through a cartridge to provide positive pressure and make breathing easier for the wearer.

PVC - polyvinyl chloride

qualitative respiratory fit test - used to subjectively check the "quality" of the respirator seal; if the worker can smell the test material, the respirator fit is not effective.

quantitative respiratory fit test - performed with sophisticated equipment that provides a numerical value for material that is leaked through the respirator seal surface.

radiation - ***1.)*** energy radiated in the form of waves or particles. ***2.)*** the transfer of heat energy through space. A worker whose body temperature is greater than the temperature of the surrounding surfaces radiates heat to these surfaces.

radiation absorbed dose (RAD) - a unit used to measure a quantity called "absorbed dose." This relates to the amount of energy actually absorbed in some material, and is used for any type of radiation and any material.

reactive - a chemical that may polymerize, decompose or condense under conditions of shock, pressure, or temperature by releasing large amounts of energy. Reactives include: explosive materials, organic peroxides, pressure-generating materials and water-reactive materials.

recommended exposure limit (REL) - NIOSH recommendations; not enforceable.

REL-TWA - highest allowable airborne concentration that is not expected to injure a worker, expressed as *time-weighted average* for up to a 10-hour work day during a 40-hour work week.

REL-ST - a short-term exposure limit This is a 15-minute TWA exposure that should not be exceeded at any time during a work day.

REL-C - ceiling concentrations should not be exceeded at any time. Any substance that NIOSH considers to be a potential occupational carcinogen is designated by the notation "Ca".

rem - a measure of the amount of and biological effect of the radiation absorbed by the body.

REP - radiation exposure permit.

Resource Conservation and Recovery Act (RCRA) - made the EPA responsible for identifying and managing hazardous waste from generation, to transport, to treatment and disposal, cradle to grave.

response - the reaction of the body to a chemical substance.

roentgen - a measure of the radiation field strength in an area.

routes of entry - the means by which chemicals can enter the body. Inhalation, skin absorption, and ingestion are the three most common routes, with injection (by puncture of the skin) the least common.

RWP - radiation work permit.

sampling - a part taken as a representative of a whole thing or group.

self-contained breathing apparatus (SCBA) - consists of a facepiece connected by a hose and regulator to an air source carried by the wearer.

shock-sensitive waste - waste materials which may evolve violently with heat and explosive forces as a result of a sudden motion or impact.

short-term exposure level (STEL) - this is the maximum concentration to which workers can be exposed to for a period of up to 15 minutes continuously without irritation or harm, with 60 minutes elapse time between exposures, provided that the daily TWA is not exceeded.

sign - as in “signs and symptoms”; the appearance of an individual which indicates an internal problem. For example, blue coloring around the mouth and nose is a sign that the person has an insufficient amount of oxygen in his blood. See also symptom.

shock-sensitive waste - waste materials which may evolve violently with heat and explosive forces as a result of a sudden motion or impact.

site characterization - provides the information needed to identify site hazards, and to select hazard-specific health and safety measures required to protect workers from exposure or injury.

solubility - the amount of a substance that will dissolve in a given amount of water or another liquid.

SOPs - standard operating procedures

specific gravity - the density of a chemical in relation to the density of an equal volume of water (water = 1). If the specific gravity of the chemical is greater than 1, the chemical is heavier than water and sinks. If the specific gravity of the chemical is less than 1, the chemical is lighter than water and will float.

stability - the ability of a material to remain unchanged in the presence of heat, moisture or air.

staging - moving wastes, in an organized manner, to another area.

storage - the temporary placement of a hazardous material in a location which provides some protection to personnel or the environment.

Superfund (established in 1980) - federal funding to clean up hazardous waste; forces industry to pay for their toxic spills and general pollution.

Superfund Amendments and Reauthorization Act (SARA) - updates Superfund; extends the authority of the federal government.

supplied-air respirator (SAR) - airline respirator; directs air into a facepiece or hood by a supply line from a fixed source.

supplied-air respirator with escape (SAR-E) - airline respirator equipped with an escape bottle that provides air in the event of an emergency or loss of primary air supply.

support zone - the uncontaminated area where the worker should not be exposed to hazardous conditions.

SWP - special work permit.

symptom - the subjective feeling of the patient indicating the presence of illness. For example, pain. See also sign.

systemic - involving the entire body.

tagout - the process of placing a tag on the power source that acts as a warning, not a physical restraint.

target organ - a bodily system most affected by a toxic substance. For example, the central nervous system is a target organ of many solvents.

Technology Safety Data Sheet (TSDS) - a standardized report patterned on a Materials Safety Data Sheet, prepared as a reference for the workers who will use the new technology; includes information from all analyses and assessments, and risk rating system.

thermoluminescent dosimeter (TLD) - device that records the radiation dose received by the worker.

threshold limit value (TLV) - a term used by ACGIH to identify the airborne concentration of substances and conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without an adverse effect.

threshold limit value-ceiling (TLV-C) - the concentration that should not be exceeded during any part of the working exposure, as published by the American Congress of Governmental Industrial Hygienists.

threshold limit value-short-term exposure limit (TLV-STEL) - a 15 minute time-weighted average exposure which should not be exceeded at any time during a work day even if the 8 hr TWA is within the TLV. Exposures at the STEL should not be repeated more than 4 times a day and there should be at least 60 minutes between successive exposures at the STEL.

threshold limit value-time-weighted average (TLV-TWA) - the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effects.

time-weighted average (TWA) - an exposure concentration averaged over an 8 hour day. This is used by OSHA and ACGIH. Most PELs and TLVs are time-weighted averages.

TLV - threshold limit value

toxic - harmful, poisonous.

toxicity - ability of a substance to cause harmful effects.

toxicology - the study of poisons.

trade name - the name under which a product is commercially known.

TSD - treatment, storage, or disposal.

Ultraviolet (UV) Photoionization Detector (PID) - Detects the total concentration of many organic and some inorganic gases and vapors. Ionizes molecules using UV radiation. Produces a current that is proportional to the number of ions.

universal precautions - the required approach to infection control in which all human blood and some body fluids must be treated as if known to be infectious. These include using resuscitation devices for mouth-to-mouth breathing and wearing latex gloves to protect from contact with blood or body fluids contaminated with blood.

upper explosive limit (UEL) - is the highest concentration of vapor in air which will burn or explode upon contact with a source of ignition.

vapor density - the relative weight of a chemical's vapor in relation to the weight of an equal volume of air (air = 1). If the vapor density is greater than 1, the vapor is heavier than air and sinks. If the vapor density is less than 1, the vapor is lighter than air and it rises.

vapor pressure - the pressure that a liquid's vapor exerts on the air. The higher the vapor pressure, the more easily it will evaporate. Vapor pressure is expressed in millimeters of mercury (mmHg); 760 mmHg is equivalent to 14.7 pounds per square inch (psi), the pressure of air at sea level.

work practices - ways to perform a task to assure safety to those involved.

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