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EPA

Health and Safety Eight-Hour Training (165.10

Student Manual

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FORWARD

This manual is for reference use of students enrolled in scheduled training courses of the U.S. Environmental Protection Agency (EPA). While it will be useful to anyone who needs information on the subjects covered, it will have its greatest value as an adjunct to classroom presentations involving discussions among the students and the instructional staff.

This manual has been developed with a goal of providing the best available current information; however, individual instructors may provide additional material to cover special aspects of their presentation.

Because of the limited availability of the manual, it should not be cited in bibliographies or other publications.

References to products and manufacturers are for illustration only; they do not imply endorsement by EPA.

Constructive suggestions for improvement of the content and format of the Health and Safety Eight-Hour Training (165.10) manual are welcome.

HEALTH AND SAFETY EIGHT HOUR TRAINING
(165.10)

This course is designed to provide eight hours of annual health and safety refresher training for compliance with 29 CFR §1910.120 (e).

After completing this course, participants will be able to:

- Identify and use regulatory guidance to develop health and safety plans and Standard Operating Procedures designed to protect workers involved in hazardous waste operations on Superfund sites.
- Select and use personal protective equipment and air monitoring equipment.
- Discuss medical surveillance requirements and identify and evaluate health hazards and exposure guidance for hazardous substances.
- Identify decontamination procedures.

HEALTH AND SAFETY 8-HOUR REFRESHER

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Health and Safety Eight Hour Training

(165.10)

presented by
Tetra Tech NUS, Inc.

for the
U.S. Environmental Protection Agency's
Environmental Response Center

Contract Number 68-C7-0033

ERTP Training Program

- ERTP Training Program resources

  Web link: www.ert.org
  www.trainex.org

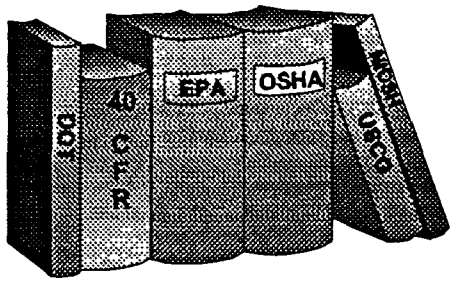
REGULATORY OVERVIEW

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Identify the paragraphs in 29 CFR §1910.120 that apply to workers involved in activities on a Superfund site.
2. List at least three applicable OSHA regulations that apply to workers involved in activities on a Superfund site.

REGULATORY OVERVIEW



REGULATORY OVERVIEW

- CERCLA
- SARA Section 126
- OSHA 29 CFR ∮1910.120
- EPA 40 CFR ∮311

REGULATORY OVERVIEW

- Mandatory cleanups at uncontrolled hazardous waste sites
- Voluntary cleanups at uncontrolled hazardous waste sites
- Corrective actions at Resource Conservation Recovery Act (RCRA) Treatment, Storage, and Disposal (TSD) facilities

REGULATORY OVERVIEW

- Routine hazardous waste operations at RCRA TSD facilities
- Emergency response without regard to location

REGULATORY OVERVIEW

(a – f)

a. Scope, application and definitions
b. Safety and health program
c. Site characterization and analysis
d. Site control
e. Training
f. Medical surveillance

REGULATORY OVERVIEW

(g – l)

g. Engineering controls, work practices and PPE
h. Monitoring
i. Informational programs
j. Handling drums and containers
k. Decontamination
l. Emergency response at uncontrolled hazardous waste sites

REGULATORY OVERVIEW

(m – q)

m. Illumination
n. Sanitation at temporary workplaces
o. New technology programs
p. TSD facilities
q. Emergency response

REGULATORY OVERVIEW

- Appendix A PPE Test Methods
- Appendix B Levels of Protection
- Appendix C Compliance Guidelines
- Appendix D References
- Appendix E Training Curriculum Guidelines

REGULATORY OVERVIEW

- 29 CFR §1910.38 Emergency Action Plans
- 29 CFR §1910.95 Occupational Noise Exposure
- 29 CFR §1910.96 Ionizing Radiation
- 29 CFR §1910.134 Respiratory Protection
- 29 CFR §1910.146 Confined Space Entry
- 29 CFR §1910.147 Lockout/tagout

Regulatory Overview

1. Under the authority of section 126 of the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA and OSHA promulgated identical health and safety standards to protect workers engaged in hazardous waste operations and emergency response.

2. The OSHA regulations, codified at 29 CFR §1910.120 became effective on March 6, 1990. The EPA regulations incorporate the OSHA standards by reference and are codified at 40 CFR Part 311.

3. The EPA and OSHA worker protection standards for hazardous waste operations and emergency response (HAZWOPER) apply to the five groups of workers listed below:

   A. Mandatory Cleanups at Uncontrolled Hazardous Waste Sites.
   B. Voluntary Cleanups at Uncontrolled Hazardous Waste Sites.
   C. Corrective Actions at RCRA TSD Facilities.
   D. Routine Hazardous Waste Operations at RCRA TSD Facilities.
   E. Emergency Response Operations Without Regard to Location.

4. The major provisions of the HAZWOPER regulation are listed in Table A.

Table A
29 CFR §1910.120

a. Scope, Application, and Definitions
b. Safety and Health Program
c. Site Characterization and Analysis
d. Site Control
e. Training
f. Medical Surveillance
g. Engineering Controls, Work Practices, and Personal Protective Equipment
h. Monitoring
i. Informational Programs
j. Handling Drums and Containers
k. Decontamination
l. Emergency Response at Uncontrolled Hazardous Waste Sites
m. Illumination
n. Sanitation at Temporary Workplaces
o. New Technology
p. RCRA TSD Facilities
q. Emergency Response

App A PPE Test Methods
App B Levels of Protection
App C Safety and Health Programs and Safety and Health Plans
App D Refemeces
App E Training Curriculum Guidelines

5. The most basic OSHA worker safety provision is the General Duty Clause. Under the General Duty clause of the OSH Act of 1970, section 5(a)(1) states that each employer "shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees".

6. In addition to the HAZWOPER regulation and the General Duty Clause, other OSHA regulations may apply to workers on a hazardous waste site. Examples of the most common OSHA regulations are listed in Table B.

Table B
Additional OSHA Regulations

29 CFR §1910 General Industry	
1910.20	Exposure and Medical Records
1910.38	Employee Emergency Plans and Fire Prevention Plans
1910.95	Occupational Noise Exposure
1910.1096	Ionizing Radiation
1910.134	Respiratory Protection
1910.146	Permit Required Confined Space Entry
1910.147	Lockout/Tagout
1910.1000	Toxic and Hazardous Substances
1910.1200	Hazard Communication
29 CFR §1926 Construction Industry	
1926.651	Specific Excavation Requirements
1926.652	Trenching Requirements

7. HAZWOPER definitions (not inclusive).

   A. CERCLA means the Comprehensive, Environmental Response, Compensation, and Liability Act. CERCLA became law in 1980. CERCLA was our nation's first comprehensive effort to properly manage the abandoned hazardous waste cleanup problem.

   B. Emergency response or responding to emergencies: A response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual-aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance.

   C. Hazardous substance.

      (1) Any substance defined under section 101(14) of CERCLA;

      (2) Any biological agent and other disease-causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations in such persons or their offspring.

      (3) Any substance listed by the U.S. Department of Transportation as hazardous materials under 49 CFR §172.101 and appendices.

   D. IDLH Immediately Dangerous To Life or Health: An atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with any individual's ability to escape from a dangerous atmosphere.

E. Post Emergency Response: That portion of an emergency response performed after the immediate threat of a release has been stabilized or eliminated and cleanup of the site has begun. If post emergency response is performed by an employer's own employees who were part of the initial emergency response, it is considered to be part of the initial response and not post emergency response. However, if a group of an employer's own employees, separate from the group providing initial response, performs the cleanup operation, then the separate group of employees would be considered to be performing post-emergency response and subject to paragraph (q)(11) of this section.

F. The "Senior Official" is the most senior official on the site who has the responsibility for controlling the operations at the site. Initially it is the senior officer on the first piece of responding emergency apparatus to arrive on the incident scene. As more senior officers arrive (i.e., battalion chief, fire chief, state law enforcement official, site coordinator, etc.) the position is passed up the line of authority which has been previously established.

8. Additional EPA Superfund Site Health and Safety Guidance is listed in Table C:

TABLE C
Additional EPA Guidance Publications for Site Health & Safety

Occupational Safety and Health Guidance Manual for Hazardous Waste Activities (NIOSH/OSHA/USCG/ EPA, 1985, NIOSH Publication 85-115 Referred to as the "Four Agency Book"

EPA Health and Safety Audit Guidelines (U.S. EPA, 1989, EPA 540/G-89010)

Standard Operating Procedures for Site Safety Planning (U.S. EPA, 1985, Publication 9285.2-05)

EPA Standard Operating Safety Guides, EPA, 1992, Publication 9285.1-03

Student Exercise

1. HAZWOPER applies to_____ groups of workers

2. The 29 CFR 1910._____ gives requirements for respiratory protection.

3. The HAZWOPER paragraph that regulates emergencies at ANY location is:

   a. q
   b. l
   c. b

4. HAZWOPER testing requirements for Level A suits are found in:

   a. App A
   b. App B
   c. App C

5. Permit-Required Confined Spaces (PRCS) are regulated in 29 CFR 1910_____.

6. Hazard Communication training requirements for General Industry are found in:

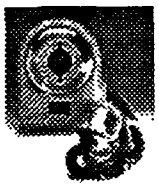
   a. 1910.1200
   b. 1910.20
   c. 1910.178

RESPIRATORY PROTECTION

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Describe the elements of the Respiratory Protection Standard.

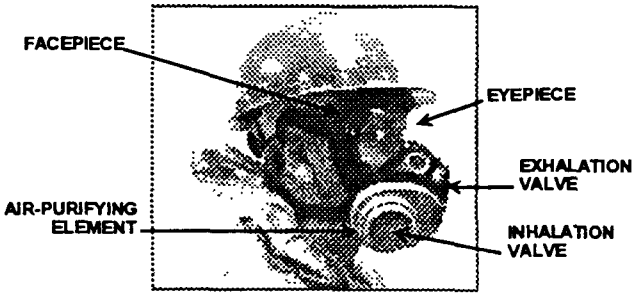


RESPIRATORY PROTECTION 29 CFR §1910.134

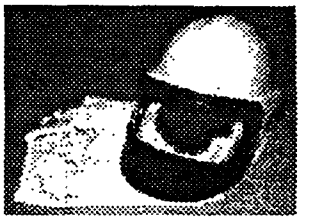
GENERAL INFORMATION

- Purpose
  - Prevent the inhalation of harmful airborne substances and/or provide breathable air in oxygen-deficient atmosphere
- Types of respirators
  - Tight-fitting respirators
    - ✓ Form a seal with the face of the wearer
  - Loose-fitting respirators
    - ✓ Form a partial seal with the face

GENERAL INFORMATION (cont.)



LOOSE-FITTING RESPIRATOR

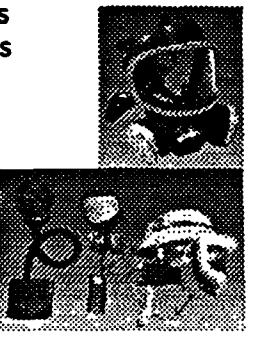


GENERAL INFORMATION (cont.)

- Airborne hazards
  - Dusts, fumes, mists
  - Gases and vapors
  - Smoke
  - Oxygen deficiency

GENERAL INFORMATION (cont.)

- Respirator Classifications
  - Air Purifying respirators
    - ✓ Particulate
    - ✓ Vapor/gas
    - ✓ Combination



GENERAL INFORMATION (cont.)

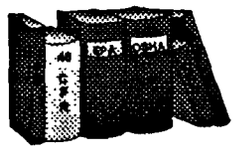
- Respirator classifications (continued)
  - Atmosphere-supplying Respirators
    - ✓ Supplied-air
    - ✓ SCBA
    - ✓ Combination

GENERAL INFORMATION (cont.)

- Limitations of Respirator Use
  - Existing medical conditions
  - Physical impairment
  - Beards/sideburns (facial hair)

RESPIRATOR PROTECTION PROGRAM (RPP)

- The standard: 29 CFR §1910.134
  - Selection, use, and care in accordance with the standard
- Worksite-specific procedures
  - Meet user-specific requirements
  - Step-by-step procedures for compliance with RPP
- Administration
  - Qualified person

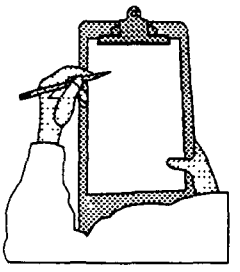


RRP (cont.)

- Elements
  - Selection procedures
  - Medical Evaluations
  - Fit testing
  - Use of respirators
  - Maintenance & cleaning
  - Air quality

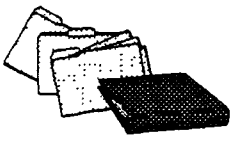
RRP (cont.)

- Elements (continued)
  - Training
    - ✓ Respiratory hazards
    - ✓ Proper use
    - ✓ Donning/doffing
    - ✓ Limitations
    - ✓ Maintenance
  - Program evaluation



RESPIRATOR SELECTION

- Proper respirator selection
  - Fully protect worker from respiratory hazards
- Selection factors
  - Nature of the hazard
  - Concentrations of atmospheric hazard
  - Exposure limits
  - Nature of the work



RESPIRATOR SELECTION (cont.)

- Selection factors (continued)
  - Length of time respirator is worn
  - Work activities and physical/psychological stress
  - Fit testing
  - Physical characteristics and capabilities/limitations of respirators
  - NIOSH-certified respirators
    - ✓ Appropriate for contaminant

RESPIRATOR SELECTION (cont.)

- Assigned protection factors (APF)
  - OSHA definition in reserved status
  - OSHA refers to NIOSH and ANSI APFs
  - Warning system
    - ✓ End of service life indicator (ESLI)
    - ✓ Cartridge change-out schedule based on objective information

RESPIRATOR SELECTION (cont.)

- IDLH
  - SCBA
  - Combination full-facepiece pressure demand SAR with an auxiliary SCBA

MEDICAL EVALUATION

- Overview
  - Ensure that employees are medically fit to tolerate the physical and psychological stress imposed by respirator use
- Questionnaire
  - PLHCP must perform a medical evaluation using the medical questionnaire in Appendix C
- Medical factors and conditions
  - Identify general medical conditions

FIT TESTING

- Purpose
  - Identify the specific make, model, style, and size of respirator best suited by each employee
- Requirement
  - Required for all negative or positive pressure tight-fitting facepiece respirators
  - Performed prior to the worker entering the work environment

FIT TESTING (cont.)

- Method
  - Show employee how to don, position, adjust, and determine fit
  - Allow employee to choose respirator
  - Employee conducts user seal check
  - Fit factor: ratio of the concentration of a substance in ambient air to its concentration inside the respirator

FIT TESTING (cont.)

- Types of fit testing
  - Qualitative fit testing
    - ✓ QLFT may only be used to fit test negative pressure air-purifying respirators that must achieve a fit factor of 100 or less

FIT TESTING (cont.)

- Quantitative fit testing
  - Equal to or greater than 100 for tight-fitting half facepiece, or equal to or greater than 500 for tight-fitting full facepiece

FIT TESTING (cont.)

- Fit test exercises
  - Performed for one minute
- Retesting
  - Employee must be given a reasonable opportunity for retesting if respirator fit is unacceptable
    - ✓ Different respirator
    - ✓ Reevaluation by PLHCP

USE OF RESPIRATORS

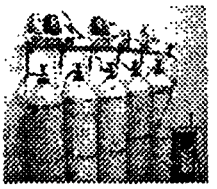
- Conditions of use
- Facepiece seal protection
  - Allows the use of contact lens
  - User seal checks
- Continuing respirator effectiveness
  - Reactions to extended use of respirators
  - Effective cartridge/filter change out
  - Proper maintenance
- IDLH
- Interior Structural Firefighting

MAINTENANCE AND CARE

- Requirements
- Cleaning and Disinfecting
- Storage
- Inspection
- Repair

BREATHING AIR QUALITY AND USE

- Standards and Specifications
  - Compressed Gas Association
    - ✓ G-7.1-1989: Grade D air
- Other Specific Requirements
  - 49 CFR §173 and §178
    - ✓ Cylinder specifications and hydrostatic testing



PROGRAM LOGISTICS

- Identification of filters, cartridges, and canisters
- Training and information
  - Required before respirator use
  - Annual retraining required

PROGRAM LOGISTICS (cont.)

- Training and information (continued)
  - Understand the operation and use of the respirator
  - Demonstrate the ability to properly use the respirator
  - Why respirator is necessary
  - Consequences of improper fit, usage, or maintenance

PROGRAM LOGISTICS (cont.)

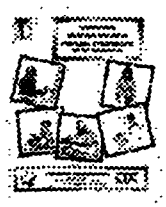
- Training and information (continued)
  - Limitations and capabilities of respirators
  - Emergency situations
  - Respirator inspection
  - Maintenance and storage
  - Medical information
  - General requirements of the RPP
  - Annual training required
  - Additional training requirements

PROGRAM EVALUATION

- Ensure that RPP is properly implemented
- Ensure effectiveness of the program
- Consult with employees
  - Views of the program
  - Identify problems
- Recordkeeping
  - Medical evaluations
  - Fit testing records
  - Available for the employee and OSHA

NIOSH GUIDELINES FOR THE SELECTION AND USE OF PARTICULATE RESPIRATORS

- 42 CFR §84
- Replaces 30 CFR §11
- Provides three levels of efficiency
  - 95%, 99%, 99.97%
  - Corresponding to three classification levels
    - ✓ 95, 99, 100
- Provides three categories of resistance to filter efficiency degradation by oil particles
  - N: Not Oil Resistant, R: Resistant, P: Oil Proof



RESPIRATORY PROTECTION EXERCISE

CALCIUM OXIDE

(NIOSH Pocket Guide: Page 48)

CONCENTRATION = up to 10 mg/m^3

RESPIRATOR = ??????

RESPIRATORY PROTECTION EXERCISE (cont.)

CALCIUM OXIDE

(NIOSH Pocket Guide: Page 48)

CONCENTRATION = up to 10 mg/m^3

RESPIRATOR = DM

Does the "DM" respirator meet the new 42 CFR Part 84 requirements?

RESPIRATORY PROTECTION EXERCISE (cont.)

NOW RECLASSED AS

42 CFR ∅84

Filter Efficiency (.3 micron)	Classified As	Oil Aerosol Resistant
95%	95	"N" Not Resistant
99%	99	"R" Oil Resistant
99.97%	100	"P" Oil Proof

RESPIRATORY PROTECTION EXERCISE (cont.)

CALCIUM OXIDE

(NIOSH Pocket Guide: Page 48)

CONCENTRATION = up to 10 mg/m^3

RESPIRATOR = DM

Select the minimally protective filter required under Part 84 for the following two situations:

1. No oil aerosols present.
2. Oil aerosols present.

(Use the transition recommendations in the NIOSH Pocket Guide on Page xxxi for this exercise.)

RESPIRATORY PROTECTION EXERCISE (cont.)

CALCIUM OXIDE

(NIOSH Pocket Guide: Page 48)

CONCENTRATION = up to 10 mg/m^3
RESPIRATOR = DM

Select the minimally protective filter required under Part 84 for the following two situations:

1. No oil aerosols present. N95
2. Oil aerosols present. R95 or P95

OSHA Technical Manual
SECTION VIII: CHAPTER 2
Respiratory Protection

Contents:

I. Introduction
II. History of the Development of Respiratory Protection
III. General Information
IV. Respirator Protection Program
V. Respirator Selection
VI. Medical Evaluation
VII. Fit Testing
VIII. Use of Respirators
IX. Maintenance and Care
X. Breathing Air Quality and Use
XI. Program Logistics

Appendix VIII:2-1. Glossary
Appendix VIII:2-2. User Seal Check
Appendix VIII:2-3. Recommended Procedures for Cleaning Respirators
Appendix VIII:2-4. NIOSH Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR §84

I. INTRODUCTION

A. Wearing respiratory protective devices to reduce exposure to airborne contaminants is widespread in industry. An estimated 5.0 million workers wear respirators, either occasionally or routinely. Although it is preferred industrial hygiene practice to use engineering controls to reduce contaminant emissions at their source, there are operations where this type of control is not technologically or economically feasible or is otherwise inappropriate.

B. Since respirators are not as consistently reliable as engineering and work practice controls, and may create additional problems, they are not the preferred method of reducing exposures below the occupational exposure levels. Accordingly, their use as a primary control is restricted to certain circumstances. In those circumstances where engineering and work practice controls cannot be used to reduce airborne contaminants below their occupational exposure levels (e.g., certain maintenance and repair operations, emergencies, or during periods when engineering controls are being installed), the use of respirators could be justified to reduce worker exposure. In other cases, where work practices and engineering controls alone cannot reduce exposure levels to below the occupational exposure level, the use of respirators would be essential for supplemental protection.

C. There are many variables that affect the degree of protection afforded by respiratory protective devices, and the misuse of respirators can be hazardous to employee safety and health. Selection of the wrong equipment, one of the most frequent errors made in respiratory protection, can result in the employee being exposed to increased concentrations of the harmful contaminant. This error may result in a broad range of health effects caused by the harmful contaminants, including silicosis, asbestosis, permanent lung damage, and cancer. Respirators that are not maintained and inspected can be less effective at reducing exposure to the harmful contaminants, and can place a greater burden on the respiratory system. Respirators that are not clean can cause dermatitis or skin irritation. Because respirator use may give the employee a false sense of security and presumed protection, an improper respirator program can actually present a high degree of hazard for the employee.

D. Respirators can only provide adequate protection if they are properly selected for the task; are fitted to the wearer and are consistently donned and worn properly; and are properly maintained so that they continue to provide the protection required for the work situation. These

variables can only be controlled if a comprehensive respiratory protection program is developed and implemented in each workplace where respirators are used. When respirator use is augmented by an appropriate respiratory protection program, it can prevent fatalities and illnesses from both acute and chronic exposures to hazardous substances.

E. The primary aim of this chapter is to give detailed instruction in the selection of the proper respirator and its use and maintenance. The emphasis is on the implementation of a respiratory protection program developed in a logical progression of steps, outlined below:

- A clear definition of the hazards that will be encountered and the degree of protection required;
- The selection and fitting of the respirator;
- Medical evaluation for respirator selection and use;
- The required training in the correct use and care of the respirator; and
- The implementation of a maintenance program that will ensure that a high level of respiratory protection is maintained.

II. HISTORY OF THE DEVELOPMENT OF RESPIRATORY PROTECTION

A. Early practices. The concept of using respiratory protective devices to reduce or eliminate hazardous exposures to airborne contaminants first came from Pliny (circa a.d. 23-79) who discussed the idea of using loose fitting animal bladders in roman mines to protect workers from the inhalation of red oxide of lead. (See proposed respiratory protection standard, 59 Federal Register 58885.) Later, in the 1700s, the ancestors of modern atmosphere-supplying devices, such as the self-contained breathing apparatus or hose mask, were developed. Although the devices themselves have become more sophisticated in design and materials, respirators' performance is still based on one of two basic principles: purifying the air by removing contaminants before they reach the breathing zone of the worker, or providing clean air from an uncontaminated source.

B. Development of modern methods. In 1814, a particulate-removing filter encased in a rigid container was developed – the predecessor of modern filters for air-purifying respirators. In 1854 it was recognized that activated charcoal could be used as a filtering medium for vapors. During world war I, with the use of chemical warfare, improvements in the design of respirators was necessary. In 1930 the development of the resin-impregnated dust filter made available efficient, inexpensive filters that have good dust-loading characteristics and low breathing resistance.

C. Latest advances. A more recent development was the high efficiency particulate filter made with very fine glass fibers. These extremely efficient filters are used for very small airborne particles and produce little breathing resistance. Some features that are currently being incorporated into respirator design include a smaller facepiece, which translates into a better field of vision and a low profile that permits the respirator to fit under other protective gear such as a welder's helmet. Over the years there have been continuing major developments in the basic design of respirators. Modern design improvements have created products that are both more comfortable to wear and more protective than earlier respirators.

III. GENERAL INFORMATION

A. Purpose. The purpose of a respirator is to prevent the inhalation of harmful airborne substances and/or an oxygen-deficient atmosphere. Functionally, a respirator is designed as an enclosure that covers the nose and mouth or the entire face or head. Respirators are of two general "fit" types, tight-fitting and loose-fitting.

1. The tight-fitting respirator (Figure VIII:2-1) is designed to form a seal with the face of the wearer. It is available in three types: quarter mask, half mask, and full facepiece. The quarter mask covers the nose and mouth, where the lower sealing surface rests between the chin and the mouth. The half mask covers the nose and mouth and fits under the chin. The full facepiece covers the entire face from below the chin to the hairline.

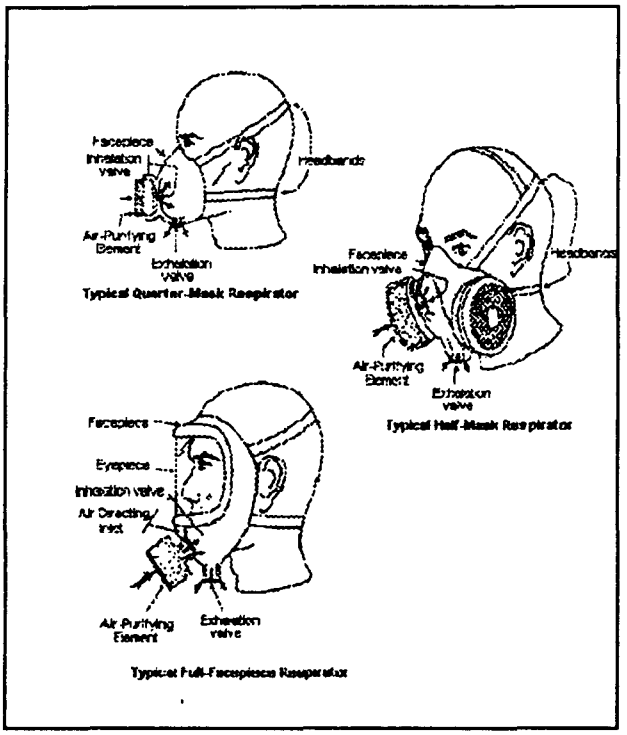


FIGURE VIII: 2-1. TIGHT-FITTING RESPIRATORS.

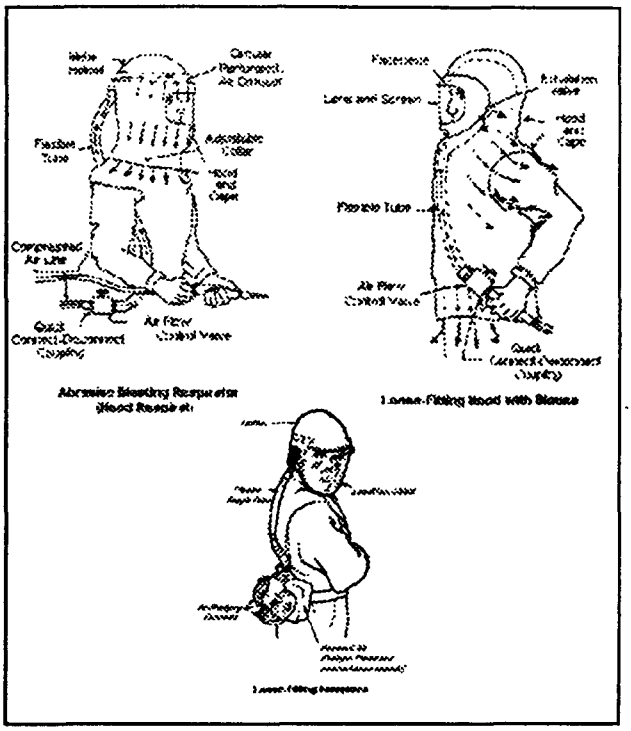


FIGURE VIII: 2-2. LOOSE-FITTING RESPIRATORS.

2. The loose-fitting respirator (Figure VIII:2-2) has a respiratory inlet covering that is designed to form a partial seal with the face. These include loose-fitting facepieces, as well as hoods, helmets, blouses, or full suits, all of which cover the head completely. The best known loose-fitting respirator is the supplied air hood used by the abrasive blaster. The hood covers the head, neck, and upper torso, and usually includes a neck cuff. Air is delivered by a compressor through a hose leading into the hood. Because the hood is not tight-fitting, it is important that sufficient air is provided to maintain a slight positive-pressure inside the hood relative to the environment immediately outside the hood. In this way, an outward flow of air from the respirator will prevent contaminants from entering the hood.

B. Airborne (or respiratory) hazards may result from either an oxygen deficient atmosphere or breathing air contaminated with toxic particles, vapors, gases, fumes or mists. The proper selection and use of a respirator depend upon an initial determination of the concentration of the hazard or hazards present in the workplace, or the presence of an oxygen deficient atmosphere.

Airborne hazards generally fall into the following basic categories:

1. Dusts. Particles that are formed or generated from solid organic or inorganic materials by reducing their size through mechanical processes such as crushing, grinding, drilling, abrading, or blasting.

2 Fumes. Particles formed when a volatilized solid, such as a metal, condenses in cool air. This physical change is often accompanied by a chemical reaction, such as oxidation. Examples are lead oxide fumes from smelting, and iron oxide fumes from arc-welding. A fume can also be formed when a material such as magnesium metal is burned or when welding or gas cutting is done on galvanized metal.

3. Mists. A mist is formed when a finely divided liquid is suspended in the air. These suspended liquid droplets can be generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, or atomizing. Examples are the oil mist produced during cutting and grinding operations, acid mists from electroplating, acid or alkali mists from pickling operations, paint spray mist from spraying operations, and the condensation of water vapor to form a fog or rain.

4. Gases. Gases are formless fluids that occupy the space or enclosure and which can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Examples are welding gases such as acetylene, nitrogen, helium and argon; and carbon monoxide generated from the operation of internal combustion engines. Another example is hydrogen sulfide, which is formed wherever there is decomposition of materials containing sulfur under reducing conditions.

5. Vapors. Vapors are the gaseous form of substances that are normally in the solid or liquid state at room temperature and pressure. They are formed by evaporation from a liquid or solid, and can be found where parts cleaning and painting takes place and where solvents are used.

6. Smoke. Smoke consists of carbon or soot particles resulting from the incomplete combustion of carbonaceous materials such as coal or oil. Smoke generally contains droplets as well as dry particles.

7. Oxygen deficiency. An oxygen deficient atmosphere has an oxygen content below 19.5% by volume. Oxygen deficiency may occur in confined spaces, which include, but are not limited to, storage tanks, process vessels, towers, drums, tank cars, bins, sewers, septic tanks, underground utility tunnels, manholes, and pits.

C. Respirator classifications. Respirators provide protection either by removing contaminants from the air before they are inhaled or by supplying an independent source of respirable air. There are two major classifications of respirators:

1. Air purifying respirators (devices that remove contaminants from the air); and

2. Atmosphere-supplying respirators (those devices that provide clean breathing air from an uncontaminated source).

Each class of respirator may have tight-fitting and loose-fitting facepieces. An important aspect of respirator operation and classification is the air pressure within the facepiece. When the air pressure within the facepiece is negative during inhalation with respect to the ambient air pressure, the respirator is termed a negative-pressure respirator. When the pressure is normally positive with respect to ambient air pressure throughout the breathing cycle, the respirator is termed a positive-pressure respirator. The concept of negative and positive pressure operation is important when considering potential contaminant leakage into the respirator.

D. Air purifying respirators are grouped into three general types: particulate removing, vapor and gas removing, and combination. Elements that remove particulates are called filters, while vapor and gas removing elements are called either chemical cartridges or canisters. Filters and canisters/cartridges are the functional portion of air-purifying respirators, and they can generally be removed and replaced once their effective life has expired. The exception would be filtering facepiece respirators (commonly referred to as "disposable respirators," "dust masks," or "single-use respirators"), which cannot be cleaned, disinfected, or resupplied with an unused filter after use.

1. Particulate-removing respirators are designed to reduce inhaled concentrations of nuisance dusts, fumes, mists, toxic dusts, radon daughters, asbestos-containing dusts or fibers, or any combination of these substances, by filtering most of the contaminants from the inhaled air before they enter the breathing zone of the worker. They may have single-use or replaceable filters. These respirators may be non-powered or powered air-purifying. A powered air-purifying respirator (PAPR) uses a blower to force the ambient atmosphere through air purifying elements to the inlet covering.

2. Vapor- and gas-removing respirators are designed with sorbent elements (canisters or cartridges) that adsorb and/or absorb the vapors or gases from the contaminated air before they can enter the breathing zone of the worker. Combination cartridges and canisters are available to protect against particulates, as well as vapors and gases.

E. Atmosphere-supplying respirators are respirators that provide air from a source independent of the surrounding atmosphere instead of removing contaminants from the atmosphere. These respirators are classified by the method that is used to supply air and the way in which the air supply is regulated. Basically, these methods are: self-contained breathing apparatus (air or oxygen is carried in a tank on the worker's back, similar to SCUBA gear); supplied-air respirators (compressed air from a stationary source is supplied through a high-pressure hose connected to the respirator); and combination self-contained and supplied-air respirators.

F. Limitations of respirator use. Not all workers can wear respirators. Individuals with impaired lung function, due to asthma or emphysema for example, may be physically unable to wear a respirator. Individuals who cannot get a good facepiece fit, including those individuals whose beards or sideburns interfere with the facepiece seal, will be unable to wear tight-fitting respirators. An adequate fit is required for a respirator to be effective. In addition to these problems, respirators may also cause communication problems, vision problems, fatigue, and reduced work efficiency.

In principle, respirators usually are capable of providing adequate protection. However, problems associated with selection, fit, and use often render them less effective in actual application; these problems prevent the assurance of consistent and reliable protection, regardless of the theoretical capabilities of

the respirator. Occupational safety and health experts have spent considerable effort over the years developing fit-testing procedures and methods of measuring respirator effectiveness, thereby improving protection for those employees required to wear them.

IV. RESPIRATOR PROTECTION PROGRAM.

A. The standard. Whenever respirators are required to be worn, a written respirator protection program must be developed and implemented in accordance with OSHA's respirator standard, 29 CFR §1910.134. (Additional program requirements may be found in the standards that regulate the hazards to which the employee is exposed.) Because workplaces differ substantially, each program must be tailored to the specific conditions of the workplace. The program must consist of worksite-specific procedures governing the selection, use, and care of respirators. The program must be updated as often as necessary to reflect changes in workplace conditions and respirator use.

B. The worksite-specific procedures must contain all the information needed to maintain an effective respirator program to meet the user's individual requirements. These procedures are a set of step-by-step instructions written so that a task (i.e., respirator use, fit-testing procedures, cleaning and storage, etc.) can be performed by all personnel in a uniform and consistent way, while supplying the maximum protection for workers who use respirators in the workplace. The employer must anticipate both the routine and non-routine use of respirators, as well as any possible emergency use based on the conditions in the workplace in which they are to be used. Worksite-specific procedures must be written so as to be useful to those who are directly involved in the respirator program: the program administrator, those fitting the respirators and training the workers, respirator maintenance workers, and the supervisors responsible for overseeing respirator use on the job.

C. Administration. In addition, the respirator standard requires that the respiratory protection program be administered by one qualified individual to ensure that the integrity of the respiratory protection program is maintained through the continuous oversight of one responsible person. The program administrator must be qualified by appropriate training and/or experience in the proper selection, use, and maintenance of respirators, be responsible for implementing the respiratory protection program, and conduct regular evaluations of the program's effectiveness.

   Although responsibility for respirator program oversight rests with the program administrator, he or she may delegate responsibilities to other qualified individuals. For instance, a large facility may find it practical and economical to have a staff of personnel involved in the respirator program, each with their own area of responsibility. However, each of these people must report to the one administrator who has overall responsibility for the program. This approach promotes coordination of all facets of the program. The administrator should have the full support of higher level management; without it, an effective respirator program is difficult to initiate and maintain.

D. Elements. The respiratory protection program must cover the following basic elements, as applicable:

   - Procedures for selecting respirators for use in the workplace;
   - Medical evaluations of employees required to use respirators;
   - Fit testing procedures for tight-fitting respirators;
   - Use of respirators in routine and reasonably foreseeable emergency situations;

- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, and otherwise maintaining respirators;
- Procedures to ensure adequate air quality, quantity and flow of breathing air for atmosphere-supplying respirators;
- Training of employees in the respiratory hazards to which they are potentially exposed;
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and maintenance procedures; and
- Procedures for regularly evaluating the effectiveness of the program.

V. RESPIRATOR SELECTION

Respirator selection requires correctly matching the respirator with the hazard, the degree of hazard, and the user. The respirator selected must be adequate to effectively reduce the exposure of the respirator user under all conditions of use, including reasonably foreseeable emergency situations. Proper respirator selection involves choosing a device that fully protects the worker from the respiratory hazards to which he or she may be exposed and permits the worker to perform the job with the least amount of physical burden.

A. Selection factors. Many factors must be considered carefully in respirator selection. In choosing the appropriate respirator, one must consider the nature and extent of the hazard, work requirements and conditions, and the characteristics and limitations of the respirators available. The following categories of information must be taken into account:

- Nature of the hazard, and the physical and chemical properties of the air contaminant;
- Concentrations of contaminants;
- Relevant permissible exposure limit or other occupational exposure limit;
- Nature of the work operation or process;
- Time period the respirator is worn;
- Work activities and physical/ psychological stress;
- Fit testing; and
- Physical characteristics, functional capabilities and limitations of respirators.

1. Nature of the hazard, and the physical/chemical properties of the air contaminant. The nature of the hazard, whether it is in the form of a gas, dust, organic vapor, fume, mist, oxygen deficiency or any combination of hazards, needs to be taken into account. The physical and chemical properties of the contaminant that affect respirator selection, and the selection of respirator components such as cartridges, canisters, and filters must also be considered. Physical properties include such factors as particle size for dusts, and vapor pressure for gases and vapors. Chemical properties of the air contaminant that affect breakthrough times, and the ability of the filter material to remove, adsorb, or absorb the contaminant must also be considered.

2. Concentrations of contaminants. Sampling and analysis of the workplace air determines what degree of exposure is occurring, and thus what degree of protection is required. Where such sampling and analysis have been done, the results are to be used as a point of comparison with the occupational exposure level, i.e., to determine how much the concentration must be lowered by the respirator to reduce employee exposure to a safe level.

3. The relevant permissible exposure limit or other occupational exposure limit. Respirators selected must be capable of protecting against overexposure by reducing and

maintaining exposure to or below the relevant exposure limit. In addition to the OSHA limits, employers should refer to the ACGIH (American Conference of Governmental Industrial Hygienists) recommended Threshold Limit Values (TLV's), the NIOSH (National Institute for Occupational Safety and Health) Recommended Exposure Limits (REL's), or other occupational exposure limits.

4. Nature of the work operation or process. The type of job operation, the equipment or tools that will be used, and any motion or travel the job requires can influence the type of respirator selected, particularly when supplied-air respirators, which require a connection to a clean air source, are used.

5. Time period respirator is worn. The employer must also consider the period of time during which the respirator will be used by employees during a work shift. Breakthrough times for different chemicals can vary greatly, and are dependent on the concentrations of contaminants in the workplace air, patterns of respirator use, and environmental factors including temperature and humidity. A respirator that provides adequate protection for one chemical may be inadequate for another chemical with a different breakthrough time. In addition, employees wearing respirators for longer periods of time may need respirators that impose the minimum possible physical burden.

6. Work activities and stress. The work activities of employees while wearing respirators are also a factor. Heavy work that is physically draining may affect an employee's capability of wearing certain types of respirators. Temperature and humidity conditions in the workplace may also affect the physical/psychological stress level associated with wearing a respirator, as well as the effectiveness of respirator filters and cartridges. These types of factors must be assessed in selecting the appropriate equipment for a particular work situation.

7. Fit testing. Some employees may be unable to achieve an adequate fit with certain respirator models or a particular type of respirator – such as half-mask air-purifying respirators – so an alternative respirator model with an adequate fit or other type of respirator that provides adequate protection must be used. Therefore, it is necessary for employers to provide a sufficient number of respirator models and sizes from which employees can choose an acceptable respirator that fits correctly.

8. Physical characteristics, functional capabilities, and limitations of respirators. The last category of information to be considered when selecting respiratory protection is the physical characteristics, functional capabilities, and limitations of the respiratory protection equipment itself. Respirators selected must not impair the worker's vision, hearing, communication, and physical movement necessary to perform jobs safely. For example, airline respirators should not be used by mobile employees around moving machinery to avoid entanglement of the respirator in the equipment.

B. Selection. Once the above factors have been taken into account, the employer must select a NIOSH-certified respirator. Where NIOSH has not specifically certified any respirator for use against the particular contaminant present in the workplace, the employer must select a NIOSH-certified respirator that has no limitation prohibiting its use for that contaminant. The respirator must be appropriate for the contaminant's physical form and chemical properties and the conditions under which it will be used. All respirators must be chosen and used

according to the limitations of the NIOSH certification, which appears on the NIOSH certification label.

C. Assigned protection factors. Until such time as OSHA addresses the issue of assigned protection factors (APF's), employers may rely on APF's published by NIOSH and ANSI. Where there are conflicts between the NIOSH and ANSI APF's, the employer should apply the more protective APF.

D. Warning system. When an air-purifying respirator is selected for protection against gases and vapors, a system must be in effect that will reliably warn respirator wearers of contaminant breakthrough. These systems are: a respirator equipped with an end-of-service life indicator (ESLI) certified by NIOSH for the contaminant, or an established and enforced cartridge/ canister change schedule that is based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life.

E. Atmospheres requiring highest level of protection. For atmospheres that are immediately dangerous to life and health (IDLH), the highest level of respiratory protection and reliability is required. These atmospheres, by definition, are the most dangerous environments in which respirators are used. In these atmospheres, there is no tolerance for respirator failure. Consequently, only the following respirators must be provided and used: full-facepiece pressure demand self-contained breathing apparatus (SCBA) certified for a minimum service life of thirty minutes, or a combination full-facepiece pressure demand supplied-air respirator (SAR) with an auxiliary self-contained air supply.

VI. MEDICAL EVALUATION

A. Overview. Persons assigned to tasks that require the use of a respirator must be physically able to perform the work while using the respirator. Accordingly, employers have the responsibility of ensuring that employees are medically fit to tolerate the physical and psychological stress imposed by respirator use, as well as the physical stress originating from job and workplace conditions.

Employees must be medically evaluated and found eligible to wear the respirator selected for their use prior to fit testing or first-time use of the respirator in the workplace. Medical eligibility is to be determined by a physician or other licensed health care professional (referred to as a "PLHCP"). A variety of qualified health care providers, besides physicians, including occupational health nurses, nurse practitioners, and physician assistants, can perform the medical evaluations provided they are licensed to do so in the state in which they practice.

B. Questionnaire. In assessing the employee's medical eligibility to use a respirator, the PLHCP must perform a medical evaluation using a medical questionnaire (Appendix C to 1910.134) or provide a medical examination that obtains the same information as the medical questionnaire. The medical evaluation must be administered confidentially and at a time and place, during working hours, that is convenient to the employee. Employers are free to provide respirator users with a medical examination in lieu of the medical questionnaire if they chose to do so, but they are not required by the standard to administer a medical examination unless the employee gives a positive response to specific questions on the questionnaire.

C. Medical factors and conditions. The purpose of a medical evaluation program is to determine if employees can tolerate the physiological burden associated with respirator use, including: the burden

imposed by the respirator itself (e.g., its weight and breathing resistance during both normal operation and under conditions of filter, canister, or cartridge overload); musculoskeletal stress (e.g., when the respirator to be worn is a SCBA); limitations on auditory, visual, and olfactory sensations; and isolation from the workplace environment. Since certain jobs and workplace conditions in which a respirator is used can also impose a physiological burden on the user, the medical evaluation must also consider the following factors: type and weight of the respirator to be worn; duration and frequency of respirator use; expected physical work effort; use of protective clothing and equipment to be worn; and temperature and humidity extremes that may be encountered. This information must be provided to the PLHCP before the PLHCP makes a recommendation regarding an employee's ability to use a respirator.

The medical evaluation is designed to identify general medical conditions that place employees who use respirators at risk of serious medical consequences. Medical conditions known to compromise an employee's ability to tolerate respirator-, job-, and workplace-related physiological stress include: cardiovascular and respiratory diseases (e.g., a history of high blood pressure, angina, heart attack, cardiac arrhythmias, stroke, asthma, chronic bronchitis, emphysema); reduced pulmonary function caused by other factors (e.g., smoking or prior exposure to respiratory hazards); neurological or musculoskeletal disorders (e.g., ringing in the ears, epilepsy, lower back pain); impaired sensory function (e.g., perforated ear drums, reduced or absent ability to smell); and psychological disorders (e.g., claustrophobia and severe anxiety).

D. Standard of evaluation. The employer must obtain a written recommendation from the PLHCP on whether the employee is medically able to wear a respirator. The recommendation must identify any limitations on the employee's use of the respirator, as well as the need for follow-up medical evaluations that are needed to assist the PLHCP in making a recommendation. The employee must also receive a copy of the PLHCP's written recommendations. A powered air-purifying respirator (PAPR) must be provided to an employee if information from the medical evaluation indicates that the employee can use a PAPR but not a negative pressure respirator. If, subsequent to this evaluation, the PLHCP determines that the employee is able to wear a negative pressure respirator, the employer is no longer required to provide a PAPR to that employee.

The standard also requires the employer to medically re-evaluate an employee when:

- That employee reports medical signs or symptoms that are related to the employee's ability to use a respirator;
- A PLHCP, supervisor, or the respirator program administrator observes that the employee is having a medical problem during respirator use and they inform the employer of their observation;
- Information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee re-evaluation;
- A change occurs in workplace conditions (e.g., physical work effort, type of respirator used, protective clothing, temperature) that may result in a substantial increase in the physiological burden placed on an employee.

VII. FIT TESTING.

It has long been recognized that respirators must fit properly to provide protection. To obtain adequate respiratory protection, there must be a proper match between respirator and wearer. Respirators that don't seal properly around the face offer only the illusion of protection. To accommodate the variability of face size characteristics among individuals, a number of manufacturers offer facepieces in several sizes and models.

A. Purpose. The primary purpose of fit testing is to identify the specific make, model, style, and size of respirator best suited for each employee. In addition, fit testing also provides an opportunity to check on problems with respirator wear, and reinforces respirator training by having wearers review the proper methods of donning and wearing the respirator.

B. Requirement. Fit testing is required for all negative or positive pressure tight-fitting facepiece respirators. The OSHA respiratory protection standard requires that fit testing be performed before an employee first starts wearing a respirator in the work environment, whenever a different respirator facepiece is used, and at least annually thereafter.

C. Method. Prior to the actual fit test, the employee must be shown how to put on a respirator, position it on the face, set strap tension, and determine an acceptable fit. Next, the employee must be allowed to choose a respirator from a sufficient number of models and sizes so that the employee can find an acceptable and correctly fitting respirator. Once an acceptable respirator has been found – which takes into account the position of the mask on the face, nose, and cheeks; room for eye protection; and room to talk – a user seal check must be conducted (refer to on "Use of Respirators").

D. Types of fit testing. Fit testing may either be qualitative (QLFT) or quantitative (QNFT), and must be administered using an OSHA-accepted QLFT or QNFT protocol. These protocols are described in mandatory Appendix A to 1910.134. Prior to the commencement of the fit test, the employee must be given a description of the fit test and a description of the exercises that he or she will be performing during fit testing. The respirator to be tested must be worn for at least five minutes before the start of the fit test. The employee must be fit tested with the same make, model, style, and size of respirator that will be used in the workplace.

1. Qualitative fit testing (QLFT). Qualitative fit testing involves the introduction of a gas, vapor, or aerosol test agent into an area around the head of the respirator user. A determination is then made as to whether or not the wearer can detect the presence of the test agent through means such as odor, taste, or nasal irritation. If the presence of the test agent is detected inside the mask, the respirator fit is considered to be inadequate.

   There are four qualitative fit test protocols approved in OSHA's standard. The isoamyl acetate (IAA) test determines whether a respirator is protecting a user by questioning whether the user can smell the distinctive odor of IAA. Both the saccharin and BitrexTM tests involve substances with distinctive tastes that should not be detected through an effective respirator. The irritant smoke (e.g., stannic chloride) test involves a substance that elicits an involuntary irritation response in those exposed to it.

   Before conducting a qualitative test, the worker must undergo a sensitivity test to determine if he or she can taste, smell or react to the substance. When performing the isoamyl acetate test, the protocol requires that separate rooms be used for the odor screening and fit tests, and that the rooms be sufficiently ventilated to ensure that there is no detectable odor

of IAA prior to a test being conducted. This will prevent olfactory fatigue among workers being fit tested by preventing a buildup of IAA in the general room air.

2. Quantitative fit testing (QNFT). In a quantitative fit test, the adequacy of respirator fit is assessed by numerically measuring the amount of leakage into the respirator. This testing can be done by either generating a test aerosol as a test atmosphere, using ambient aerosol as the test agent, or using controlled negative pressure (CNP) to measure the volumetric leak rate. Appropriate instrumentation is required to quantify respirator fit.

E. Fit test exercises. The following test exercises must be performed for all fit testing methods described in the OSHA standards, except the CNP method which has its own fit testing exercise regimen:

1. Normal breathing in a normal standing position, without talking;
2. Deep breathing in a normal standing position, breathing slowly and deeply, taking precaution not to hyperventilate;
3. Turning the head slowly from side to side, while standing in place, with the employee holding his/her head momentarily at each extreme so that the employee can inhale at each side;
4. Moving the head up and down slowly, while standing in place, inhaling in the up position when looking toward the ceiling;
5. Talking out loud slowly, reading from a prepared text such as the Rainbow Passage (see Appendix A of the standard), counting backward from 100, or reciting a memorized poem or song;
6. Grimacing by smiling or frowning (only for QNFT testing);
7. Bending at the waist as if to touch toes (jogging in place can be done when the fit test enclosure doesn't permit bending at the waist); and
8. Normal breathing (as described above).

Each test exercise must be performed for one minute, except for the grimace exercise which must be performed for 15 seconds. The respirator must not be adjusted once the fit test exercises begin. Any adjustment voids the test, and the fit test must be repeated.

The employee must perform exercises in the test environment while wearing any applicable safety equipment that may be worn during actual respirator use and that could interfere with respirator fit. If the employee exhibits breathing difficulty during the fit test, he or she must be referred to a physician or other licensed health care professional to determine whether the employee can wear a respirator while performing his or her duties.

F. Retesting. If the employee finds the fit of the respirator unacceptable, he or she must be given a reasonable opportunity to select a different respirator and to be retested. In addition, retesting is required whenever an employee reports, or the employer, PLHCP, supervisor, or program administrator observe changes in an employee's physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes (e.g., wearing new dentures), cosmetic surgery, or an obvious change in body weight.

VIII. USE OF RESPIRATORS.

A. Conditions. Once the respirator has been properly selected and fitted, it is necessary to ensure that the respirator is used properly in the workplace. The following conditions may compromise the effective use of the respirator and jeopardize worker protection: facepiece seal leakage; removing the respirator at the wrong times in hazardous atmospheres; not properly performing user seal checks; or not properly repairing defective parts. In these circumstances, there is the danger that employees may have a false sense of security in feeling that they are protected when they are not.

The employer must also be aware of the conditions in the work areas where employees are using respirators. Employers are required to routinely evaluate workplace conditions, the degree of employee exposure, and physical stress so that they can provide additional or different respiratory protection when necessary. By observing respirator use under actual workplace conditions, employers can note problems such as changes in the fit of a respirator due to the use of other protective equipment, or conditions leading to skin irritation.

B. Facepiece seal protection.

1. Seal of tight-fitting respirators and valve function. The employer must not permit respirators with tight-fitting facepieces to be worn by employees who have conditions that would compromise the facepiece-to-face seal. Examples of these conditions include facial hair that interferes with the facepiece seal or valve function, absence of normally worn dentures, facial deformities (e.g., scars, deep skin creases, prominent cheekbones), or the use of jewelry or headgear that projects under the facepiece seal.

2. Corrective glasses or goggles. Corrective glasses or goggles, or other personal protective equipment, must be worn in such a way that they do not interfere with the seal of the facepiece to the face. Since eye glasses or goggles may interfere with the seal of half-facepieces, it is strongly recommended that full-facepiece respirators be worn where either corrective glasses or eye protection is required, since corrective lenses can be mounted inside a full-facepiece respirator. In addition, the full-facepiece respirator may be more comfortable, and less cumbersome, than the combination of a half-mask and chemical goggles. OSHA's current standard on respiratory protection, unlike the previous one, allows the use of contact lenses with respirators where the wearer has successfully worn such lenses before.

3. User seal check. A user seal check (formerly known as a fit check) must be performed every time a tight-fitting respirator is put on or adjusted to ensure proper seating of the respirator to the face. The user seal check conducted must be either the positive and/or negative pressure checks described in Appendix VIII:2-2 of this chapter, or the manufacturer's recommended procedures (when equally protective). If the employee fails the user seal check test, another facepiece must be selected.

The employee must not have any hair growth (e.g., beard stubble, sideburns, or beard) that comes between the sealing surface of the respirator facepiece and the face, as well as hair that interferes with valve function, or any other condition that might interfere with the face-to-facepiece seal such as jewelry or facial makeup. The user seal check must be used for all respirators on which such checks are possible. If a user seal check cannot be performed on a tight-fitting respirator, the OSHA standard prohibits that respirator from being used.

C. Continuing respirator effectiveness.

1. Skin or eye irritation. Skin or eye irritation can result from wearing a respirator in hot, humid conditions, as well as in contaminated environments. Such irritation can be distressing to workers, causing them to remove or adjust the respirator, or to refrain from wearing the respirator altogether. Therefore, to prevent skin or eye irritation associated with respirator use, employees must be permitted to leave the respirator use area to wash their faces and respirator facepieces as needed.

2. Filter, canister, and cartridge elements for air-purifying respirators. Whenever the respirator user can detect vapor or gas breakthrough (by odor, taste, and/or irritation effects), a change in breathing resistance or leakage of the facepiece, the worker must be allowed to leave the respirator use area to replace the respirator or the filter, cartridge, or canister elements. Similarly, employees must be permitted to leave the respirator use area if they are replacing cartridge or canister elements according to a change schedule, or when the end-of-service-life indicator shows that the canister or cartridge(s) must be changed.

3. Repair, disposal, and replacement of Respirators. Since respirators must be in good working condition to function, it is imperative that they not be used if they have been impaired in any way. Impairments include a broken strap, loss of respirator shape, and a face seal that can no longer be maintained. Therefore, respirators that are not properly functioning must be replaced, repaired, or discarded. The respirator manufacturers can supply replacement parts for damaged parts on elastomeric respirators. Only when the respirator has been replaced or repaired can the employee return to the respirator use area.

D. Immediately dangerous to life or health (IDLH) atmospheres. Atmospheres are IDLH when they pose an immediate threat to life, would cause irreversible adverse health effects, or would interfere with an individual's ability to escape from a dangerous atmosphere. Care must be exercised in these situations since failure of the respirator to provide the appropriate protection may result in serious injury or death. Consequently, the employer must develop and implement specific procedures for the use of respirators in IDLH atmospheres that include the following provisions:

1. At least one employee (referred to as the "standby employee") is to be located outside the IDLH atmosphere and maintain visual, voice, or signal line communication with the employee(s) in the IDLH atmosphere;

2. The standby employee(s) located outside the IDLH atmosphere must be trained and equipped to provide effective emergency rescue;

3. The employer or authorized designee is to be notified before the standby employees(s) enter the IDLH atmosphere to provide emergency rescue;

4. The employer or authorized designee, once notified of such entry, must provide the necessary assistance appropriate to the situation;

5. Standby employee(s) must be equipped with pressure demand or other positive pressure SCBA, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA; and

6. Standby employee(s) must be equipped with appropriate retrieval equipment for lifting or removing the employee from the hazardous atmosphere, or, when such retrieval equipment cannot be used because it would increase the overall risk resulting from entry, ensure that

equivalent provisions for rescue have been made.

E. Interior structural firefighting. In the ultra-hazardous situation of interior structural firefighting, firefighters must operate using a buddy system. Safeguards that may be adequate for well-controlled and well-characterized IDLH situations are not adequate in the uncontrolled and unpredictable situation characterized by a burning building. Therefore, in addition to the above safeguards for IDLH atmospheres, the following requirements apply to interior structural fire fighting:

1. Two or more firefighters must always be sent in together and remain in visual or voice contact with one another at all times;
2. At least two standby personnel are to be located outside the fire area;
3. All personnel engaged in interior structural firefighting must use SCBA.

The "two-in/two-out" requirement does not take effect until firefighters begin to perform interior structural fire fighting. While the fire is in the incipient stage (as determined by the commander or other person in charge), or when emergency rescue operations are required before the entire team has assembled, the standard does not require two-member teams inside and outside the structure.

IX. MAINTENANCE AND CARE.

A. Requirements. The OSHA standard requires that employers provide each respirator user with a respirator that is clean, sanitary, and in good working order. These requirements are a vital part of any successful respiratory protection program. To ensure that the respirator remains serviceable and delivers effective protection, a maintenance program must be in place prior to respirator use.

The OSHA respirator standard strongly emphasizes the importance of a good maintenance program, but permits its tailoring to the type of facilities, working conditions, and hazards involved. However, all programs are required to include at least:

- Cleaning and disinfecting procedures;
- Proper storage;
- Regular inspections for defects (including leak check); and
- Repair methods.

In addition to the OSHA requirements, the manufacturer's instructions for inspection, cleaning, and maintenance of respirators should be consulted to ensure that the respirator continues to function properly. A proper maintenance program ensures that the worker's respirator remains as effective as when it was new.

B. Cleaning and disinfecting.

1. Cleaning and sanitizing respirators are necessary to prevent skin irritation, dermatitis, and to encourage worker acceptance. Where the contaminant is a dust, mist, or fume, build-up on the respirator face-to-facepiece seal or within the respirator will reduce the protection provided by the respirator because the contaminant is in the breathing zone or has compromised the seal. In addition, the build-up of contamination on the respirator can contribute to the deterioration of the respirator's materials, which can lead to reduced protection. Full facepieces must be cleaned to ensure that employees can see through the facepiece.
2. Respirators that are issued for the exclusive use of an employee must be cleaned and disinfected as often as necessary to be maintained in a sanitary condition. Respirators used by more than one employee must be cleaned and disinfected prior to being used by a different individual. Respirators maintained for emergency use as well as respirators used in fit testing and training, must be cleaned and disinfected after each use. The employer must use either the OSHA cleaning and disinfecting procedures

recommended in Appendix VIII:2-3 of this chapter or the procedures recommended by the respirator manufacturer, as long as they are equivalent in effectiveness to the OSHA method.

C. Storage.

1. All respirators must be stored so that they are protected against damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals. When respirators are packed or stored, the facepiece and exhalation valve must be stored in a manner that will prevent deformation. Each respirator should be positioned so that it retains its natural configuration. Synthetic materials and even rubber will warp if stored in an unnatural shape, thus affecting the fitting characteristics of the facepiece.

2. Respirators intended for emergency use must be kept accessible to the work area, but not in an area that might itself be involved in the emergency because such an area may become contaminated or inaccessible. Emergency-use respirators must be stored in compartments or covers that are clearly marked to indicate that they contain emergency respirators, and stored according to any applicable manufacturer instructions.

D. Inspection. To ensure the continued reliability of respiratory equipment, it must be inspected on a regular basis. The frequency of inspection and the procedures to be followed depend on whether the respirator is intended for non-emergency, emergency, or escape use only.

1. The OSHA standard requires that all respirators used in non-emergency situations be inspected before each use and during cleaning. Respirators designated for use in an emergency situation are to be inspected at least monthly and in accordance with the manufacturer's instructions, and checked for proper function before and after each use. Emergency escape-only respirators must be inspected before being carried into the workplace.

2. For all respirators, inspections must include a check of respirator function, tightness of connections, and the condition of the various parts including, but not limited to, the facepiece, head straps, valves, connecting tube, and cartridges, canisters, or filters. In addition, the elastomeric parts must be evaluated for pliability and signs of deterioration.

3. For SCBAs, which require monthly inspections, the air and oxygen cylinders must be maintained in a fully charged state and recharged when the pressure falls to 90% of the manufacturer's recommended pressure level. In addition, the regulator and warning devices must be inspected to ensure that they function properly.

4. For respirators that are maintained for use in emergencies, the OSHA standard requires certifying the respirator by documenting the date that the inspection was performed, the name or signature of the inspector, the findings of the inspection, any required remedial action, and a serial number or other means of identifying the inspected respirator. This information must be provided on a tag or label that is attached to the storage compartment for the respirator, is kept with the respirator, or is stored in the form of inspection reports (paper or electronic). The information must be maintained until it is replaced following a subsequent certification.

E. Repair. Respirators that fail to pass inspection or are otherwise found to be defective, must be removed from service, and discarded, repaired, or adjusted. Repairs or adjustments to respirators

must be done only by appropriately trained personnel, using only the respirator manufacturer's NIOSH-approved parts designed for that respirator. The repairs also must be made in accordance with the manufacturer's recommendations and specifications regarding the type and extent of repairs to be performed. Because components such as reducing and admission valves, regulators, and alarms are complex and essential to the safe functioning of the respirator, they are required to be adjusted and repaired only by the manufacturer or a technician trained by the manufacturer.

X. BREATHING AIR QUALITY AND USE.

A. Standards and specifications.

1. Breathing air for atmosphere-supplying respirators must be of high purity, meet quality levels for content, and not exceed certain contaminant levels and moisture requirements. Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration must be in accordance with the following requirements:

   - Compressed and liquid oxygen must meet the United States Pharmacopoeia for medical or breathing oxygen.
   - Compressed breathing air must meet at least the requirements for Grade D breathing air as described in the ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989.

2. Compressed oxygen must not be used in atmosphere-supplying respirators, including open circuit SCBA's, that have previously used compressed air. This prohibition is intended to prevent fires and explosions that could result if high-pressure oxygen comes into contact with oil or grease that has been introduced to the respirator or the air lines during compressed-air operations. Also, oxygen in concentrations >23.5% can only be used in equipment designed for oxygen service or distribution.

3. Breathing air may be supplied to respirators from cylinders or air compressors. Where cylinders are used, they must be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR parts 173 and 178). Cylinders of purchased breathing air must have a certificate of analysis from the supplier stating that the air meets the requirements for Grade D breathing air. The moisture content of the compressed air in the cylinder cannot exceed a dew point of -50°F (-45.6°C) at 1 atmosphere pressure. This requirement prevents respirator valves from freezing, which can occur when excess moisture accumulates on the valves. All breathing gas containers must be marked in accordance with the NIOSH Respirator Certification Standard, 42 CFR part 84.

A. Other specific requirements.

1. Where compressors are used for supplying air, the compressor must be constructed and situated so contaminated air cannot enter the air-supply system. The location of the air intake is very important, and must be in an uncontaminated area where exhaust gases from nearby vehicles, the internal combustion engine that is powering the compressor itself (if applicable), or other exhaust gases being ventilated from the plant will not be picked up by the compressor air intake.

2. In addition, compressors must be equipped with suitable in-line, air-purifying sorbent beds and filters to further ensure breathing air quality, and to minimize moisture content so that the dew point at 1 atmosphere pressure is 10°F (5.56°C) below the ambient temperature. Sorbent beds and filters must be maintained and

replaced or refurbished periodically according to the manufacturer's recommendations, and a tag must be kept at the compressor indicating the most recent change date and the signature of the person authorized by the employer to perform the change.

3. For compressors that are not oil-lubricated, the employer must ensure that carbon monoxide levels do not exceed 10 ppm. This requirement can be met by several different methods, including the use of continuous carbon monoxide alarms, carbon monoxide sorbent materials, proper air intake location in an area free of contaminants, frequent monitoring of air quality, or the use of high-temperature alarms and automatic shutoff devices, as appropriate. Employers have flexibility in selecting the method(s) most appropriate for conditions in their workplace. Since no single method will be appropriate in all situations, several methods may be needed. For example, it may be necessary to combine the use of a carbon monoxide alarm with a carbon monoxide sorbent bed where conditions are such that a reliable carbon monoxide-free area for air intake cannot be found.

4. Oil-lubricated compressors can produce carbon monoxide if the oil enters the combustion chamber and is ignited. This problem can be particularly severe in older compressors with worn piston rings and cylinders. Consequently, if an oil-lubricated compressor is used, it must have a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. If only a high-temperature alarm is used, the air from the compressor must be tested for carbon monoxide at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm.

5. Breathing air couplings must be incompatible with outlets for non-respirable plant air or other gas systems to prevent accidental servicing of air line respirators with non-respirable gases or oxygen. Also, no asphyxiating substance must be allowed in the breathing air lines.

XI. PROGRAM LOGISTICS.

A. Identification of filters, cartridges, and canisters. The employer must ensure that all filters, cartridges, and canisters used in the workplace are labeled and color coded with the NIOSH approval label, and ensure that the label is not removed and remains legible.

B. Training and information.

1. Employee training is an important part of the respiratory protection program and is essential for correct respirator use. The OSHA respiratory protection standard requires employers to provide training before the employee uses a respirator in the workplace. For the training to be effective, the training information must be comprehensive and presented in an understandable way.

2. Employers should develop training programs based upon the employees' educational level and language background. Such an approach will ensure that all employees receive training that enables them to maximize the effectiveness of the respirators they use. As a result of this training, the employee will be able to understand the operation of the respirator and demonstrate the ability to properly use the respirator.

3. Employee training must include a discussion of why the use of the respirator is necessary. Such training would address the identification of the hazards involved, the extent of employee exposures to those hazards, and the potential health effects of such exposures.

4. Information regarding the consequences of improper fit, usage, or maintenance on respirator effectiveness must also be provided to employees. Inadequate attention to any of these program elements would obviously defeat the effectiveness of the respirator. Proper fit, usage, and maintenance of respirators are critical to ensure employee protection.

5. Employees must also be provided with an explanation of the limitations and capabilities of the respirator selected for employee use. A discussion of the limitations and capabilities of the respirator must address how the respirator operates. This training would include, for example, an explanation of how the respirator provides protection by either filtering the air, absorbing the vapor or gas, or providing clean air from an uncontaminated source. Where appropriate, it should include limitations on the use of the equipment, such as prohibitions against using an air-purifying respirator in IDLH atmospheres and an explanation of why such a respirator should not be used in these situations.

6. Employees must also know how to use the respirator effectively in emergency situations, including those in which the respirator malfunctions. Comprehensive training is necessary where respirators are used in IDLH situations, including oxygen-deficient atmospheres such as those that occur in fire fighting, rescue operations, and confined-area entry.

7. Training must include the procedures for inspecting the respirator, donning and removing it, checking the fit and respirator seal, and actually wearing the respirator. Employees must also be capable of recognizing any problems that may threaten the respirator's continued protective capability. The training must include the steps employees must follow if they discover problems during inspection, i.e., to whom problems are to be reported and where to get replacement equipment, if necessary.

8. Instructions must be given to respirator users regarding the proper procedures for maintenance and storage of respirators. The extent of training may vary according to workplace conditions. In some cases, where employees are responsible for performing some or all respirator maintenance and for storing respirators while not in use, detailed training in maintenance and storage procedures may be necessary. In other facilities, where specific personnel or central repair facilities are assigned to perform these tasks, most employees may need to be informed only of the maintenance and storage procedures without having to learn detailed technical information. By providing this training, respirator users will be able to identify respirator deficiencies that can result from improper maintenance and storage of respirators so that they will not use improperly functioning respirators.

9. The training program must also provide employees with medical information that is sufficient for them to recognize the signs and symptoms of medical conditions (e.g., shortness of breath, dizziness) that may limit or prevent the effective use of respirators. Employee knowledge of this information is important to ensure implementation of a successful respirator program.

10. In addition to specific training requirements regarding the proper use of respirators, employees must be informed of the general requirements of the OSHA respiratory protection standard. This discussion could simply inform employees that employers are obligated to develop a written program, properly select respirators,

evaluate respirator use and correct deficiencies in use, conduct medical evaluations, provide for the maintenance, storage, and cleaning of respirators, and retain and provide access to specific records. Thus, employees will know in general what the employer's obligations are under the standard with respect to employee protection.

11. At a minimum, annual training is required by the OSHA respiratory protection standard. With few exceptions, a new employee must be provided with respirator training prior to using a respirator in the workplace. OSHA believes that annual training is necessary and appropriate to ensure that employees know about the respiratory protection program and that they cooperate and actively participate in the program. Training and interaction with respirator instructors on at least an annual basis reinforces employee knowledge about the correct use of respirators and other pertinent elements of the respiratory protection program. It also builds employee confidence when using respirators.

12. Under some conditions, additional training will be required to supplement the annual training. Circumstances which require additional training include situations where changes in the workplace (e.g., process changes, increase in exposure, emergence of new hazards) or the type of respirator used by the employee render previous training obsolete. Additional training is also required when the employee has not retained the requisite understanding or skill to use the respirator properly, or when any other situation arises in which retraining appears necessary.

C. Program evaluation.

1. The employer must conduct evaluations of the workplace as necessary to ensure that the provisions of the current written respirator program are being properly implemented for all employees required to use respirators. In addition, evaluations must be conducted to ensure the continued effectiveness of the program. Evaluations of the workplace determine whether the correct respirators are being used and worn properly, and will also serve to determine whether the training program is effective.

2. The employer must regularly consult with employees wearing respirators to ascertain the employees' views on program effectiveness and to identify any problems. This assessment must determine if the respirators are properly fitted. It must also evaluate whether: employees are able to wear the respirators without interfering with effective workplace performance; respirators are correctly selected for the hazards encountered; respirators are being worn when necessary; and respirators are being maintained properly. The employer must correct any problems associated with wearing a respirator that are identified by employees, or that are revealed during any other part of this evaluation.

D. Recordkeeping. The OSHA respiratory protection standard requires the employer to establish and retain written information regarding medical evaluations, fit testing, and the respirator program. This information will promote employee involvement in the respirator program, assist the employer in auditing the adequacy of the program, and provide a record for compliance determinations by OSHA.

1. The employer must retain a medical evaluation record for each employee subject to medical evaluation. This record is to include the result of the medical questionnaire and, if applicable, a copy of the PLHCP's

written opinion and recommendations, including the results of relevant medical examinations and tests. Records of medical evaluations must be retained and made available as required by 29 CFR §1910.1020, OSHA's Access to Employee Exposure and Medical Records rule.

2. Fit test records must be retained for respirator users until the next fit test is administered. These records consist of:
   - Name or identification of the employee tested;
   - Type of fit test performed (QLFT, QNFT – irritant smoke, saccharin, etc.);
   - Make, model, and size of the respirator fitted;
   - Date of the fit test;
   - Pass/fail results if a QLFT is used; or
   - Fit factor and strip chart recording or other record of the test results if quantitative fit testing was performed.
3. If the employee's use of a respirator is discontinued (e.g., because of a change of duties or successful implementation of engineering controls), fit test records need not be retained for the employee. Fit test records must be maintained to determine whether annual fit testing has been done, and whether the employee who was tested passed the QLFT, or passed the QNFT with a fit factor that was appropriate for the type of respirator being used.
4. All written materials required to be maintained under the recordkeeping requirements must be made available, upon request, to the employee who is subject of the records and to the Assistant Secretary for OSHA or designee for examination and copying.

E. NIOSH guidelines for the selection and use of particulate respirators. In June 1995, NIOSH updated and modernized the Federal Regulation for certifying air-purifying particulate respirators [42 CFR part 84]. As a consequence of this new regulation, NIOSH developed a User's Guide to familiarize respirator users with the new Part 84 certification regulations for particulate respirators, and to provide guidance for the selection and use of the new particulate respirators. The new regulation became effective on July 10, 1995, and replaces 30 CFR part 11 under which NIOSH and the Mine Safety and Health Administration (MSHA) jointly certified respirators before that date. Respirators certified under this new regulation are tested under much more demanding conditions than under the old regulation to provide increased worker protection. See Appendix VIII:2-4 of this chapter for a summary of the NIOSH Guide to the Selection and Use of Particulate Respirators Certified Under 42 CFR §84.

Appendix Viii: 2-1. Glossary.

Air-purifying respirator a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Assigned protection factor (APF) [reserved]

Atmosphere-supplying respirator a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SAR's) and self-contained breathing apparatus (SCBA) units.

Canister or cartridge a container with a filter, sorbent, or catalyst, or a combination of these items, that removes specific contaminants from the air passed through the container.

Demand respirator an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

Emergency situation any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled substantial release of an airborne contaminant.

Employee exposure an exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

End-of-service-life indicator (ESLI) a system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective.

Escape-only respirator a respirator intended to be used only for emergency exit.

Filtering facepiece (dust mask) a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Filter or air purifying element a component used in respirators to remove solid or liquid aerosols from the inspired air.

Fit factor a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit test the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. See also "Qualitative fit test (QLFT)" and "Quantitative fit test (QNFT)."

Helmet a rigid respiratory inlet covering that also provides head protection against impact and penetration.

High efficiency particulate air (HEPA) filter a filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter and larger. The equivalent NIOSH 42 CFR part 84 particulate filters are the N100, R100, and P100 filters.

Hood a respiratory inlet covering that completely covers the head and neck, and may also cover portions of the shoulders and torso.

Immediately dangerous to life or 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.

Interior structural firefighting the physical activity of fire suppression, rescue or both, within buildings or enclosed structures involved in a fire situation beyond the incipient stage.

Loose-fitting facepiece a respiratory inlet covering that is designed to form a partial seal with the face.

Maximum use concentration (MUC) [reserved]

Negative pressure respirator (tight fitting) a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Oxygen deficient atmosphere an atmosphere with an oxygen content below 19.5% by volume.

Physician or other licensed health care professional (PLHCP) an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by 29 CFR 1910.134(e), "Medical evaluation."

Positive-pressure a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Powered air-purifying respirator (PAPR) an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Pressure demand respirator a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

Qualitative fit test (QLFT) a pass/fail fit test to assess the adequacy of respiratory fit that relies on the individual's response to the test agent.

Quantitative fit test (QNFT) an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Respiratory inlet covering the portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source, or both. It may be a facepiece, helmet, hood, suit, or a mouthpiece respirator with nose clamp.

Self-contained breathing apparatus (SCBA) an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Service life the period of time that a respirator, filter or sorbent, or other respiratory equipment provides adequate protection to the wearer.

Supplied-air respirator (SAR) or airline respirator an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Tight-fitting facepiece a respiratory inlet covering that forms a complete seal with the face.

User seal check an action conducted by the respirator user to determine if the respirator is properly seated to the face.

Appendix Viii:2-2. User Seal Check.

A. Facepiece Positive and/or Negative Pressure Checks

Positive Pressure Check

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

Negative Pressure Check

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

B. Manufacturer's Recommended User Seal Check Procedures

The respirator manufacturer's recommended procedures for performing a user seal check may be used instead of the positive and/or negative pressure check procedures, provided that the employer demonstrates that the manufacturer's procedures are equally effective in detecting seal leakage compared to the positive pressure and negative pressure checks described above.

Appendix Viii: 2-3. Recommended Procedures for Cleaning Respirators.

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

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

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

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

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

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

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

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

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

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

Appendix Viii: 2-4. NIOSH Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR §84.

Summary for Respirator Users

Appendix Viii: 2-2. User Seal Check.

This summary presents a brief overview of what the respirator user needs to know about the new categories of particulate respirators certified by the National Institute for Occupational Safety and Health (NIOSH).

NIOSH has developed a new set of regulations in 42 CFR §84 (also referred to as "Part 84") for testing and certifying nonpowered, air-purifying, particulate-filter respirators. The new Part 84 respirators have passed a more demanding certification test than the old respirators (e.g., dust and mist [DM], dust, fume and mist [DFM], spray paint, pesticide, etc.) certified under 30 CFR §11 (also referred to as "Part 11").

Changes in the new regulations involve only nonpowered, air-purifying, particulate-filter respirators. Certification requirements for all other classes of respirators (e.g., chemical cartridges, self-contained breathing apparatus [SCBA], airlines, gas masks without a particulate filter, powered air-purifying respirators [PAPR's] equipped with high efficiency particulate air [HEPA] filters, etc.) have been transferred to Part 84 without change. Until further notice, the Occupational Safety and Health Administration (OSHA) is allowing the continued use of Part 11 particulate-filter respirators. Under Part 84, NIOSH is allowing manufacturers to continue selling and shipping Part 11 particulate filters as NIOSH-certified until July 10, 1998.

The new Part 84 regulation provides for nine classes of filters (three levels of filter efficiency, each with three categories of resistance to filter efficiency degradation). The three levels of filter efficiency are 95%, 99%, and 99.97%. The three categories of resistance to filter efficiency degradation are labeled N, R, and P. The class of filter will be clearly marked on the filter, filter package, or respirator box. For example, a filter marked N95 would mean an N-series filter that is at least 95% efficient. Chemical cartridges that include particulate filter elements will carry a similar marking that pertains only to the particulate filter element.

Filter efficiency is the stated percentage of particles removed from the air. Filter efficiency degradation is defined as a lowering of filter efficiency or a reduction in the ability of the filter to remove particles as a result of workplace exposure.

The new classes of nonpowered particulate respirators require new decision logic for selection of the proper respirator. The selection process for using the new particulate classification is outlined as follows and is discussed in Section II of NIOSH Guide to the Selection and Use of Particulate Respirators Certified Under 42 CFR §84:

1. The selection of N-, R-, and P-series filters depends on the presence or absence of oil particles, as follows:

   - If no oil particles are present in the work environment, use a filter of any series (i.e., N-, R-, or P-series).
   - If oil particles (e.g., lubricants, cutting fluids, glycerine, etc.) are present, use an R-or P-series filter.

Note: N-series filters cannot be used if oil particles are present.

- If oil particles are present and the filter is to be used for more than one work shift, use only a P-series filter.
  Note: To help you remember the filter series, use the following guide:

  N for Not Resistant to oil

  R for Resistant to oil

  P for Oil-Proof

2. Selection of filter efficiency (i.e., 95%, 99%, or 99.97%) depends on how much filter leakage can be accepted. Higher filter efficiency means lower filter leakage.

3. The choice of facepiece depends on the level of protection needed — that is, the assigned protection factor (APF) needed.

Call 1-800-35-NIOSH (1-800-356-4674) for additional information or for free single copies of the complete document NIOSH Guide to the Selection and Use of Particulate Respirators Certified Under 42 CFR §84 [DHHS (NIOSH) Publication No. 96-101].

NIOSH is the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, U.S. Department of Health and Human Services.

TOXICOLOGY AND EXPOSURE GUIDELINES

Student Performance Objectives

Upon completion of this unit, students will be able to:

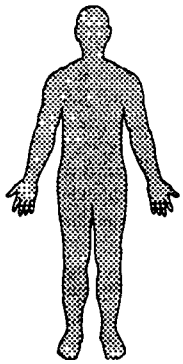
1. Describe basic toxicology and exposure guidance terms.

TOXICOLOGY AND EXPOSURE GUIDELINES

EXPOSURE GUIDELINES

Routes of entry:

- Inhalation
- Skin contact
- Eye contact
- Ingestion
- Injection



TOXICOLOGY AND EXPOSURE GUIDELINES

DURATION OF ADVERSE HEALTH EFFECTS

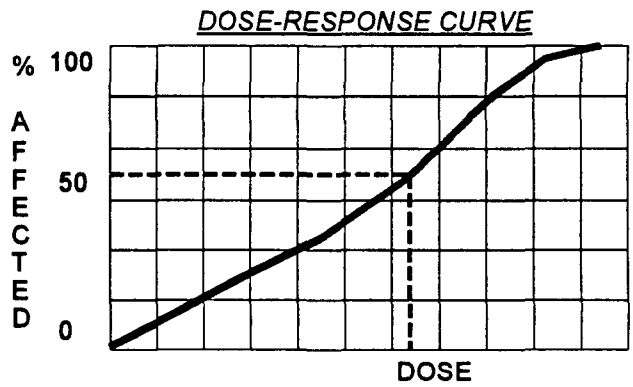
Acute Symptoms	Immediate
Chronic Symptoms	Long term
Symptoms	Observable without warning signs

TOXICOLOGY AND EXPOSURE GUIDELINES

All things are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.

Paracelsus (1493? -1541)

TOXICOLOGY AND EXPOSURE GUIDELINES



TOXICOLOGY AND EXPOSURE GUIDELINES

Factors that influence the toxic effect of substances:

- Route of exposure
- Duration and frequency of exposure
- Personal characteristics
- Chemical interactions

TOXICOLOGY AND EXPOSURE GUIDELINES

Adverse health effects:

- Local effects
- Systemic effects
- Asphyxiation
  - Simple
  - Chemical

TOXICOLOGY AND EXPOSURE GUIDELINES

Adverse health effects (cont.):

- Sensitization
- Teratogenic
- Mutagenic
- Carcinogenic

TOXICOLOGY AND EXPOSURE GUIDELINES

Lethal Dose 50% (LD_{50})

The dose of a substance which is:

Expected to cause the death of 50% of a defined experimental animal population.

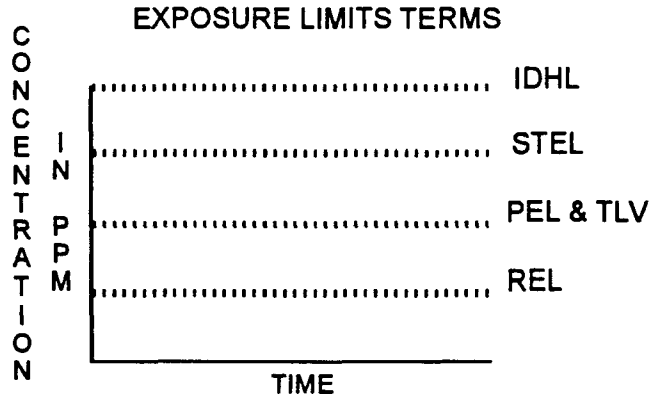
TOXICOLOGY AND EXPOSURE GUIDELINES

EXPOSURE LIMIT TERMS

Permissible Exposure Limit OSHA	PEL
Threshold Limit Value ACGIH	TLV
Recommended Exposure Limit NIOSH	REL
Short Term Exposure Limit	STEL
Ceiling	C

TOXICOLOGY AND EXPOSURE GUIDELINES

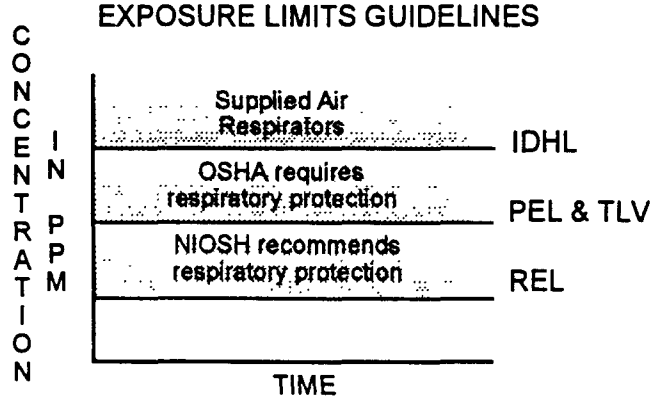
EXPOSURE LIMITS TERMS



NIOSH RELs

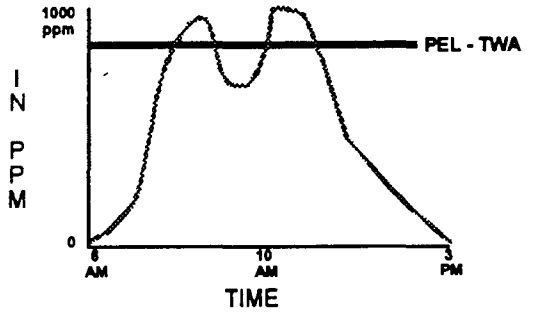
TOXICOLOGY AND EXPOSURE GUIDELINES

EXPOSURE LIMITS GUIDELINES



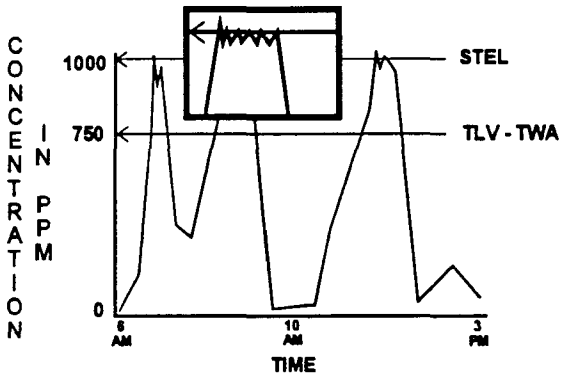
TOXICOLOGY AND EXPOSURE GUIDELINES

EXPOSURE LIMITS GUIDELINES (cont.)



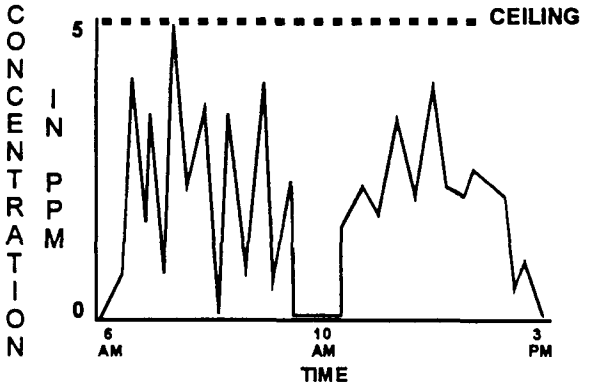
TOXICOLOGY AND EXPOSURE GUIDELINES

EXPOSURE LIMITS GUIDELINES (cont.)



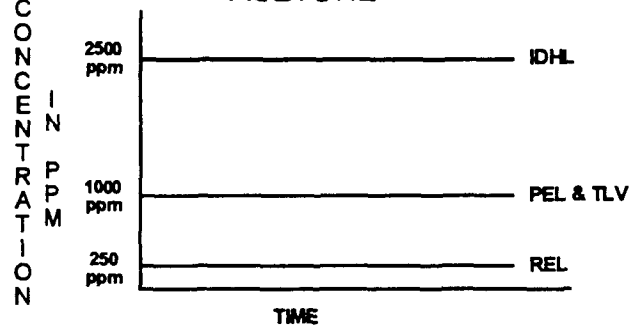
TOXICOLOGY AND EXPOSURE GUIDELINES

EXPOSURE LIMITS GUIDELINES (cont.)



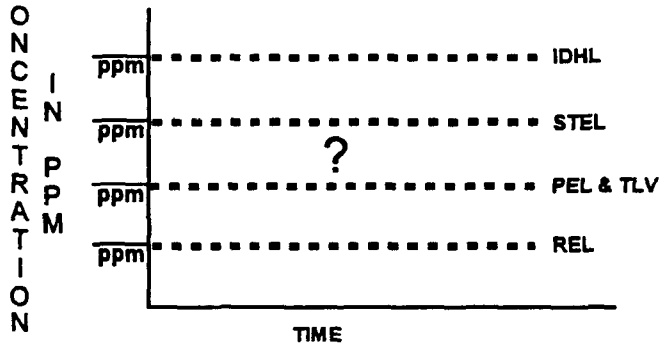
TOXICOLOGY AND EXPOSURE GUIDELINES
EXPOSURE LIMITS GUIDELINES (cont.)

ACETONE



TOXICOLOGY AND EXPOSURE GUIDELINES
EXPOSURE LIMITS GUIDELINES (cont.)

ACETIC ACID



TOXICOLOGY AND EXPOSURE GUIDELINES

IDLH Exposure:

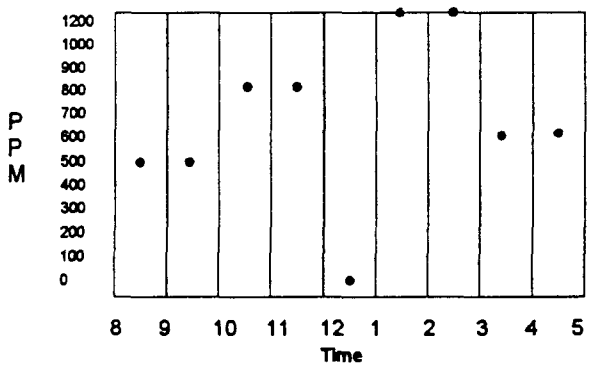
- IDLH exposure likely to cause:
  - Immediate/delayed permanent adverse health effects or death
- Based on NIOSH Pocket guide IDLH definitions

TOXICOLOGY AND EXPOSURE GUIDELINES

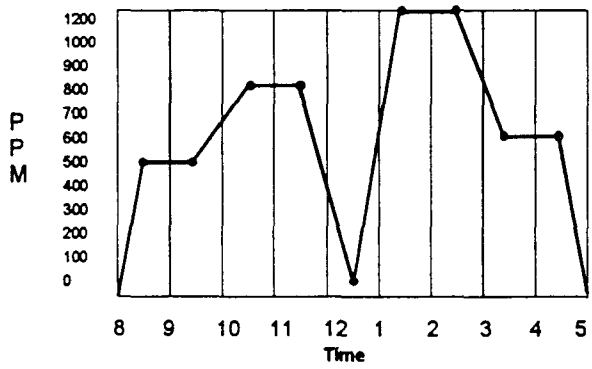
IDLH Exposure (cont.):

- IDLH based on 10% LEL for some chemicals
- Example: acetone
  - IDLH for acetone is 2500 ppm
  - 10% of LEL for acetone is 2500 ppm

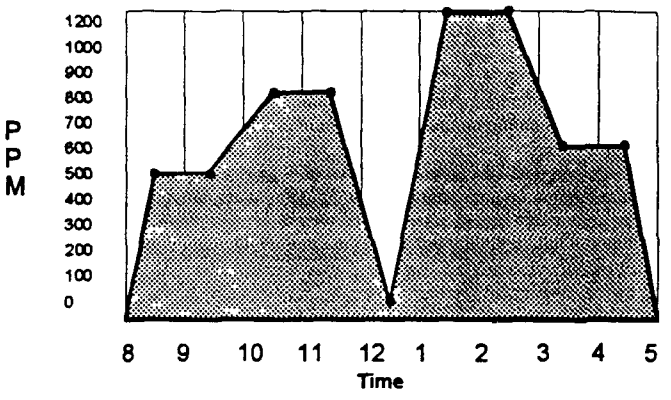
TOXICOLOGY AND EXPOSURE GUIDELINES



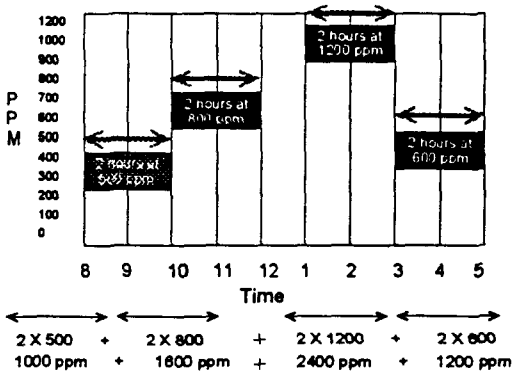
TOXICOLOGY AND EXPOSURE GUIDELINES



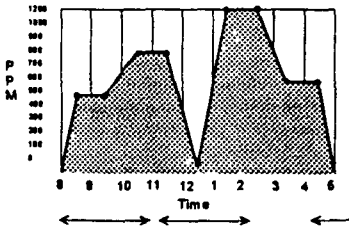
TOXICOLOGY AND EXPOSURE GUIDELINES



TOXICOLOGY AND EXPOSURE GUIDELINES



TOXICOLOGY AND EXPOSURE GUIDELINES



Step 1 → 2 X 500 + 2 X 800 + 2 X 1200 + 2 X 600
time X concentration

Step 2 → 1000 ppm + 1600 ppm + 2400 ppm + 1200 ppm
add concentration
= 6200 ppm

Step 3 → $\frac{6200 \text{ ppm}}{8}$ = 775 ppm TWA
divide by 8 hours

TOXICOLOGY AND EXPOSURE GUIDELINES

Question:

A worker exposure is 775 ppm averaged over 8 hours. If the product is acetone, has the worker exceeded the OSHA-PEL for acetone?

Conversion Chart: PPM % LEL

PERCENT ACETONE VAPORS IN AIR	PPM OF ACETONE IN AIR 10,000 PPM=1%	PPM OF NITROGEN AND OTHER TRACE GASES	PERCENT OF NITROGEN AND OTHER TRACE GASES	PPM OF OXYGEN IN AIR	PERCENT OXYGEN IN AIR	PERCENT LEL FOR ACETONE
12.8	128,000	690,624.0	69.06	181,376.	18.14	UEL
2.5	25,000	772,200.0	77.2	202,800.	20.3	100.0
1.0	10,000	784,080.0	78.4	205,920.	20.6	40.0
0.5	5,000	788,040.0	78.8	206,960.	20.7	20.0
0.25	2,500	790,020.0	79.0	207,480.	20.75	10.0
0.2	2,000	790,416.0	79.04	207,584.	20.76	8.0
0.1	1,000	791,208.0	79.12	207,792.	20.78	4.0
0.025	250	791,802.0	79.18	207,948.	20.795	1.0
0.01	100	791,920.8	79.192	207,979.2	20.798	0.4
0.0025	25	791,980.2	79.198	207,994.8	20.7995	0.1
0.001	10	791,992.08	79.1992	207,997.92	20.7998	0.04
0.0001	1	791,999.792	79.19992	207,999.208	20.79998	0.004
0.0	0	792,000.0	79.2	208,000.	20.8	0.

TOXICOLOGY

1. Employees at hazardous waste sites may be exposed to a number of toxic chemicals with dangerous properties. Most sites have several contaminants in multiple compartments (soil, water, air) which present several exposure scenarios.

2. Preventing exposure to toxic chemicals is a primary concern at any site. Protective clothing and respirators help prevent the wearer from contamination, and good work practices and engineering controls help reduce contamination on protective clothing, instruments, and equipment.

3. However, contamination can occur even with these safeguards. It is important to identify the chemical hazards that exist at a site, and to take steps to prevent contamination.

4. Chemical exposures are generally divided into two categories: acute and chronic. Symptoms resulting from acute exposures usually occur during and shortly after exposure to a high concentration of a contaminants. A chronic exposure usually occurs at a low concentration over a long period of time. Lethal concentrations vary with each chemical. The symptoms of an acute exposure for a given contaminant may be completely different from those resulting from a chronic exposure to the same contaminant.

5. For chronic and acute exposures, the toxic effect may be temporary and reversible or permanent (causing disability or death). Although some chemicals cause obvious symptoms (e.g., burning, nausea, rashes), others may cause health damage without any warning signs (e.g., cancer, respiratory disease). Some toxic chemicals may be colorless and/or odorless, may dull the sense of smell, or may not produce immediate or obvious physiological sensation. A worker's senses or feelings cannot be relied upon in all cases to warn of toxic exposures.

6. The primary routes of chemical contamination are as follows:

   A. Inhalation is an exposure route of concern because the lungs are extremely vulnerable to chemical agents. Respiratory protection should be used if there is any possibility that the site may contain hazardous substances that can be inhaled. Chemicals can also enter the respiratory tract through punctured eardrums.

   B. Direct contact of the skin and eyes is another route of exposure to hazardous substances. Some chemicals will directly injure the skin; some may pass through the skin into the bloodstream where they are transported to vulnerable organs. This absorption is enhanced by abrasions, cuts, heat, and moisture. Workers can protect against direct contact of a hazardous chemical by wearing PPE, refraining from use of contact lenses in contaminated atmospheres, keeping hands away from the face, and minimizing contact with liquid and solid chemicals.

   C. Ingestion occurs when chemicals are accidentally swallowed.

   D. Injection can occur when chemicals are introduced into the body through puncture wounds, such as those caused by stepping or tripping or falling onto contaminated sharp objects. To protect against this type of exposure, the site should be prepared and workers should wear safety shoes, avoid physical hazards, and take common sense precautions.

DIRECT-READING INSTRUMENTS

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Describe air monitoring instruments used to measure hazardous atmospheres on Superfund sites.

DIRECT READING INSTRUMENTS

MONITORING FOR HAZARDOUS ATMOSPHERES

- Flammable and explosive vapors and gases
- Toxic vapors and gases
- Oxygen deficiency
- Radiation

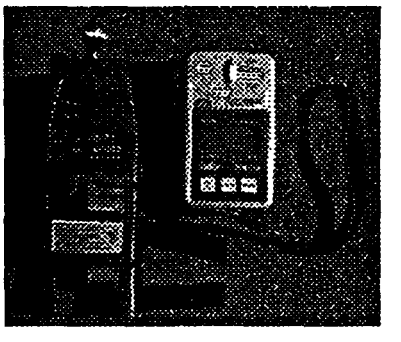
OBJECTIVES

- Evaluate potential of exposure to hazardous substances
- Identify and quantify airborne contaminants
- Selection of PPE and levels of protection
- Define work zones
- Identify medical monitoring needs

DIRECT READING INSTRUMENTS

- Combustible gas indicators
- Oxygen monitors
- Toxic vapors and gases monitors
- Radiation monitors

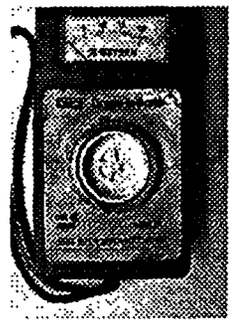
COMBUSTIBLE GAS INDICATORS



COMBUSTIBLE GAS INDICATORS (cont.)

- Wheatstone bridge
- Measures % Lower Explosive Limit (LEL)
- May not identify specific flammable vapor/gas
- Needs more than 10% oxygen to work

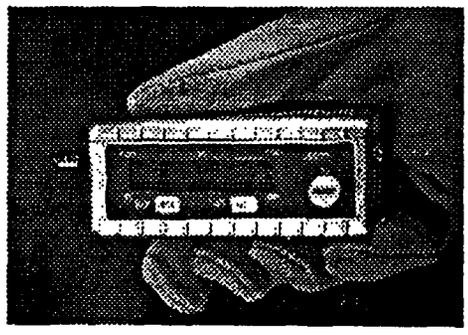
OXYGEN METERS



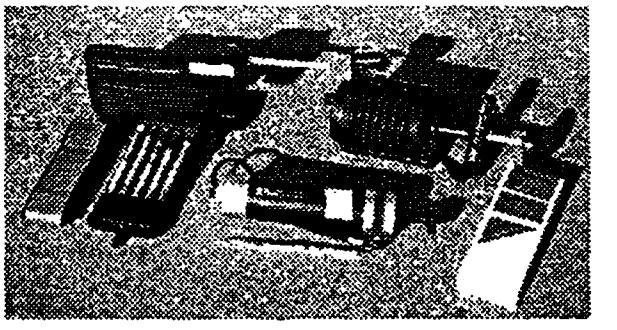
OXYGEN METERS (cont.)

- Passive or pump
- Action level
  - <19.5% – oxygen deficient
  - >25% – high oxygen (increase fire risk)

MONITORING FOR TOXIC CONTAMINANTS



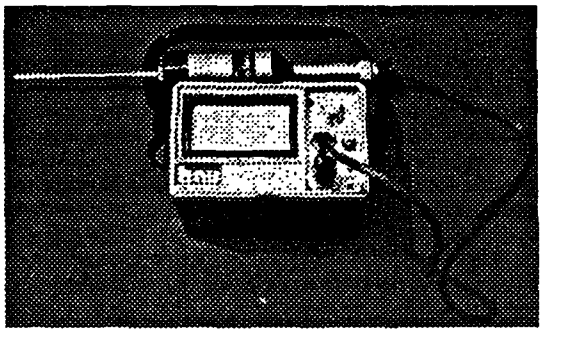
COLORIMETRIC TUBES



COLORIMETRIC TUBES (cont.)

- Pumps are manual or electric
- Accurate within +/-25%
- General vs. specific tubes

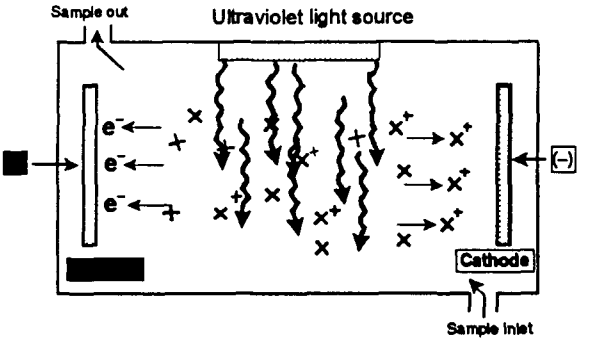
PHOTOIONIZATION INSTRUMENTS



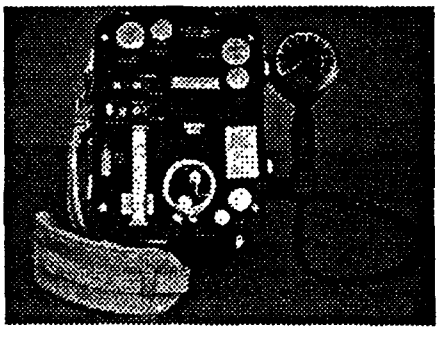
PHOTOIONIZATION INSTRUMENTS (cont.)

- Detects many organic and some inorganic gases and vapors
- Detects total concentration (non-specific)
- Sensitivity relates to Ionization Potential (IP) of compound to UV light

HOW DOES A PID WORK?



FLAME IONIZATION INSTRUMENTS

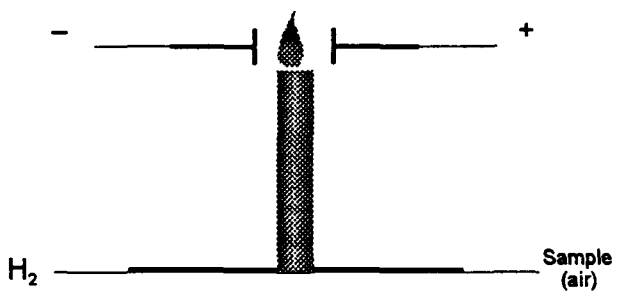


DEFINITIONS OF SAMPLE

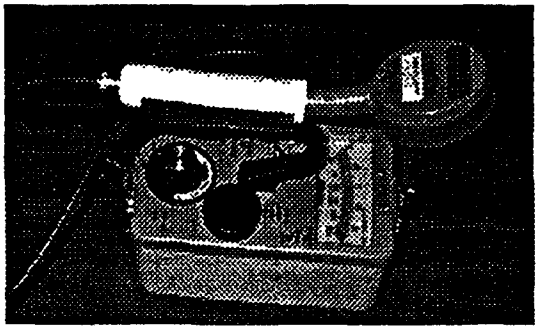
FLAME IONIZATION INSTRUMENTS (cont.)

- Detects many organic gases and vapors
- Detects total concentrations in survey mode
- Measures specific compounds in gas chromatograph mode

HOW DOES A FID WORK?



MONITORING FOR RADIATION



MONITORING FOR RADIATION (cont.)

- Monitor for three types of radiation
  - Gamma >1mr is
  - Beta
  - Alpha
- May require holding monitor very close to source
- Total dose vs. dose rate instruments

AIR SAMPLING

- Provides more complete information
- Provides data over lifetime of site
- Sorbent tubes and pumps for organic or inorganic
- Particulate filters
- Colorimetric tubes

PHOTOIONIZATION DETECTOR (PID)

EXERCISE 1:

- The PID in this exercise has a 10.2 eV probe
- Identify the correct ionization potential, based on the meter readings of the instrument
- Ignore the Relative Response and calibration

WHAT CHEMICAL HAS THE IP OF: A. 12.5

CHEMICAL NAME	ACTUAL CONCENTRATION	METER READING	IP
HEXANE	100 PPM	14	?
METHANE	100 PPM	0	?
TOLUENE	100 PPM	110	?
ACETONE	100 PPM	90	?

IONIZATION POTENTIALS

A. 12.5 C. 9.69

B. 10.18 D 8.82

WHAT CHEMICAL HAS THE IP OF: B. 10.18

CHEMICAL NAME	ACTUAL CONCENTRATION	METER READING	IP
HEXANE	100 PPM	14	?
METHANE	100 PPM	0	?
TOLUENE	100 PPM	110	?
ACETONE	100 PPM	90	?

IONIZATION POTENTIALS

A. 12.5 C. 9 69

B. 10 18 D. 8.82

WHAT CHEMICAL HAS THE IP OF: C. 9.69

CHEMICAL NAME	ACTUAL CONCENTRATION	METER READING	IP
HEXANE	100 PPM	14	?
METHANE	100 PPM	0	?
TOLUENE	100 PPM	110	?
ACETONE	100 PPM	90	?

IONIZATION POTENTIALS

A. 12.5 C 9.69

B 10 18 D. 8.82

WHAT CHEMICAL HAS THE IP OF: D. 8.82

CHEMICAL NAME	ACTUAL CONCENTRATION	METER READING	IP
HEXANE	100 PPM	14	?
METHANE	100 PPM	0	?
TOLUENE	100 PPM	110	?
ACETONE	100 PPM	90	?

IONIZATION POTENTIALS

A. 12.5 C. 9.69

B. 10.18 D. 8.82

PHOTOIONIZATION DETECTOR (PID)

EXERCISE 2:

- What is the ppm present in the air for each of the two chemicals listed below?

Chemical vapors present:

a. Acetone

b. Carbon Tetrachloride (CCl_4)

PHOTOIONIZATION DETECTOR (PID)

EXERCISE 2 (cont.):

- What is the concentration of CCl_4 and acetone?

Step 1:

Look up the IP

a. Acetone IP: 9.69

b. CCl_4 IP: 11.47

PHOTOIONIZATION DETECTOR (PID)

EXERCISE 2 (cont.):

Step 2:

Monitor the air with the following probes

PID with *11.7 eV* lamp meter reading: 100

PID with *10.2 eV* lamp meter reading: 20

PHOTOIONIZATION DETECTOR (PID)

EXERCISE 2 (cont.):

Step 3:

Find the difference

100 meter reading units with 11.7 eV probe
-20 meter reading units with with 10.2 eV probe

80 meter reading: CCl_4

The remaining meter reading units ppm is:
20 meter reading reading: acetone

PHOTOIONIZATION DETECTOR (PID)

EXERCISE 3:

- Can the meter reading for exercise #2 for acetone be expressed as ppm?

Direct Reading Instruments

1. Direct Reading Instrument Requirements.

   A. HAZWOPER requires air monitoring with direct reading instruments (DRIs) to be performed wherever the possibility of employee exposure to hazardous substances exists. Upon initial entry, representative air monitoring should be conducted to identify any Immediately Dangerous to Life and Health (IDLH) conditions, exposure over Permissible Exposure Limits (PELs), exposure over a radioactive material's dose limits, or other dangerous conditions, such as flammable or oxygen-deficient or enriched environments.

   B. Air monitoring should also be conducted to confirm that the area considered for the Support Zone is clean (i.e., does not contain concentrations of hazardous substances that require worker protection).

   C. The results of air monitoring will be used to evaluate medical monitoring requirements.

2. Types of Direct Reading Instruments (DRI).

   A. Combustible Gas Indicators (CGIs).

      (1). CGIs operate using the "Wheatstone Bridge" principle. The wheatstone bridge consists of two filaments, or beads, coated with a catalyst. However, only one of the filaments is heated, and this causes the combustion of the flammable vapors as they pass over the filament. The purpose of the catalyst coating on the filament is to cause combustion of the hydrocarbon molecules to occur at temperatures below what is normally required to produce combustion.

      (2). As combustion of hydrocarbon molecules on the surface of the catalyst increases, this causes an increase in temperature in the filament. The increase in temperature causes higher resistance to an electric current passing through the heated filament. As combustion does not take place on the surface of the non-heated filament, there is no associated resistance in current. This process results in an imbalance of current passing through the filaments, and the instrument reads this imbalance as percent Lower Explosive Limit (LEL).

      (3). CGIs measure the percent LEL. The LEL for a substance represents the concentration of ignitible vapors mixed with oxygen in the air that will ignite when exposed to an ignition source. When the percent LEL is 100% on the face of the CGI, this represents an ignitible atmosphere. A substance may produce enough ignitible vapors to displace oxygen.

      (4). In a condition where the fuel vapors are so concentrated that oxygen is displaced, ignition can not take place. This condition is an example of a fuel rich environment referred to as above the Upper Explosive Level (UEL). CGIs can not be considered accurate in conditions where less than approximately 18% oxygen is present. CGIs usually need a minimum of 10% oxygen to work.

      (5). CGIs are calibrated to a specific flammable vapor or gas. The presence of any flammable vapor or gas will cause the CGI to indicate a percent LEL on the meter face. However, the CGI can only be considered accurate when monitoring the substance that it is calibrated for. Reading for all other substances must be considered to be a relative response.

B. Oxygen Meters.

(1). Oxygen meters measure the percent oxygen in the atmosphere. Oxygen levels below 19.5% are considered oxygen deficient and oxygen levels above 25% are considered to be unsafe for Superfund site workers.

C. Colorimetric tubes and pumps.

(1). Colorimetric tubes are operated by attaching the tube to a pump. Most pumps are hand-aspirated. However, some of the newer colorimetric systems have electric pumps.

(2). Colorimetric tubes contain an "indicating chemical" that will turn color in the presence of specific contaminants. Contaminants with similar molecular structure may cause false color changes in the indicating chemical. The operation of colorimetric tubes requires the use of an operators manual that lists the types of contaminants that are known to cause false color changes.

(3). The operator of the colorimetric tube must look at the color stain on the tube and determine visually what the results are. Colorimetric tubes are considered to be +/- 25%

D. Photoionization Detectors (PID).

(1). PIDs use ultraviolet light to ionize the molecules of organic vapors and gases. PIDs will also ionize some inorganics. The PID uses a pump or fan to draw the atmosphere over the ultraviolet light. If the ultraviolet light radiation is strong enough to displace electrons on the molecule passing over the lamp, the molecule is left with an overall positive charge and can carry an electrical current. The ionized molecules are attracted to a charged plate near the lamp. As these ionized molecules accumulate on the charged plate, an increase in current through the plate occurs, and the PID interprets this increase in current as an indication of ppm on the meter face.

(2). Since the PID can ionize many organic compounds, it is considered to be a total vapor monitor. However, if only one substance is present, and the PID is calibrated to that substance, the results can be very accurate for that specific compound.

(3). Some PIDs have interchangeable probes with lamps of diferent IPs. The operator must know the ionization potential of the substance being monitored in order to select a lamp with sufficient ionization energy to ionize the substance.

E. Flame Ionization Detectors (FIDs).

(1). FIDs operate by drawing vapors and gases over a hydrogen gas flame. The hydrogen gas flame has a high enough temperature to ionize many organics. However, it is not used to ionize inorganics.

F. Radiation Monitoring Instruments.

(1). The primary radiation hazard on a Superfund site is gamma radiation. Gamma radiation is a highly penetrating form of electromagnetic radiation. Gamma radiation can pass through the Radiation Monitoring Instrument, and through the site worker.

(2). Beta particles are most commonly a negative charged electron that is ejected at high speed from a radioactive source. Beta particles only travel about one meter through air. Beta particles in contact with skin are penetrating enough to pass through a few layers of living tissue.

(3). Alpha particles consist of two positively charged protons and two neutrons that do not have an electrical charge. Alpha particles in contact with skin can not pass through the layers of dead skin cells that exist above the layers of living skin cells.

(4). Monitoring for beta or alpha particles will require holding the monitoring instrument very close to the surface being monitored.

(5). Types of Radiation Meters.

a. Exposure Rate Meters. Exposure Rate Meters monitor radiation as Roentgen (R/hr), milliroentgen (mR/hr), or microroentgen (μR/hr) per hour

b. Count Per Minute (CPM) Radiation Meters monitor μR/hr radiation by counting each ionizing event caused by the radiation passing through the instrument detector media.

c. Total Dose Radiation Meters. Total Dose Radiation Meters measure the total amount of radiation that the detector media was exposed to. As an example, if the Superfund site worker was exposed to 10 mR/hr for one hour, the total dose received would be 10 mR.

3. Identifying Airborne Contaminants.

A. The two methods generally available for identifying and/or quantifying airborne contaminants are: (1) on-site use of direct-reading instruments (DRIs); and (2) laboratory analysis of air samples obtained by gas sampling bag, filter, sorbent, or wet-contaminant collection methods.

B. DRIs may be used to quickly detect flammable or explosive atmospheres, oxygen deficiency, certain gases and vapors, and ionizing radiation, as well as to identify changing site conditions.

C. Because DRIs provide information at the time of monitoring sampling and allow for rapid decision-making, they are the primary tools of initial site characterization. All DRIs, however, have inherent limitations in their ability to detect hazards. DRIs detect and/or measure only specific classes of chemicals and usually are not designed to detect airborne concentrations below 1 ppm.

D. DRIs are usually calibrated to detect one particular substance. The presence of other substances result in inaccurate readings. DRIs must be operated, and their data interpreted, by qualified individuals using properly calibrated instruments. Additional monitoring and air sampling should be conducted at any location where a positive instrument response occurs in order to identify the substance.

4. Air Sampling.

A. To obtain more complete information about air contaminants, measurements obtained with DRIs should be supplemented with air sampling. To assess air contaminants more thoroughly, air sampling devices equipped with appropriate collection media should be placed at various locations throughout the area. These samples provide air quality information, and can indicate the presence and concentrations of contaminants over the lifetime of site operations. As data are obtained (from the analysis of samples, DRIs, and site operations), adjustments should be made in the type and number of samples, frequency of sampling, and analysis required. In addition to air samplers, area sampling stations may also include DRIs equipped with recorders and operated as continuous air monitors.

5. Sample Collection and Analysis.

   A. Samples are analyzed to determine types and quantities of substances present at a site. Good sources of information on collecting and analyzing samples for a variety of chemical substances include: (1) EPA's Compendium of Methods for Determination of Toxic Organic Compounds in Air, (2) the National Institute for Occupational Safety and Health's (NIOSH) Manual of Analytical Methods, (Volumes 1-3, 4th Edition); and (3) OSHA Analytical Methods. These references may be consulted for specific procedures.

Student Exercise

1. The "Wheatstone" Bridge Filament is a part of this instrument. _____
2. The PID produces this type of light. _____
3. You are sure that methane gas is present. However, the PID registers "0 ppm". What's the problem? _____
4. Although the indicator tube (colorimetric tube) can identify a chemical vapor, it has an accuracy of about +/-_____percent.
5. The "F" in FID means _____Ionization Detector.
   a. Flame
   b. Fast
   c. Fleeting
6. Your PID shows 10 ppm at 8:00 am on the first day of August. At 2:00 p.m. that same day the PID indicated 100 ppm at the same location. What may have caused the difference in these air monitoring results?

_____

_____

_____

DRI EXERCISE RESULTS

% LEL: _____

% OXYGEN: _____

COLORIMETRIC TUBE: _____

PID: _____

RADIATION METER: _____

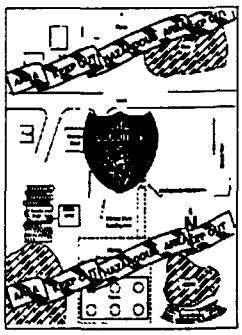
SITE CONTROL

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Describe the three work zones required on a Superfund site.

SITE CONTROL

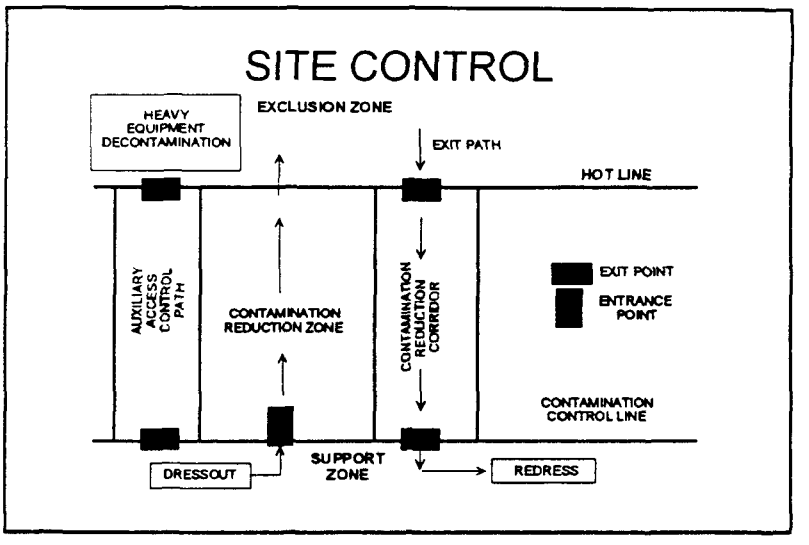


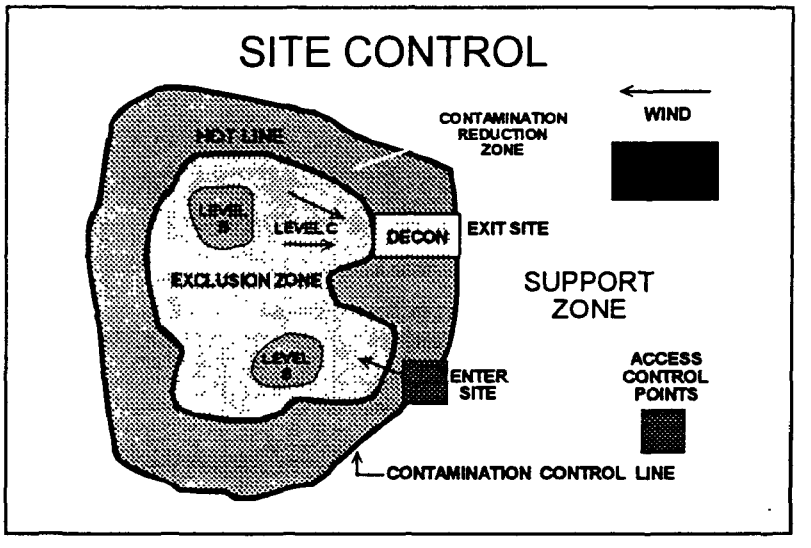
COMPONENTS

- Control personnel and equipment
- Minimize worker exposure
- Develop site map
- Establish work zones

WORK ZONES

- Exclusion zone
  - Hot line
- Contamination reduction zone
  - Contamination control line
- Support zone


SITE CONTROL
HEAVY EQUIPMENT DECONTAMINATION
EXCLUSION ZONE
EXIT PATH
HOT LINE
AUXILLIARY ACCESS CONTROL PATH
CONTAMINATION REDUCTION ZONE
CONTAMINATION REDUCTION CORRIDOR
EXIT POINT
ENTRANCE POINT
CONTAMINATION CONTROL LINE
DRESSOUT
SUPPORT ZONE
REDRESS


SITE CONTROL
HOT LINE
CONTAMINATION REDUCTION ZONE
WIND
LEVEL B
LEVEL C
DECON
EXIT SITE
EXCLUSION ZONE
SUPPORT ZONE
LEVEL B
ENTER SITE
ACCESS CONTROL POINTS
CONTAMINATION CONTROL LINE

SITE CONTROL

1. Requirements.

   A. As an essential element of the Health and Safety Plan (HASP), the site control program is used to control the activities and movement of people and equipment at hazardous waste sites in order to minimize the potential for worker exposure to hazardous substances. The provisions of 29 CFR §1910.120(d) require that an appropriate site control program be developed prior to the implementation of response operations.

   B. Although the degree of site control necessary for the protection of workers depends largely on site-specific characteristics (e.g., site size, nature of contamination, etc.), 29 CFR §1910.120(d)(3) identifies some essential elements of an effective site control program.

2. The Exclusion Zone.

   A. The Exclusion Zone is the area where contamination is either known or expected to occur and the greatest potential for exposure exists. The outer boundary of the Exclusion Zone (hot zone), is called the Hotline. The Hotline separates the area of contamination from the rest of the site.

3. The Contamination Reduction Zone (CRZ)

   A. As the transition area between the Exclusion Zone ("hot zone") and the Support Zone ("cold zone"), the CRZ is the area in which decontamination procedures take place. The purpose of the CRZ is to reduce the possibility that the Support Zone will become contaminated or affected by the site hazards.

   B. Because of both distance and decontamination procedures, the degree of contamination in the CRZ generally will decrease as one moves from the exclusion zone to the support zone.

   C. The Contamination Control Line marks the boundary between the CRZ and the support zone and separates the clean areas of the site from those areas used to decontaminate workers and equipment (i.e., partially contaminated areas).

4. The Support Zone.

   A. The Support Zone (cold zone) is the uncontaminated area where workers are unlikely to be exposed to hazardous substances or dangerous conditions. The Support Zone is the appropriate location for the command post, medical station, equipment and supply center, field laboratory, and any other administrative or support functions that are necessary to keep site operations running efficiently.

   B. Because the Support Zone is free from contamination, personnel working within it may wear normal work clothes, and access to and from the area is not restricted to authorized site personnel. Any potentially contaminated clothing, equipment, and samples must remain outside of the Support Zone until decontaminated. However, all personnel located in the Support Zone must receive instruction in the proper evacuation procedures in case of a hazardous substance emergency.

PERSONAL PROTECTIVE EQUIPMENT

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Identify the components of a full face Air Purifying Respirator.
2. Identify the four levels of protection discussed in this module.

PERSONAL PROTECTIVE EQUIPMENT

OBJECTIVES

- Protect workers from safety hazards
  - Fire
  - Noise
  - Injury

OBJECTIVES (cont.)

- Protect workers from health hazards
- Toxic hazards
- Radiation hazards
- Biological hazards

FACTORS TO DETERMINE LEVELS OF PROTECTION

- Identification of hazards
  - Known and unknown
- Routes of entry
- Performance of Personal Protective Equipment (PPE) materials

PERSONAL PROTECTIVE EQUIPMENT

Level of Protection (A-D)

Level	Respiratory Protection	Chemical Suit
A	Supplied air	Gas tight suit
B	Supplied air	Splash suit
C	Air purifying respirator	Splash suit
D	None	None

PERSONAL USE FACTORS

- Facial hair
- Spectacle kits
- Personal hygiene

EQUIPMENT LIMITATIONS

- Permeation
- Degradation
- Penetration
- Storage and maintenance

TRAINING

- Familiarize worker with PPE
- Instill confidence
- Increase proficiency of PPE use
- Develop awareness of advantages and disadvantages of PPE.

RESPIRATOR FIT TEST

- Facepiece to face seal
- Isoamyl acetate protocol
- Saccharin protocol
  - Solution/aerosol protocol
- Irritant fume protocol
- Rainbow passage

PERSONAL PROTECTIVE EQUIPMENT

1. Key Selection Factors

   A. As required by Hazardous Waste Operations and Emergency Response (HAZWOPER), Personal Protective Equipment (PPE) must protect employees from the specific hazards they are likely to encounter on-site. Selection of the appropriate PPE is a complex process that should take into consideration a variety of factors. Key factors should include: (1) identification of the hazards or suspected hazards; (2) potential exposure routes (e.g., inhalation, skin absorption, etc.); and (3) the performance of the PPE materials and seams in providing a barrier to these hazards.

2. Levels of Protection

   A. Level A: Is the highest level of protection. Level A is required when the greatest potential for exposure to hazards exists, and when the greatest level of skin, respiratory, and eye protection is required. The following are examples of appropriate Level A equipment: positive pressure, full face-piece self-contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA; totally-encapsulating chemical-protective suit; inner and/or outer chemical-resistant gloves; and disposable protective suit, gloves, and boots.

   B. Level B: Is required under circumstances requiring the highest level of respiratory protection, with a lesser level of skin protection. Potential Level B equipment includes: positive pressure, full face-piece SCBA or positive pressure supplied air respirator with escape SCBA; inner and/or outer chemical-resistant gloves; face shield; hooded chemical resistant clothing; coveralls; and outer chemical-resistant boots.

      (1) Level B is the minimum level of protection for initial site entry.

   C. Level C: Is required when the concentration and type of airborne substances is known, and the criteria for using air purifying respirators is met. Typical Level C equipment includes: full-face air-purifying respirators, inner and outer chemical-resistant gloves, hard hat, escape mask, and disposable chemical-resistant outer boots.

   D. Level D: Is the lowest level of protection. Appropriate Level D protective equipment may include: gloves, coveralls, safety glasses, face shield, and chemical-resistant steel-toe boots or shoes. Level D protection is primarily a work uniform. This protection is sufficient under the following conditions: No contaminants are present; or Work operations preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

3. Personal Use Factors and Equipment Limitations

   A. Certain personal features of workers may jeopardize safety during equipment use. Prohibitive or precautionary measures should be taken as necessary for the following personal features:

   B. <u>Facial hair and long hair</u> that passes between the face and the sealing surface of the respirator should be prohibited because it interferes with respirator fit and wearer vision, allowing excessive contaminant penetration. Long hair must be effectively contained within protective hair coverings.

   C. <u>Eyeglasses</u> with conventional temple pieces will interfere with the respirator-to-face seal of a full face-piece. A spectacle kit should be installed in the face masks of workers requiring vision correction, providing a gas-tight seal. Contact lenses may trap contaminants

and/or particulate between the lens and the eye, causing irritation.

4. Training and Fit Testing

   A. Site workers should be trained in the proper use of protective equipment prior to using any PPE on-site. The purpose of training is to: (1) become familiar with the equipment in a nonhazardous situation; (2) instill confidence and awareness in the user of the limitations and capabilities of the equipment; (3) increase the operating and protective efficiency of PPE use; and (4) reduce maintenance expenses.

   B. The fit testing of the respirator begins with the facepiece-to-face seal of a respirator to the worker's face. The fit test is performed to ensure a tight seal; every facepiece does not fit every wearer. Certain features, such as scars, very prominent cheekbones, deep skin creases, dentures or missing teeth, and the chewing of gum and tobacco may interfere with the respirator-to-face seal. Under conditions where these features may impede a good seal, a respirator must not be worn.

   C. For a qualitative respirator fit testing protocol, see 29 CFR 1910.134 Appendix A. For specific quantitative testing protocols, literature supplied by manufacturers of quantitative fit testing equipment should be consulted.

Excerpt from:
OSHA Technical Manual
SECTION VIII: CHAPTER 1

I. CHEMICAL PROTECTIVE CLOTHING

A. Introduction

1. The purpose of chemical protective clothing and equipment is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered during hazardous materials operations. During chemical operations, it is not always apparent when exposure occurs. Many chemicals pose invisible hazards and offer no warning properties.

2. These guidelines describe the various types of clothing that are appropriate for use in various chemical operations, and provides recommendations in their selection and use. The final paragraph discusses heat stress and other key physiological factors that must be considered in connection with protective clothing use.

3. It is important that protective clothing users realize that no single combination of protective equipment and clothing is capable of protecting you against all hazards. Thus protective clothing should be used in conjunction with other protective methods. For example, engineering or administrative controls to limit chemical contact with personnel should always be considered as an alternative measure for preventing chemical exposure. The use of protective clothing can itself create significant wearer hazards, such as heat stress, physical and psychological stress, in addition to impaired vision, mobility, and communication. In general, the greater the level of chemical protective clothing, the greater the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as under-protection can be hazardous and should be avoided.

II. DESCRIPTIONS

A. Protective Clothing Applications

Protective clothing must be worn whenever the wearer faces potential hazards arising from chemical exposure. Some examples include:

1. Emergency response;
2. Chemical manufacturing and process industries;
3. Hazardous waste site cleanup and disposal;
4. Asbestos removal and other particulate operations; and
5. Agricultural application of pesticides.
6. Within each application, there are several operations which require chemical protective clothing. For example, in emergency response, the following activities dictate chemical protective clothing use:

   a. Site Survey: The initial investigation of a hazardous materials incident; these situations are usually characterized by a large degree of uncertainty and mandate the highest levels of protection.

   b. Rescue: Entering a hazardous materials area for the purpose of removing an exposure victim; special considerations must be given to how the selected protective clothing may affect the

ability of the wearer to carry out rescue and to the contamination of the victim.

c. Spill Mitigation: Entering a hazardous materials area to prevent a potential spill or to reduce the hazards from an existing spill (i.e., applying a chlorine kit on railroad tank car). Protective clothing must accommodate the required tasks without sacrificing adequate protection.

d. Emergency Monitoring: Outfitting personnel in protective clothing for the primary purpose of observing a hazardous materials incident without entry into the spill site. This may be applied to monitoring contract activity for spill cleanup.

e. Decontamination: Applying decontamination procedures to personnel or equipment leaving the site; in general a lower level of protective clothing is used by personnel involved in decontamination.

7. The clothing ensemble. The approach in selecting personal protective clothing must encompass an "ensemble" of clothing and equipment items which are easily integrated to provide both an appropriate level of protection and still allow one to carry out activities involving chemicals. In many cases, simple protective clothing by itself may be sufficient to prevent chemical exposure, such as wearing gloves in combination with a splash apron and face shield (or safety goggles).

   The following is a checklist of components that may form the chemical protective ensemble:

   a. Protective clothing (suit, coveralls, hoods, gloves, boots);
   b. Respiratory equipment (SCBA, combination SCBA/SAR, air purifying respirators);
   c. Cooling system (ice vest, air circulation, water circulation);
   d. Communications device;
   e. Head protection;
   f. Eye protection;
   g. Ear protection;
   h. Inner garment;
   i. Outer protection (overgloves, overboots, flashcover)

8. Factors that affect the selection of ensemble components include:

   a. How each item accommodates the integration of other ensemble components. Some ensemble components may be incompatible due to how they are worn (e.g., some SCBA's may not fit within a particular chemical protective suit or allow acceptable mobility when worn).
   b. The ease of interfacing ensemble components without sacrificing required performance (e.g. a poorly fitting overglove that greatly reduces wearer dexterity).
   c. Limiting the number of equipment items to reduce donning time and complexity (e.g. some communications devices are built into SCBA's which as a unit are NIOSH certified).

B. Level of Protection

Table VIII:1-1 lists ensemble components based on the widely used EPA Levels of Protection: Levels A, B, C, and D. These lists can be used as the starting point for ensemble creation; however, each ensemble must be tailored to the specific situation in order to provide the most appropriate level of protection. For example, if an emergency response activity involves a highly contaminated area or if the potential of contamination is high, it may be advisable to wear a disposable covering such as Tyvek® coveralls or PVC splash suits, over the protective ensemble.

TABLE VIII:1-1. EPA LEVELS OF PROTECTION

Level A:

Vapor protective suit (meets NFPA 1991) Pressure-demand, full-face SCBA, Inner chemical-resistant gloves, chemical-resistant safety boots, two-way radio communication.

Optional: Cooling system, outer gloves, hard hat

Protection Provided: Highest available level of respiratory, skin, and eye protection from solid, liquid and gaseous chemicals.

Used When: The chemical(s) have been identified and have high level of hazards to respiratory system, skin and eyes. Substances are present with known or suspected skin toxicity or carcinogenity. Operations must be conducted in confined or poorly ventilated areas.

Limitations: Protective clothing must resist permeation by the chemical or mixtures present. Ensemble items must allow integration without loss of performance.

Level B:

Liquid splash-protective suit (meets NFPA 1992)

Pressure-demand, full-facepiece SCBA, Inner chemical-resistant gloves, chemical-resistant safety boots, two-way radio communications, Hard hat.

Optional: Cooling system, outer gloves

Protection Provided: Provides same level of respiratory protection as Level A, but less skin protection. Liquid splash protection, but no protection against chemical vapors or gases.

Used When: The chemical(s) have been identified but do not require a high level of skin protection. Initial site surveys are required until higher levels of hazards are identified. The primary hazards associated with site entry are from liquid and not vapor contact.

Limitations: Protective clothing items must resist penetration by the chemicals or mixtures present. Ensemble items must allow integration without loss of performance.

Level C:

Support Function Protective Garment (meets NFPA 1993) Full-facepiece, air-purifying, canister-equipped respirator Chemical resistant gloves and safety boots Two-way communications system, hard hat

Optional: Face shield, escape SCBA, Protection Provided: The same level of skin protection as Level B, but a lower level of respiratory protection. Liquid splash protection but no protection to chemical vapors or gases.

Used When: Contact with site chemical(s) will not affect the skin. Air contaminants have been identified and concentrations measured. A canister is available which can remove the contaminant. The site and its hazards have been completely characterized.

Limitations: Protective clothing items must resist penetration by the chemical or mixtures present. Chemical airborne concentration must be less than IDLH levels. The atmosphere must contain at least 19.5% oxygen.

Not Acceptable for Chemical Emergency Response

Level D:

Coveralls, safety boots/shoes, safety glasses or chemical splash goggles

Optional: Gloves, escape SCBA, face-shield, Protection Provided: No respiratory protection, minimal skin protection.

Used When: The atmosphere contains no known hazard. Work functions preclude splashes, immersion, potential for inhalation, or direct contact with hazard chemicals.

Limitations: This level should not be worn in the Hot Zone. The atmosphere must contain at least 19.5% oxygen.

Not Acceptable for Chemical Emergency Response

The type of equipment used and the overall level of protection should be reevaluated periodically as the amount of information about the chemical situation or process increases, and when workers are required to perform different tasks. Personnel should upgrade or downgrade their level of protection only with concurrence with the site supervisor, safety officer, or plant industrial hygienist.

The recommendations in Table VIII:1-1 serve only as guidelines. It is important for you to realize that selecting items by how they are designed or configured alone is not sufficient to ensure adequate protection. In other words, just having the right components to form an ensemble is not enough. The EPA levels of protection do not define what performance the selected clothing or equipment must offer. Many of these considerations are described in the "limiting criteria" column of Table VIII: 1-1. Additional factors relevant to the various clothing and equipment items are described in subsequent Paragraphs.

C. Ensemble Selection Factors

1. Chemical Hazards. Chemicals present a variety of hazards such as toxicity, corrosiveness, flammability, reactivity, and oxygen deficiency. Depending on the chemicals present, any combination of hazards may exist.

2. Physical Environment. Chemical exposure can happen anywhere: in industrial settings, on the highways, or in residential areas. It may occur either indoors or outdoors; the environment may be extremely hot, cold, or moderate; the exposure site may be relatively uncluttered or rugged, presenting a number of physical hazards; chemical handling activities may involve entering confined spaces, heavy lifting, climbing a ladder, or crawling on the ground. The choice of ensemble components must account for these conditions.

3. Duration of Exposure. The protective qualities of ensemble components may be limited to certain exposure levels (e.g. material chemical resistance, air supply). The decision for ensemble use time must be made assuming the worst case exposure so that safety margins can be applied to increase the protection available to the worker.

4. Protective Clothing or Equipment Available. Hopefully, an array of different clothing or equipment is available to workers to meet all intended applications. Reliance on one particular clothing or equipment item may severely limit a facility's ability to handle a broad range of chemical exposures. In its acquisition of equipment and clothing, the safety department or other responsible authority should attempt to provide a high degree of flexibility while choosing protective clothing and equipment that is easily integrated and provides protection against each conceivable hazard.

D. Classification of Protective Clothing

Personal protective clothing includes the following:

1. Fully encapsulating suits;
2. Non-encapsulating suits;
3. Gloves, boots, and hoods;
4. Firefighter's protective clothing;
5. Proximity, or approach clothing;
6. Blast or fragmentation suits; and
7. Radiation-protective suits.

Firefighter turnout clothing, proximity gear, blast suits, and radiation suits by themselves are not acceptable for providing adequate protection from hazardous chemicals.

Table VIII:1-2 describes various types of protection clothing available, details the type of protection they offer, and lists factors to consider in their selection and use.

TABLE VIII: 1-2. TYPES OF CLOTHING FOR FULL BODY PROTECTION

Description	Type of Protection	Use Considerations
Fully encapsulating suit. One-piece garment. Boots and gloves may be integral, attached and replaceable, or separate.	Protects against splashes, dust gases, and vapors.	Does not allow body heat to escape. May contribute to heat stress in wearer, particularly if worn in conjunction with a closed-circuit SCBA; a cooling garment may be needed. Impairs worker mobility, vision, and communication.
Non-encapsulating suit Jacket, hood, pants or bib overalls, and one-piece coveralls.	Protects against splashes, dust, and other materials but not against gases and vapors. Does not protect parts of head or neck.	Do not use where gas-tight or pervasive splashing protection is required. May contribute to heat stress in wearer. Tape-seal connections between pant cuffs and boots and between gloves and sleeves.
Aprons, leggings, and sleeve protectors Fully sleeved and gloved apron. Separate coverings for arms and legs. Commonly worn over non-encapsulating suit.	Provides additional splash protection of chest, forearms, and legs.	Whenever possible, should be used over a non-encapsulating suit to minimize potential heat stress. Useful for sampling, labeling, and analysis operations. Should be used only when there is a low probability of total body contact with contaminants.
Firefighters' protective clothing Gloves, helmet, running or bunker coat, running or bunker pants (NFPA No. 1971, 1972, 1973, and boots (1974).	Protects against heat, hot water, and some particles. Does not protect against gases and vapors, or chemical permeation or degradation. NFPA Standard No. 1971 specifies that a garment consists of an outer shell, an inner liner and a vapor barrier with a minimum water penetration of 25 lb/in^2 (1.8 kg/cm^2) to prevent passage of hot water.	Decontamination is difficult. Should not be worn in areas where protection against gases, vapors, chemical splashes or permeation is required.
Proximity garment (approach suit) One- or two-piece overgarment with boot covers, gloves, and hood of aluminized nylon or cotton fabric. Normally worn over other protective clothing, firefighters' bunker gear, or flame-retardant coveralls.	Protects against splashes, dust, gases, and vapors.	Does not allow body heat to escape. May contribute to heat stress in wearer, particularly if worn in conjunction with a closed-circuit SCBA; a cooling garment may be needed. Impairs worker mobility, vision, and communication.
Blast and fragmentation suit Blast and fragmentation vests and clothing, bomb blankets, and bomb carriers.	Provides some protection against very small detonations. Bomb blankets and baskets can help redirect a blast.	Does not provide for hearing protection.
Radiation-contamination protective suit Various types of protective clothing designed to prevent contamination of the body by radioactive particles.	Protects against alpha and beta particles. Does not protect against gamma radiation.	Designed to prevent skin contamination. If radiation is detected on site, consult an experienced radiation expert and evacuate personnel until the radiation hazard has been evaluated.
Flame/fire retardant coveralls Normally worn as an undergarment.	Provides protection from flash fires.	Adds bulk and may exacerbate heat stress problems and impair mobility

E. Classification of Chemical Protective Clothing. Table VIII:1-3 provides a listing of clothing classifications. Clothing can be classified by design, performance, and service life.

TABLE VIII:1-3. CLASSIFICATION OF CHEM. PROTECTIVE CLOTHING

By Design	By Performance	By Service Life
glovesboots aprons, jackets, coveralls, full body suits	particulate protection liquid-splash protection vapor protection	single use limited use reusable

Categorizing clothing by design is mainly a means for describing what areas of the body the clothing item is intended to protect.

In emergency response, hazardous waste site cleanup, and dangerous chemical operations, the only acceptable types of protective clothing include fully or totally encapsulating suits and non-encapsulating or "splash" suits plus accessory clothing items such as chemically resistant gloves or boots. These descriptions apply to how the clothing is designed and not to its performance.

1. Performance. The National Fire Protection Association (NFPA) has classified suits by their performance as:

   a. Vapor-protective suits (NFPA Standard 1991) provide "gas-tight" integrity and are intended for response situations where no chemical contact is permissible. This type of suit would be equivalent to the clothing required in EPA's Level A.

   b. Liquid splash-protective suits (NFPA Standard 1992) offer protection against liquid chemicals in the form of splashes, but not against continuous liquid contact or chemical vapors or gases. Essentially, the type of clothing would meet the EPA Level B needs. It is important to note, however, that by wearing liquid splash-protective clothing, the wearer accepts exposure to chemical vapors or gases because this clothing does not offer gas-tight performance. The use of duct tape to seal clothing interfaces does not provide the type of wearer encapsulation necessary for protection against vapors or gases.

   c. Support function protective garments (NFPA Standard 1993) must also provide liquid splash protection but offer limited physical protection. These garments may comprise several separate protective clothing components (i.e., coveralls, hoods, gloves, and boots). They are intended for use in non-emergency, nonflammable situations where the chemical hazards have been completely characterized. Examples of support functions include proximity to chemical processes, decontamination, hazardous waste clean-up, and training. Support function protective garments should not be used in chemical emergency response or in situations where chemical hazards remain uncharacterized.

d. These NFPA standards define minimum performance requirements for the manufacture of chemical protective suits. Each standard requires rigorous testing of the suit and the materials that comprise the suit in terms of overall protection, chemical resistance, and physical properties. Suits that are found compliant by an independent certification and testing organization may be labeled by the manufacturer as meeting the requirements of the respective NFPA standard. Manufacturers also have to supply documentation showing all test results and characteristics of their protective suits.

e. Protective clothing should completely cover both the wearer and his or her breathing apparatus. In general, respiratory protective equipment is not designed to resist chemical contamination. Level A protection (vapor-protective suits) require this configuration. Level B ensembles may be configured either with the SCBA on the outside or inside. However, it is strongly recommended that the wearer's respiratory equipment be worn inside the ensemble to prevent its failure and to reduce decontamination problems. Level C ensembles use cartridge or canister type respirators which are generally worn outside the clothing.

2. Service Life

a. Clothing item service life is an end user decision depending on the costs and risks associated with clothing decontamination and reuse. For example, a Saranex/ Tyvek® garment may be designed to be a coverall (covering the wearer's torso, arms, and legs) intended for liquid splash protection, which is disposable after a single use.

b. Protective clothing may be labeled as:

(1) Reusable, for multiple wearings; or
(2) Disposable, for one-time use.

The distinctions between these types of clothing are both vague and complicated. Disposable clothing is generally lightweight and inexpensive. Reusable clothing is often more rugged and costly. Nevertheless, extensive contamination of any garment may render it disposable. The basis of this classification really depends on the costs involved in purchasing, maintaining, and reusing protective clothing versus the alternative of disposal following exposure. If an end user can anticipate obtaining several uses out of a garment while still maintaining adequate protection from that garment at lower cost than its disposal, the suit becomes reusable. Yet, the key assumption in this determination is the viability of the garment following exposure. This issue is further discussed in the Paragraph on decontamination.

F. Protective Clothing Selection Factor

Clothing design – Manufacturers sell clothing in a variety of styles and configurations.

1. Design Considerations.
2. Clothing configuration;
3. Components and options;
4. Sizes;
5. Ease of donning and doffing;
6. Clothing construction;
7. Accommodation of other selected ensemble equipment;
8. Comfort; and
9. Restriction of mobility.

G. Material Chemical Resistance. Ideally, the chosen material(s) must resist permeation, degradation, and penetration by the respective chemicals.

1. Permeation is the process by which a chemical dissolves in or moves through a material on a molecular basis. In most cases, there will be no visible evidence of chemicals permeating a material.

   Permeation breakthrough time is the most common result used to assess material chemical compatibility. The rate of permeation is a function of several factors such as chemical concentration, material thickness, humidity, temperature, and pressure. Most material testing is done with 100% chemical over an extended exposure period. The time it takes chemical to permeate through the material is the breakthrough time.

   An acceptable material is one where the breakthrough time exceeds the expected period of garment use. However, temperature and pressure effects may enhance permeation and reduce the magnitude of this safety factor. For example, small increases in ambient temperature can significantly reduce breakthrough time and the protective barrier properties of a protective clothing material.

2. Degradation involves physical changes in a material as the result of a chemical exposure, use, or ambient conditions (e.g. sunlight). The most common observations of material degradation are discoloration, swelling, loss of physical strength, or deterioration.

3. Penetration is the movement of chemicals through zippers, seams, or imperfections in a protective clothing material.

It is important to note that no material protects against all chemicals and combinations of chemicals, and that no currently available material is an effective barrier to any prolonged chemical exposure.

H. Sources of information include:

1. Guidelines for the Selection of *Chemical Protective Clothing*, 3rd Edition. This reference provides a matrix of clothing material recommendations for approximately 500 chemicals based on an evaluation of chemical resistance test data, vendor literature, and raw material suppliers. The major limitation for these guidelines are their presentation of recommendations by generic material class. Numerous test results have shown that similar materials from different manufacturers may give widely different performance. That is to say manufacturer A's butyl rubber glove may protect against chemical X, but a butyl glove made by manufacturer B may not.

2. Quick Selection Guide to Chemical Protective Clothing. Pocket size guide that provides chemical resistance data and recommendations for 11 generic materials against over 400 chemicals. The guide is color-coded by material-chemical recommendation. As with the "Guidelines..." above, the major limitation of this reference is its dependence on generic data.

3. Vendor data or recommendations. The best source of current information on material compatibility should be available from the manufacturer of the selected clothing. Many vendors supply charts which show actual test data or their own recommendations for specific chemicals. However, unless vendor data or the recommendations are well documented, end users must approach this information with caution.

Material recommendations must be based on data obtained from tests performed to standard ASTM methods. Simple ratings of "poor," "good," or "excellent" give no indication of how the material may perform against various chemicals.

NOTE: Mixtures of chemicals can be significantly more aggressive towards protective clothing materials than any single chemical alone. One permeating chemical may pull another with it through the material. Very little data is available for chemical mixtures. Other situations may involve unidentified substances. In both the case of mixtures and unknowns, serious consideration must be given to deciding which protective clothing is selected. If clothing must be used without test data, garments with materials having the broadest chemical resistance should be worn, i.e. materials which demonstrate the best chemical resistance against the widest range of chemicals.

I. Physical Properties

As with chemical resistance, manufacturer materials offer wide ranges of physical qualities in terms of strength, resistance to physical hazards, and operation in extreme environmental conditions. Comprehensive manufacturing standards such as the NFPA Standards set specific limits on these material properties, but only for limited applications, i.e. emergency response.

End users in other applications may assess material physical properties by posing the following questions:

1. Does the material have sufficient strength to withstand the physical strength of the tasks at hand?
2. Will the material resist tears, punctures, cuts, and abrasions?
3. Will the material withstand repeated use after contamination and decontamination?
4. Is the material flexible or pliable enough to allow end users to perform needed tasks?
5. Will the material maintain its protective integrity and flexibility under hot and cold extremes?
6. Is the material flame-resistant or self-extinguishing (if these hazards are present)?
7. Are garment seams in the clothing constructed so they provide the same physical integrity as the garment material?

J. Ease of Decontamination. The degree of difficulty in decontaminating protective clothing may dictate whether disposable or reusable clothing is used, or a combination of both.

K. Cost. Protective clothing end users must endeavor to obtain the broadest protective equipment they can buy with available resources to meet their specific application.

L. Chemical Protective Clothing Standards. Protective clothing buyers may wish to specify clothing that meets specific standards, such as 1910.120 or the NFPA standards (see Paragraph on classification by performance). The NFPA Standards do not apply to all forms of protective clothing and applications.

III. General Guidelines

A. Decide if the clothing item is intended to provide vapor, liquid-splash, or particulate protection.

Vapor protective suits also provide liquid splash and particulate protection. Liquid splash protective garments also provide particulate protection. Many garments may be labeled as totally encapsulating but do not provide gas-tight integrity due

to inadequate seams or closures. Gas-tight integrity can only be determined by performing a pressure or inflation test and a leak detection test of the respective protective suit. This test involves:

1. Closing off suit exhalation valves;
2. Inflating the suit to a specified pressure; and
3. Observing whether the suit holds the above pressure for a designated period.

ASTM Standard Practice F1052 (1987 Edition) offers a procedure for conducting this test.

Splash suits must still cover the entire body when combined with the respirator, gloves, and boots. Applying duct tape to a splash suit does not make it protect against vapors. Particulate protective suits may not need to cover the entire body, depending on the hazards posed by the particulate. In general, gloves, boots and some form of face protection are required. Clothing items may only be needed to cover a limited area of the body such as gloves on hands. The nature of the hazards and the expected exposure will determine if clothing should provide partial or full body protection.

B. Determine if the clothing item provides full body protection.

Vapor-protective or totally encapsulating suit will meet this requirement by passing gas-tight integrity tests.

Liquid splash-protective suits are generally sold incomplete (i.e. fewer gloves and boots).

Missing clothing items must be obtained separately and match or exceed the performance of the garment.

Buying a PVC glove for a PVC splash suit does not mean that you obtain the same level of protection. This determination must be made by comparing chemical resistance data.

C. Evaluate manufacturer chemical resistance data provided with the clothing.

Manufacturers of vapor-protective suits should provide permeation resistance data for their products, while liquid and particulate penetration resistance data should accompany liquid splash and particulate protective garments respectively. Ideally data should be provided for every primary material in the suit or clothing item. For suits, this includes the garment, visor, gloves, boots, and seams.

Permeation data should include the following:

1. Chemical name;
2. Breakthrough time (shows how soon the chemical permeates);
3. Permeation rate (shows the rate that the chemical comes through);
4. System sensitivity (allows comparison of test results from different laboratories); and
5. A citation that the data was obtained in accordance with ASTM Standard Test Method F739-85.

If no data are provided or if the data lack any one of the above items, the manufacturer should be asked to supply the missing data. Manufacturers that provide only numerical or qualitative ratings must support their recommendations with complete test data.

Liquid penetration data should include a pass or fail determination for each chemical listed, and a citation that testing was conducted in accordance with ASTM Standard Test Method F903-86. Protective suits which are certified to NFPA 1991 or NFPA 1992 will meet all of the above requirements.

Particulate penetration data should show some measure of material efficiency in preventing particulate penetration in terms of particulate type or size and percentage held out. Unfortunately, no standard tests are available in this area and end users may have little basis for company products.

Suit materials which show no breakthrough or no penetration to a large number of chemicals are likely to have a broad range of chemical resistance. (Breakthrough times greater than one hour are usually considered to be an indication of acceptable performance.) Manufacturers should provide data on the ASTM Standard Guide F1001-86 chemicals. These 15 liquid and 6 gaseous chemicals listed in Table VIII:1-4 below represent a cross-section of different chemical classes and challenges for protective clothing materials. Manufacturers should also provide test data on other chemicals as well. If there are specific chemicals within your operating area that have not been tested, ask the manufacturer for test data on these chemicals.

TABLE VIII:1-4. RECOMMENDED CHEMICALS TO EVALUATE THE PERFORMANCE OF PROTECTIVE CLOTHING MATERIALS

Chemical	Class
Acetone	Ketone
Acetonitrile	Nitrile
Ammonia	Strong base (gas)
1,3-Butadiene	Olefin (gas)
Carbon Disulfide	Sulfur-containing organic
Chlorine	Inorganic gas
Dichloromethane	Chlorinated hydrocarbon
Diethylamine	Amine
Dimethyl Formamide	Amide
Ethyl Acetate	Ester
Ethyl Oxide	Oxygen heterocyclic gas
Hexane	Aliphatic hydrocarbon
Hydrogen Chloride	Acid gas
Methanol	Alcohol
Methyl Chloride	Chlorinated hydrocarbon (gas)
Nitrobenzene	Nitrogen-containing organic
Sodium Hydroxide	Inorganic base
Sulfuric Acid	Inorganic acid
Tetrachloroethylene	Chlorinated hydrocarbon
Tetrahydrofuran	Oxygen heterocyclic
Toluene	Aromatic hydrocarbon

D. Obtain and examine the manufacturer's instruction or technical manual.

This manual should document all the features of the clothing, particularly suits, and describe what material(s) are used in its construction. It should cite specific limitations for the clothing and what restrictions apply to its use. Procedures and recommendations should be supplied for at least the following:

1. Donning and doffing;
2. Inspection, maintenance, and storage;
3. Decontamination;
4. Use

NOTE: The manufacturer's instructions should be thorough enough to allow the end users to wear and use the clothing without a large number of questions.

E. Obtain and inspect sample clothing item garments.

Examine the quality of clothing construction and other features that will impact its wearing. The questions listed under "Protective Clothing Selection Factors, Clothing Design" should be considered. If possible, representative clothing items should be obtained in advance and inspected prior to purchase, and discussed with someone who has experience in their use. It is also helpful to try out representative garments prior to purchase by suiting personnel in the garment and having them run through exercises to simulate expected activities.

F. Field selection of chemical protective clothing.

Even when end users have gone through a very careful selection process, a number of situations will arise when no information is available to judge whether their protective clothing will provide adequate protection. These situations include:

1. Chemicals that have not been tested with the garment materials;
2. Mixtures of two or more different chemicals;
3. Chemicals that cannot be readily identified;
4. Extreme environmental conditions (hot temperatures); and
5. Lack of data in all clothing components (e.g. seams, visors).

Testing material specimens using newly developed field test kits may offer one means for making an on-site clothing selection. A portable test kit has been developed by the EPA using a simple weight loss method that allows field qualification of protective clothing materials within one hour. Use of this kit may overcome the absence of data and provide additional criteria for clothing selection.

Selection of chemical protective clothing is a complex task and should be performed by personnel with both extensive training and experience.

Under all conditions, clothing should be selected by evaluating its performance characteristics against the requirements and limitations imposed by the application.

IV. MANAGEMENT PROGRAM.

A. Written Management Program

A written Chemical Protective Clothing Management Program should be established by all end users who routinely select and use protective clothing. Reference should be made to 29 CFR §1910.120 for those covered.

The written management program should include policy statements, procedures, and guidelines. Copies should be made available to all personnel who may use protective clothing in the course of their duties or job. Technical data on clothing, maintenance manuals, relevant regulations, and other essential information should also be made available.

The two basic objectives of any management program should be to protect the wearer from safety and health hazards, and to prevent injury to the wearer from incorrect use and/or malfunction of the chemical protective clothing. To accomplish these goals, a comprehensive management program should include: hazard identification; medical monitoring; environmental surveillance; selection, use, maintenance, and decontamination of chemical protective clothing; and training.

B. Program Review and Evaluation. The management program should be reviewed at least annually. Elements which should be considered in the review include:

1. The number of person-hours that personnel wear various forms of

chemical protective clothing and other equipment;

2. Accident and illness experience;
3. Levels of exposure;
4. Adequacy of equipment selection;
5. Adequacy of the operational guidelines;
6. Adequacy of decontamination, cleaning, inspection, maintenance, and storage programs;
7. Adequacy and effectiveness of training and fitting programs;
8. Coordination with overall safety and health program;
9. The degree of fulfillment of program objectives;
10. The adequacy of program records;
11. Recommendations for program improvement and modification; and
12. Program costs.

The results of the program evaluation should be made available to all end users and presented to top management so that program changes may be implemented.

C. Types of Standard Operating Procedures. Personal protective clothing and equipment can offer a high degree of protection only if it is used properly. Standard Operating Procedures (SOP's) should be established for all workers involved in handling hazardous chemicals. Areas that should be addressed include:

1. Selection of protective ensemble components;
2. Protective clothing and equipment donning, doffing, and use;
3. Decontamination procedures;
4. Inspection, storage, and maintenance of protective clothing/equipment; and
5. Training.

D. Selection of Protective Clothing Components.

Protective clothing and equipment SOP's must take into consideration the factors presented in the Clothing Ensemble and Protective Clothing Applications Paragraphs of this chapter. All clothing and equipment selections should provide a decision tree that relates chemical hazards and information to levels of protection and performance needed.

Responsibility in selecting appropriate protective clothing should be vested in a specific individual who is trained in both chemical hazards and protective clothing use such as a safety officer or industrial hygienist. Only chemical protective suits labeled as compliant with the appropriate performance requirements should be used. In cases where the chemical hazards are known in advance or encountered routinely, clothing selection should be predetermined. That is, specific clothing items should be identified in specific chemical operations without the opportunity for individual selection of other clothing items.

E. Clothing Donning, Doffing, and Use.

The procedures below are given for vapor protective or liquid-splash protective suit ensembles and should be included in the training program.

1. Donning the Ensemble.

A routine should be established and practiced periodically for donning the various ensemble configurations that a facility or team may use. Assistance should be provided for donning and doffing since these operations are difficult to perform alone, and solo efforts may increase the possibility of ensemble damage.

The following lists sample procedures for donning a totally encapsulating suit/SCBA ensemble. These procedures should be modified depending on the suit and accessory equipment used. The procedures

assume the wearer has previous training in respirator use and decontamination procedures.

Once the equipment has been donned, its fit should be evaluated. If the clothing is too small, it will restrict movement, increase the likelihood of tearing the suit material, and accelerate wearer fatigue. If the clothing is too large, the possibility of snagging the material is increased, and the dexterity and coordination of the wearer may be compromised. In either case, the wearer should be recalled and better-fitting clothing provided.

Sample Donning Procedures

1. Inspect clothing and respiratory equipment before donning (see Paragraph on Inspection).
2. Adjust hard hat or headpiece if worn, to fit user's head.
3. Open back closure used to change air tank (if suit has one) before donning suit.
4. Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit; then gather the suit around the waist.
5. Put on chemical-resistant safety boots over the feet of the suit. Tape the leg cuff over the tops of the boots. If additional chemical-resistant safety boots are required, put these on now. Some one-piece suits have heavy-soled protective feet. With these suits, wear short, chemical resistant safety boots inside the suit.
6. Put on air tank and harness assembly of the SCBA. Don the facepiece and adjust it to be secure, but comfortable. Do not connect the breathing hose. Open valve on air tank.
7. Perform negative and positive respirator facepiece seal test procedures. To conduct a negative-pressure test, close the inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for about 10 seconds. Any inward rushing of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit. To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.

Depending on type of suit:

8. Put on long-sleeved inner gloves (similar to surgical gloves). Secure gloves to sleeves, for suits with detachable gloves (if not done prior to entering the suit). Additional overgloves, worn over attached suit gloves, may be donned later.
9. Put sleeves of suit over arms as assistant pulls suit up and over the SCBA. Have assistant adjust suit around SCBA and shoulders to ensure unrestricted motion.
10. Put on hard hat, if needed.
11. Raise hood over head carefully so as not to disrupt face seal of SCBA mask. Adjust hood to give satisfactory comfort.
12. Begin to secure the suit by closing all fasteners on opening until there is only adequate room to connect the breathing hose. Secure all belts and/or adjustable leg, head, and waistbands.
13. Connect the breathing hose while opening the main valve.
14. Have assistant first ensure that wearer is breathing properly and then make final closure of the suit.

15. Have assistant check all closures.
16. Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable, and that the equipment is functioning properly.

HAZARD RECOGNITION EXERCISE

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Given information provided by an initial site entry team, evaluate this information and develop a brief health and safety plan.

HAZARD RECOGNITION EXERCISE

1. Your site entry team has just found nine steel drums labeled methyl chloroform solvent in the storage shed located West of the control building. The building has one open door on the south side of the building. The building has a rusty sheet metal roof. The floor is concrete. The floor is six inches below ground level. There is a concrete ramp from the door to the floor of the building. The ramp can be used to drum dolly out the solvent drums.
2. Your site entry team is in Level B Protection with 30 minute SCBA and Saranex coated chemical suits. They have a CGI with oxygen meter, PID/with a 10.2 eV lamp, and pH paper. The instrument readings are provided here:

Instrument Readings	
Oxygen:	20.8%
LEL:	1%
PID:	0
pH Paper:	Light Red

3. The site East of the control building has been investigated and sampled and is free of contamination. The wind is from East to West at 6 mph. There are locked gates on the left and right side of the road just North of the control building. You have the keys to these gates.
4. There are pools of liquid about 1/4 inch deep on the floor of the storage building. Some drums may have small leaks. The roof of the storage building does leak, and some liquid on the floor may be rain water. All of the drums still have the manufactures seal on the bungs.
5. **Here is the objective of this exercise:** ***The solvent drums need to be removed off site. Assess the hazards of the solvent drums and decide if the entry team can safely remove the drums with a drum dolly.***
6. The site entry team may have additional information. The instructor represents this team.

Key Safety Checks

1. Evaluate the instrument readings:
   - Oxygen
   - LEL
   - PID
   - PH
2. Evaluate the chemical hazards: Use the attached NIOSH Pocket Guide worksheet for the chemical hazard evaluation.
3. Any other chemicals present?
4. Is the saranex coated chemical suit compatible with Methyl Chloroform?
5. Is the saranex coated chemical suit compatible with any other chemicals present?
6. Select the appropriate level of protection for the entry team to accomplish their task:

   Level A Level C
   Level B Level D

Recommendations for Chemical Protective Clothing

A Companion to the *NIOSH Pocket Guide to Chemical Hazards*

Table H

Chemical	CAS No.	Recommendation for skin protection†	Recommended protective clothing barriers*
Hydrazine	302-01-2	Prevent skin contact	8 hr: Butyl, Neoprene, Nitrile, PVC, Teflon, Saranex, Barricade, Responder 4 hr: PE/EVAL
Hydrogenated terphenyls	61788-32-7	Prevent skin contact	Contact the manufacturer for recommendations
Hydrogen bromide	10035-10-6	Prevent skin contact (solution)/ Frostbite	4 hr: Teflon Prevent possible skin freezing from direct liquid contact
Hydrogen chloride	7647-01-0	Prevent skin contact (solution)/ Frostbite	8hr: Butyl, Teflon, Saranex, Barricade, Responder, Trellchem, Tychem 4 hr: Neoprene, PVC Prevent possible skin freezing from direct liquid contact
Hydrogen cyanide	74-90-8	Prevent skin contact	8 hr: Teflon 4 hr: PE/EVAL, Responder, Tychem
Hydrogen fluoride (as F)	7664-39-3	Prevent skin contact (liquid)	8 hr: Tychem 4 hr: Teflon
Hydrogen peroxide	7722-84-1	Prevent skin contact	(solution 30%-70%) 8 hr: Butyl, Natural, Nitrile, PE, Viton, CPF3, Responder, Tychem 4 hr: PVC, PE/EVAL
Hydrogen sulfide	7783-06-4	Prevent skin contact/ Frostbite	8 hr: Tychem 4 hr: Teflon Prevent possible skin freezing from direct liquid contact

Recommendations for Chemical Protective Clothing
A Companion to the
NIOSH Pocket Guide to Chemical Hazards
Table M

Chemical	CAS No.	Recommendation for skin protection†	Recommended protective clothing barriers*
Mercury compounds [except (organo) alkyls] (as Hg)	743-99-76 (metal)	Prevent skin contact	Contact the manufacturer for recommendations for the specific compound
Mercury (organo) alkyl compounds (as Hg)		Prevent skin contact	Contact the manufacturer for recommendations for the specific compound
Methyl bromide	74-83-9	Prevent skin contact (liquid)	8 hr: Responder, Tychem 4 hr: Butyl, Neoprene, Teflon
Methyl Cellosolve®	109-86-4	Prevent skin contact	8 hr: Butyl, Tychem 4 hr: PE/EVAL
Methyl Cellosolve® acetate	110-49-6	Prevent skin contact	8 hr: Butyl, Tychem 4 hr: Saranex, PE/EVAL
Methyl chloride	74-87-3	Prevent skin contact/ Frostbite	8 hr: Viton, Saranex, Barricade, Responder, Trellchem, Tychem 4 hr: Teflon Prevent possible skin freezing from direct liquid contact
Methyl chloroform	71-55-6	Prevent skin contact	8 hr: PVA, Viton, PE/EVAL, Barricade, CPF3, Responder, Tychem 4 hr: Teflon
Methylcyclohexane	108-87-2	Prevent skin contact	Contact the manufacturer for recommendations

Recommendations for skin protection

Prevent skin contact....	Wear appropriate personal protective clothing to prevent skin contact. **Suggested barriers for use should be confirmed with the vendor and for additional information and use limitations.**
Frostbite.....	Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the **evaporating** liquid or from contact with vessels containing the liquid.
N.R.....	**No specific recommendation can be made. Actual working conditions will determine the need and type of personal protective equipment.**

†**Bold type** indicates a change from or an addition to what is published in the *NIOSH Pocket Guide to Chemical Hazards, June 1997 Edition.*

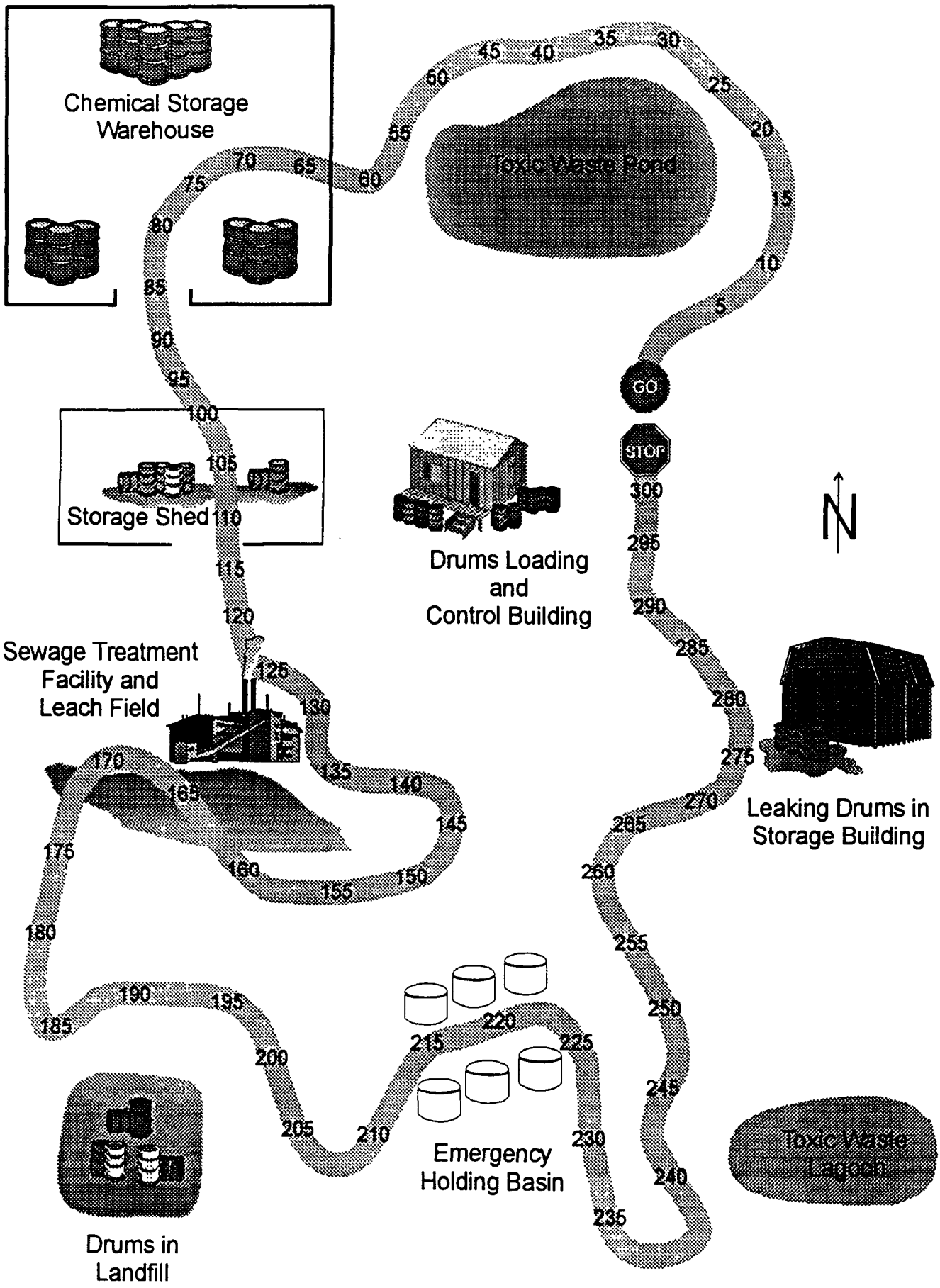
Recommended protective clothing barriers*

Butyl = Butyl Rubber (Gloves, Suits, Boots)	**Viton = Viton™ (Gloves, Suits)**
Natural = Natural Rubber (Gloves)	**Saranex = Saranex™ coated suits**
Neoprene = Neoprene Rubber (Gloves, Suits, Boots)	**PE/EVAL = 4H™ and Silver Shield™ brand gloves**
Nitrile = Nitrile Rubber (Gloves, Suits, Boots)	**Barricade = Barricade™ coated suits**
PE = Polyethylene (Gloves, Suits, Boots)	**CPF3 = CPF3™ suits**
PVA = Polyvinyl Alcohol (Gloves)	**Responder = Responder™ suits**
PVC = Polyvinyl Chloride (Gloves, Suits, Boots)	**Trellchem = Trellchem HPS™ suits**
Teflon = Teflon™ (Gloves, Suits, Boots)	**Tychem = Tychem 10000™ suits**

8 hr = More than 8 hours of resistance to breakthrough >0.1 $g/cm^2/min$.

4 hr = At least 4 but less than 8 hours of resistance to breakthrough >0.1 $g/cm^2/min$.

***Neoprene is a tradename and Teflon™, Barricade™ and Tychem 10000™ are trademarks of the DuPont Company. Viton™ is a registered trademark of DuPont Dow Elastomers. Saranex is a tradename of the Dow Chemical Company. 4H is a trademark of the Safety 4 Company. Silver Shield is a trademark of the Siebe North Company. CPF3 and Responder are trademarks of the Kappler Company. Trellchem HPS is a trademark of the Trelleborg Company. Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).**


Chemical Storage Warehouse
Toxic Waste Pond
GO
STOP
Storage Shed
Drums Loading and Control Building
Sewage Treatment Facility and Leach Field
Leaking Drums in Storage Building
Emergency Holding Basin
Toxic Waste Lagoon
Drums in Landfill
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HEAT AND COLD STRESS

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Identify and describe heat and cold stress considerations for Superfund site workers wearing level A, B, and C protection.

HEAT AND COLD STRESS

HEAT STRESS AND COLD STRESS AT HAZARDOUS WASTE SITES

- The cause of illness and injuries on many sites
- Heat/cold stress factors should be part of PPE selection process
- Included in medical monitoring for site workers

A CONTROL PROGRAM FOR HEAT/COLD STRESS

- Medical supervision
- Orientation and training
- Work/rest schedules and fluid replacement
- Environmental monitoring
- Engineering and administrative controls PPE

HEAT STRESS CONSIDERATIONS

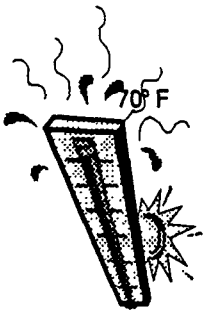
- Can cause serious illness or injury
- Interacting factors
  - Environmental conditions
  - PPE
  - Workload
  - Individual characteristics

HEAT STRESS CONSIDERATIONS (cont.)

- Can occur within 15 minutes
- Early stages:
  - Rashes
  - Cramps
  - Drowsiness
- Continued heat stress can lead to heat stroke

HEAT STRESS AND PPE

- PPE may limit dissipation of body heat
- Initiate heat stress monitoring before entry
- Must monitor for heat stress when temperature is above 70 degrees F

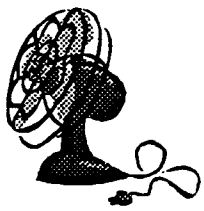


MONITORING FOR HEAT STRESS

- Heart rate exceeds 110 beats per minute
  - Shorten work cycle by 1/3
- Oral temperature exceeds 99.6 degrees F
  - Short work cycle by 1/3
- Oral temperature exceeds 100.6 degrees F
  - Workers should not wear PPE

PREVENTING HEAT STRESS

- Adjust work and rest cycles
- Provide shelter or shaded area
- Maintain body fluids
- Provide cooling devices
- Ensure proper training and acclimation



COLD EXPOSURE HAZARDS

- May result in frostbite or hypothermia
- May impair ability to work
- Exposure to wind may increase cold exposure danger

HEAT AND COLD STRESS

1. Heat Stress

   A. All workers, even those not wearing protective equipment, should be monitored, because the incidence of heat stress depends on a variety of factors and can affect any worker. Monitoring should be initiated before initial entry and should be continued during each break cycle. Some general guidelines include:

   B. For workers wearing permeable clothing, monitor for signs of heat stress and follow established work/rest schedules.

   C. For workers wearing semipermeable or impermeable encapsulating ensembles, workers should also be monitored when the temperature in the work area is above 70oF (21oC). Below 70oF, monitoring is considered on a case-by-case basis.

2. Personnel monitoring for heat stress.

   A. Heart Rate. Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same. If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.

   B. Oral Temperature. Use of clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking). If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).

3. Preventing Heat Stress.

   A. To protect against heat stress, it is important to choose the appropriate level of protection, to provide careful training for workers and site personnel, and to monitor frequently personnel who wear protective clothing. It is also important to ensure that work and rest periods are scheduled regularly, and that workers frequently replace lost fluids (it is not uncommon for workers to lose as many as 6 to 8 quarts of water in a hot shift).

   B. Proper training and preventive measures will help avert serious illness and loss of work productivity caused by heat stress. Preventing heat stress is particularly important because on incident of heat stress will increase the likelihood of future incidences.

4. Cold Stress.

   A. Recognizing the early signs and symptoms of cold stress can help prevent serious injury. Described below are the most common types of cold injury and their monitoring signals.

      a. Hypothermia. The first symptoms of hypothermia are uncontrollable shivering and the sensation of cold; the heartbeat slows and sometimes becomes irregular, the pulse weakens, and the blood pressure changes. Severe shaking or rigid muscles may be caused by bursts of body energy and changes in the body's chemistry. Uncontrollable fits of shivering, vague or slow slurred speech, memory lapses, incoherence and drowsiness are some of the symptoms that can occur. Other symptoms that can be seen before complete collapse are cool skin, slow and irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest.

b. As the core body temperature drops, the victim may become listless, confused, and make little or no attempt to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. Severe shivering must be taken as a sign of danger. If the body core temperature reaches about 85°F, significant and dangerous drops of blood pressure, pulse rate, and respiration can occur. In some cases, the victim may die.

c. Frostbite. Frostbite can occur without hypothermia when the extremities do not receive sufficient heat from central body stores. This can occur because of inadequate circulation and/or insulation. Frostbite occurs when there is freezing of the fluids around the cells of the body tissues due to extremely low temperatures. Frostbite may result in damage to and loss of tissue, and usually affects the nose, cheeks, ears, fingers, and toes. Damage from frostbite can be serious (e.g., scarring, tissue death resulting in amputation, and permanent loss of movement in the affected parts).

A. The freezing point of the skin is about 30°F (-1°C). As wind velocity increases, heat loss is greater and frostbite will occur more rapidly. If skin comes into contact with objects colder that freezing (e.g., tools or machinery), frostbite may develop at the point of contact, even in warmer environments.

B. There are three degrees of frostbite: first degree, which is freezing without blistering or peeling; second degree, which is freezing with blistering or peeling; and third degree, which is freezing with tissue death. It is important to remember that the victim is often unaware of the frostbite until someone else observes the symptoms.

OSHA Fact Sheets
01/01/1995 - Protecting Workers in Hot Environments

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- Subject: Protecting Workers in Hot Environments
- Information Date: 01/01/1995
- Fact Sheet: 95-16

Fact Sheet No. OSHA 95-16

PROTECTING WORKERS IN HOT ENVIRONMENTS

Many workers spend some part of their working day in a hot environment. Workers in foundries, laundries, construction projects, and bakeries — to name a few industries — often face hot conditions which pose special hazards to safety and health.

HEAT STRESS CAUSES BODY REACTIONS

Four environmental factors affect the amount of stress a worker faces in a hot work area: temperature, humidity, radiant heat (such as from the sun or a furnace) and air velocity. Perhaps most important to the level of stress an individual faces are personal characteristics such as age, weight, fitness, medical condition and acclimatization to the heat.

The body reacts to high external temperature by circulating blood to the skin which increases skin temperature and allows the body to give off its excess heat through the skin. However, if the muscles are being used for physical labor, less blood is available to flow to the skin and release the heat.

Sweating is another means the body uses to maintain a stable internal body temperature in the face of heat. However, sweating is effective only if the humidity level is low enough to permit evaporation and if the fluids and salts lost are adequately replaced.

Of course there are many steps a person might choose to take to reduce the risk of heat stress, such as moving to a cooler place, reducing the work pace or load, or removing or loosening some clothing.

When the body cannot dispose of excess heat, it will store it. When this happens, the body's core temperature rises and the heart rate increases. As the body continues to store heat, the individual begins to lose concentration and has difficulty focusing on a task, may become irritable or sick and often loses the desire to drink. The next stage is most often fainting. Death is possible if the person is not removed from the heat stress.

HEAT DISORDERS

Heat stroke, the most serious health problem for workers in hot environments, is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include (1) mental confusion, delirium, loss of consciousness, convulsions or coma; (2) a body temperature of 106°F or higher; and (3) hot dry skin which may be red, mottled, or bluish. Victims of heat stroke will die unless treated promptly. While awaiting medical help, the victim must be removed to a cool area and his or her clothing soaked with cool water. He or she should be fanned vigorously to increase cooling. Prompt first aid can prevent permanent injury to the brain and other vital organs.

Heat exhaustion results from loss of fluid through sweating when a worker has failed to drink enough fluids or take in enough salt or both. The worker with heat exhaustion still sweats but experiences extreme weakness or fatigue, giddiness, nausea, or headache. The skin is clammy and moist, the complexion pale or flushed, and the body temperature normal or slightly higher. Treatment is usually simple: the victim should rest in a cool place and drink an electrolyte solution (a beverage used by athletes to quickly restore potassium, calcium, and magnesium salts). Severe cases involving victims who vomit or lose consciousness may require longer treatment under medical supervision.

Heat cramps, painful spasms of the muscles, are caused when workers drink large quantities of water but fail to replace their bodies' salt loss. Tired muscles — those used for performing the work — are usually the ones most susceptible to cramps. Cramps may occur during or after working hours and may be relieved by taking

liquids by mouth or saline solutions intravenously for quicker relief, if medically determined to be required.

Fainting (heat syncope) may be a problem for the worker unacclimatized to a hot environment who simply stands still in the heat. Victims usually recover quickly after a brief period of lying down. Moving around, rather than standing still, will usually reduce the possibility of fainting.

Heat rash, also known as prickly heat, may occur in hot and humid environments where sweat is not easily removed from the surface of the skin by evaporation. When extensive or complicated by infection, heat rash can be so uncomfortable that it inhibits sleep and impedes a worker's performance or even results in temporary total disability. It can be prevented by resting in a cool place and allowing the skin to dry.

PREVENTING HEAT STRESS

Most heat-related health problems can be prevented or the risk of developing them reduced. Following a few basic precautions should lessen heat stress.

1. A variety of engineering controls including general ventilation and spot cooling by local exhaust ventilation at points of high heat production may be helpful. Shielding is required as protection from radiant heat sources. Evaporative cooling and mechanical refrigeration are other ways to reduce heat. Cooling fans can also reduce heat in hot conditions. Eliminating steam leaks will also help. Equipment modifications, the use of power tools to reduce manual labor and personal cooling devices or protective clothing are other ways to reduce the hazards of heat exposure for workers.

2. Work practices such as providing plenty of drinking water—as much as a quart per worker per hour—at the workplace can help reduce the risk of heat disorders. Training first aid workers to recognize and treat heat stress disorders and making the names of trained staff known to all workers is essential. Employers should also consider an individual worker's physical condition when determining his or her fitness for working in hot environments. Older workers, obese workers and personnel on some types of medication are at greater risk.

3. Alternating work and rest periods with longer rest periods in a cool area can help workers avoid heat stress. If possible, heavy work should be scheduled during the cooler parts of the day and appropriate protective clothing provided. Supervisors should be trained to detect early signs of heat stress and should permit workers to interrupt their work if they are extremely uncomfortable.

4. Acclimatization to the heat through short exposures followed by longer periods of work in the hot environment can reduce heat stress. New employees and workers returning from an absence of two weeks or more should have 5-day period of acclimatization. This period should begin with 50 percent of the normal workload and time exposure the first day and gradually building up to 100 percent on the fifth day.

5. Employee education is vital so that workers are aware of the need to replace fluids and salt lost through sweat and can recognize dehydration, exhaustion, fainting, heat cramps, salt deficiency, heat exhaustion, and heat stroke as heat disorders. Workers should also be informed of the importance of daily weighing before and after work to avoid dehydration.

DRUM HANDLING

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Describe safe drum handling procedures.

DRUM HANDLING

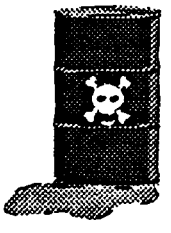
DRUM HANDLING: REGULATORY GUIDANCE

- Regulatory guidance
  - 29 CFR 1910.120 (j)
- Remote opening procedures for drums under pressure
- Provide adequate safety gear and equipment

DRUM HANDLING PROCEDURES

Check for:

- Labels and markings
- Signs of deterioration
- Drums under pressure
- Closed or open top drums
- Type of drum material
  - Plastic
  - Metal
  - Fiber



DRUM HANDLING PROCEDURES (cont.)

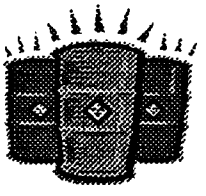
- Review site background data
- Unknown drums
- Visual inspection hazards
- Exposure hazards
- Drum rupture hazards
- Hazards of mixing incompatible waste

DRUM HANDLING PROCEDURES (cont.)

- Use appropriate equipment
- Explain drum hazards in safety meetings
- Conduct training on how to handle drums and containers
- Drums containing radioactive waste
- Shock sensitive drums
- Bulging drums

DRUM HANDLING: VISUAL INSPECTION

- Lab packs
- Potential rupture drums
- Leaking drums
- Spill control measures and equipment



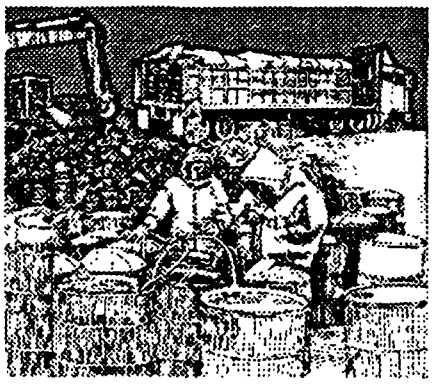
DRUM HANDLING: OPENING PROCEDURES

- Usually opened and sampled in place
- Drums may need to be moved to a staging area
- Ensure site worker safety during drum opening
- Use remote opening procedures for bulging drums

DRUM HANDLING: SAMPLING PROCEDURES

- Prepare sampling plan
- Identify drums to be sampled
- Select appropriate sampling equipment
- Develop procedures for opening drums and taking samples

DRUM HANDLING



DRUM HANDLING: SAMPLING PROCEDURES (cont.)

- Characterize wastes to determine safe handling SOPs for
  - Packaging/bulking
  - Transportation
  - Treatment
- Compatibility testing process
- Use the HazCat Checklist

DRUM HANDLING

1. Accidents may occur during handling of drums and other hazardous waste containers. Hazards include detonations, fires, explosions, vapor generations, and physical injury. The most significant ways to improve the safety of drum handling activities at a site are to keep the operation as remote from workers as possible, to avoid sudden releases of chemicals if the operation cannot be remote, and to provide adequate safety gear and equipment to the worker if spillage or contact with the drums is unavoidable.

2. Regulations defining practices and procedures for safe handling of drums and other hazardous waste containers include:

   A. OSHA regulations (29 CFR Part §1910.120(j) and Part 1926) – general requirements and standards for storing, containing, and handling chemicals and containers, and for maintaining equipment used for handling materials;

   B. EPA regulations (40 CFR parts 264 and 265) – requirements for types of hazardous waste containers, maintenance of containers and containment structures, and design and maintenance of storage areas; and

   C. DOT regulations (49 CFR parts 171 through 178) – requirements for containers and procedures for shipment of hazardous wastes.

2. Drum Handling

   A. Drums containing radioactive waste should not be handled until experts in handling radioactive materials have been consulted. If a drum is suspected to contain explosive or shock-sensitive waste, specialized assistance should be sought before handling is initiated . If handling is necessary, extreme caution should be used and all non-essential personnel should remain a safe distance from the handling area. In addition, continuous communication with the Site Health and Safety Officer and/or the command post should be maintained until handling operations are complete.

   B. Drums that may be under internal pressure can be identified by bulging or swelling. If a pressurized drum must be moved, whenever possible, the drum should be handled with a grabber unit constructed for explosive containment. Either move the bulged drum only as far as necessary to allow seating on firm ground, or carefully overpack the drum. Exercise extreme caution when working with or adjacent to potentially pressurized drums.

   C. Laboratory packs (lab packs) should be considered to hold explosive or shock-sensitive wastes until otherwise characterized. Prior to handling or transporting lab packs, all non-essential personnel should move a safe distance from the handling area. If handling is required, continuous communication with the Site Health and Safety Officer and/or the command post should be maintained until handling operations are complete. Once a lab pack has been opened, it should be inspected and classified according to the hazards of the wastes to ensure safe segregation of the lab packs' contents.

   D. If a drum containing a liquid cannot be moved without rupture, its contents should be immediately transferred to a sound drum. Leaking drums that contain sludges or semi-solids, open drums that contain liquid or solid waste, and deteriorated drums that can be moved without rupture should be placed in overpack containers.

   E. Prior to initiating subsurface excavation, ground-penetrating systems should be used to confirm the location and depth of

drums. Soil should be removed with caution to minimize the potential for drum rupture. In addition, a dry chemical fire extinguisher should be available to control small fires.

3. Drum Opening

   A. Drums are usually opened and sampled in place during site investigations. However, remedial and emergency operations may require a separate drum opening area.

   B. Keep personnel at a safe distance from the drums being opened; place explosion-resistant plastic shields between personnel and the drums for protection in case of detonation; locate controls for drum opening equipment, monitoring equipment, and fire suppression equipment behind the explosion-resistant plastic shield;

   C. Conduct air monitoring during drum-opening activities;

   D. Use non-sparking bronze-beryllium tools when possible;

   E. Use remote-controlled devices for opening drums, when feasible;

   F. If the drum shows signs of swelling or bulging, perform all steps slowly and relieve excess pressure prior to opening;

   G. Open exotic metal drums and polyethylene or polyvinyl chloride-lined drums through the bung by removal or drilling;

   H. Do not open or sample individual containers within laboratory packs;

   I. Reseal open bungs and drill openings as soon as possible; and

   J. Decontaminate or replace equipment after each use to avoid mixing incompatible wastes.

4. DRUM SAMPLING

   A. Drum sampling can be hazardous to worker health and safety because it can involve direct contact with unidentified wastes. Prior to collecting samples, a sampling plan should be developed, including; (1) research about the waste; (2) identification of drums to be sampled; (3) selection of appropriate sampling devices(s) and container(s); (4) determination of the number, volume, and locations of samples to be taken; and (5) development of procedures for opening drums, sampling, and sample packaging and transportation. A trained health and safety professional should determine the appropriate personal protection to be used during sampling, decontamination, and packaging of the sample.

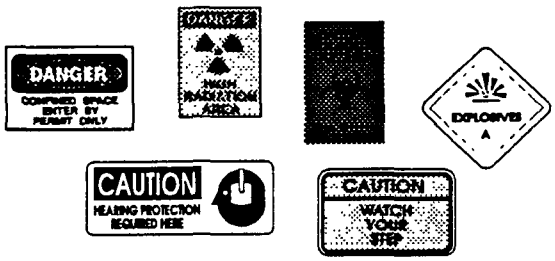
SAFETY CONSIDERATIONS

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Describe safety considerations for Superfund workers engaged in waste site activities.

SAFETY CONSIDERATIONS



SAFETY CONSIDERATIONS

- Emergency response
- Confined space entry
- Specific safety hazards

SAFETY CONSIDERATIONS: EMERGENCY RESPONSE PLANS

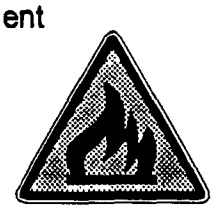
- Elements of an emergency response plan
  - 29 CFR 1910.120 (l)
  - 29 CFR 1910.120 (q)
- Training and practice
- Alarms and signals
- Emergency Action Plan 29 CFR 1910.38

SAFETY CONSIDERATIONS: EMERGENCY RESPONSE PLANS (cont.)

- Stay alert to hazardous situations
- Establish effective communication
- Prepare a site map
  - Essential for site operations and emergency plans

SAFETY CONSIDERATIONS: FLAMMABLE HAZARDS

- Conduct monitoring for flammable vapors
- Keep ignition sources away from area
- Use nonsparking equipment
- Action levels:
  - >25% LEL
  - >10% LEL confined space



SAFETY CONSIDERATIONS: OXYGEN HAZARDS

- Gases/vapors may displace oxygen
- Monitor for oxygen levels
- Action levels:
  - <19.5% oxygen
  - >25% oxygen

SAFETY CONSIDERATIONS: RADIATION HAZARDS

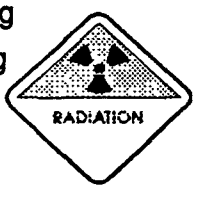
TYPE	FORM	NUMBER OF IONIZATIONS (per cm in air)	BIOLOGICAL HAZARD
Alpha α	Particle	Hundreds of thousands	Internal
Beta β	Particle	Hundreds	Internal and external
Gamma γ	Photon	1	External

SAFETY CONSIDERATIONS: RADIATION MONITORING

- Monitor for low and high levels of radiation
- Monitor for Alpha, Beta and Gamma
- Personnel monitoring for radiation contamination
- 29 CFR 1910.1096
  - 1.25 REM per quarter

SAFETY CONSIDERATIONS: RADIATION MONITORING (cont.)

- Area survey
- Point surveys
- Downwind monitoring
- Container monitoring



SAFETY CONSIDERATIONS: BIOLOGICAL HAZARDS

- Medical waste
- Animals
- Insects
- Plants
- Biological hazards present physical and psychological hazards

SAFETY CONSIDERATIONS: COMMON SAFETY HAZARDS

- Slip, trip and fall hazards
- Puncture hazards
- Heavy equipment hazards
- Electrocution hazards

SAFETY CONSIDERATIONS: NOISE HAZARDS

- Conduct a noise survey
- OSHA PEL for noise is 90 dB
- Establish hearing conservation program when noise levels reach an 85 dB TWA
- Provide and use noise protection equipment

SAFETY CONSIDERATIONS: PERMIT REQUIRED CONFINED SPACE

- 29 CFR 1910.146 permit required for confined spaces
- Limited openings and exits
- Not intended for continuous employee occupancy
- Employee can bodily enter the confined space

SAFETY CONSIDERATIONS: PERMIT REQUIRED CONFINED SPACE (cont.)

- Requires a permit
- Each team has responsibilities and training requirements under this standard
  - Entry team
  - Attendants and supervisors
  - Rescue team

SAFETY CONSIDERATIONS

1. Emergency Response.

A. One of the most important components of the HASP is the written site-specific emergency response plan. The emergency response plan should be designed as a separate section of the HASP, and must be compatible and integrated with the disaster, fire, and/or emergency response plans of local, state, and federal agencies. The plan must include a description of how anticipated emergencies would be handled at the site and how the risks associated with a response would be minimized. The emergency response plan must be developed and implemented prior to commencing operations at a site.

B. In lieu of preparing an emergency response plan, site managers may prepare an emergency action plan in accordance with 29 CFR §1910.38(a). This plan may only be developed in lieu of the emergency response plan if employees are evacuated from the site when an emergency occurs, and are not permitted to assist in responding to the emergency. An emergency action plan includes an evacuation plan in which persons responsible for an orderly exit are identified. These designated individuals would direct employees to leave the site and maintain a safe distance, and would also call the appropriate emergency response organization.

2. Explosion and Fire Hazards.

A. Explosions and fires may arise spontaneously, although they more commonly result from site activities. In addition to the normal dangers of intense heat, open flame, smoke inhalation, and flying objects, an explosion or fire at a hazardous waste site poses the additional threat of potentially releasing hazardous substances into the atmosphere.

3. Oxygen Deficiency Hazards.

A. Oxygen deficiency may result from the displacement of oxygen by another gas, or the consumption of oxygen by a chemical reaction. Confined spaces or low-lying areas are particularly vulnerable to oxygen deficiency and should always monitor oxygen levels and should use atmosphere-supplying respiratory equipment when oxygen concentration drop below 19.5 percent.

4. Ionizing Radiation Hazards.

A. Alpha radiation has limited penetration ability and is usually stopped by clothing and the outer layers of the skin. Alpha radiation is a positively charged particle and poses little threat outside the body.

B. Beta radiation can cause harmful "beta burns" to the skin and damage the subsurface blood system. Both alpha and beta radiation can be hazardous if radioactive materials emitting alpha or beta radiation are introduced into the body.

C. Gamma radiation passes easily through clothing and human tissue and can also cause serious permanent damage to the body. Chemical-protective clothing affords no protection against gamma radiation itself; however, use of respiratory and other protective equipment can help keep radioactive materials from entering the body.

D. If levels of radiation above natural background levels are discovered, a health physicist should be consulted. At levels greater than 1 millirem per hour, all site activities should cease until the site has been assessed by health physicists.

5. Biological Hazards.

A. Wastes from hospitals and research facilities may contain disease-causing organisms that could infect site personnel. Like chemical hazards, pathogens may be dispersed in the

environment via water and wind. Other biologic hazards that may be present include poisonous plants, insects, animals, and indigenous pathogens.

6. Safety Hazards.

   A. Hazardous waste sites may contain a variety of safety hazards, including holes, ditches, precariously positioned or sharp objects, slippery surfaces, steep grades, uneven terrain, and unstable surfaces. In addition to those safety hazards that are a function of the site, many safety hazards that are a function of the work itself. Heavy equipment creates an additional hazard for workers in the vicinity of the operating equipment. PPE can impair workers' vision, hearing, or agility. Removal of wastes can create physical hazards at the site that were not present prior to the beginning of operations.

   B. One potential hazard that results from a variety of sources is electrocution. Overhead power lines, downed electrical wires, and buried cables all pose a danger of shock or electrocution if workers come into contact with or sever them during site operations. The OSHA standards at 29 CFR §1910.136 describe proper clothing and equipment for protection against electrical hazards.

7. Noise Hazards.

   A. The OSHA-Permissible Exposure Limit (PEL) for an 8-hour work day, 40-hour work week is 90 decibels, as recorded on a sound level meter on the A weighted scale (dBA). If the 8-hour time weighted average noise exposures equal or exceed 85 dBA, the site manager must implement a hearing conservation program. If feasible administrative and engineering controls do not reduce sound levels to within acceptable limits, employees should use appropriate PPE to reduce personal exposure.

   B. Impulsive or Impact Noise. No exposures in excess of 140 dB peak sound pressure level are permitted. Impulsive or impact noise is considered to be a variation in noise levels that involves maxima at intervals of greater than one second. Where the intervals are less than one second, exposure should be considered continuous and should be integrated into the time weighted average.

8. Work Hazards.

   A. The nature of the work done at a hazardous waste site can contribute to the health and safety risks at the site. Trench excavation can increase the instability of the site and increase the risk of a "cave in" or collapse. Moving chemical drums may injure a worker if the drum ruptures, spilling chemicals in higher quantity than the protective clothing was designed to accommodate. Drums also pose the threat of back injury or a hernia if those workers moving them do not take proper precautions.

9. Confined Space Entry Hazards.

   A. The Confined Space Standards at 29 CFR §1910.146 may provide the basis upon which to develop a program for entry into confined spaces that pose potential health and safety risks. A confined space is defined as any location that an employee can bodily enter, has limited openings for entry and egress, and is not intended for continuous employee occupancy.

   B. The following elements of confined site entry should be addressed at each site:

      a. Hazards information and control;
      b. Employee training and information;
      c. Prevention of unauthorized entry;
      d. Equipment;
      e. Emergency rescue;
      f. Protection from external hazards;
      g. Training and duties of authorized entrants, attendants, rescue team, and individuals authorizing or in charge of entry.

   C. Before entry could be made into a confined space, a confined space checklist should be completed and signed.

   D. A hazard evaluation should be conducted before any work in a confined space is

started, to identify existing or potential work area hazards that have the potential to cause injuries, illness, or property damage. Examples of work are hazard control items include unguarded openings, high or low temperatures, poor illumination, sharp edges, steam, compressed gases and liquids, flammable or combustible materials, and mechanical or electrical exposures. When dealing with hazards that cannot be eliminated or controlled, adequate PPE should be used.

E. Prior to entry into a confined space, consideration should be given to how life support systems would function in the event of a power failure. For example, in the event of electrical failure, air supply pumps, lights, warning systems, and other electrically powered devices would be inoperative. Site personnel should have an emergency plan of action that provides alternate life support systems and a means of escape from the confined space. The Site Health and Safety Officer should have communicated this plan to all employees engaged in work in confined space.

F. Each employee entering a confined space should wear a safety belt equipped with a life-line for evacuation purposes in case of an emergency. If the entry is through a top opening, the safety belt should be of the harness type that will suspend a person in an upright position.

DECONTAMINATION

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Identify and describe personnel and equipment decontamination requirements.

DECONTAMINATION

DECONTAMINATION LOCATION

- Located in the Contamination Reduction Zone (CRZ)
- 15 x 75 foot minimum size
- Decontaminate heavily-contaminated PPE first
- Establish clearly-marked entry and exit points
- Establish decontamination procedures for Levels A – C

PHYSICAL REMOVAL OF CONTAMINANTS

- Wipe/brush/scrape
- Soap and water
- Freeze/solidify/melt

CHEMICAL REMOVAL OF CONTAMINANTS

- Solvents for equipment decontamination
- Neutralization
- Industrial hygienist oversight
- Combination of physical and chemical decontamination

DECONTAMINATION

1. All personnel, clothing, equipment, and samples leaving the contaminated area of a site (the Exclusion Zone) must be decontaminated to remove any harmful chemicals or infectious organisms that may have adhered to them. Step-by-step procedures for decontamination of personnel wearing PPE Levels A through C are described in pages 7 through 9.

2. Three general types of decontamination methods are commonly used: (1) physical removal of contaminants; (2) inactivation of contaminants by chemical detoxification of disinfection/sterilization; or (3) a combination of both physical and chemical means.

   A. Physical Removal of Contaminants

      a. In many cases, contaminants may be removed by physical means; however, high pressure and/or heat should be used only as necessary and with caution because they can spread contamination and cause burns.

      b. Loose Contaminants. Soils or dusts that cling to equipment and personnel or that become lodged in PPE materials can be removed with water or a liquid rinse. Commercially available anti-static solutions may help to remove electrostatically attached particles.

      c. Adhering Contaminants. Some contaminants adhere by forces other than electrostatic attraction. Adhesive qualities vary greatly with the specific contaminants and the temperature. For example, contaminants such as glues, cements, resins, and muds have great adhesive properties and, consequently, are difficult to remove by physical means. Adhesive contaminants can be removed using methods such as solidification, freezing (e.g., using dry ice or ice water), adsorption or absorption (e.g., with powdered lime or kitty litter), or melting.

      d. Volatile Liquids. Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation (using steam jets) followed by a water rinse. This method should be used with caution because of the potential for employees to inhale the vaporized hazardous chemicals.

   B. Chemical Removal of Contaminants

      a. Physical removal of gross contamination should be followed by washing and rinsing with cleaning solutions. These solutions normally use one or more of the following methods:

      b. Dissolving Contaminants. Chemical removal of surface contaminants can be accomplished by dissolving them in a solvent that must be chemically compatible with the equipment being cleaned. This is particularly important when decontaminating personal protective clothing constructed of organic materials that could be damaged or dissolved by organic solvents. In addition, any flammable or toxic organic solvents must be used and disposed of cautiously. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products.

      c. Halogenated solvents are toxic and generally are incompatible with most types of PPE. They should be used only for decontamination in extreme cases where other cleaning agents will not remove the contaminant. Because of the potential hazards, decontamination using chemicals

should be done only if recommended by an industrial hygienist or other qualified health professional.

C. Combination of physical and chemical removal.

a. Surfactants. Surfactants supplement physical cleaning methods by minimizing adhesion between contaminants and the surface being cleaned and, therefore, prevent recontamination. Among the detergents, some of which can be sued with organic solvents to improve the dissolving and dispersal of contaminants into the solvent.

b. Solidification. Solidifying liquid or gel contaminants can enhance their physical removal. Contaminants may be solidified by: (1) using absorbents such as grounded clay or powder lime to remove moisture; (2) chemical reactions using polymerization catalysts and chemical reagents; and (3) freezing with ice water.

c. Rinsing. Rinsing removes contaminants through dilution, physical attraction, and solubilization. Multiple rinses with clean solutions remove more contaminants that a single rinse with the same volume of solution. Continuous rinsing with large volumes is the most effective way to remove contaminants.

d. Disinfection/Sterilization. Chemical disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization techniques are generally impractical for large equipment and PPE. For this reason, disposable PPE is recommended for use with infectious agents.

3. Decontamination Equipment

A. Decontamination equipment, materials, and supplies are generally selected based on availability. It is also necessary to consider whether the equipment itself can be decontaminated for reuse or can be easily disposed of. Most equipment and supplied needed for decontamination are easily procured (e.g., soft bristle and long handled brushes for scrubbing; buckets or garden sprayers for rinsing; large galvanized wash tubs or stock tanks for solutions; and large plastic garbage cans or other similar lined containers for storing contaminated clothing and equipment). Other decontamination gear includes paper or cloth towels for drying protective clothing and equipment.

4. Determining the effectiveness of decontamination.

A. Currently, there ar no available methods for immediately determining the effectiveness of decontamination procedures. Discolorations, stains, corrosive effects, and substances adhering to objects may indicate contaminants have not been removed. However, observable effects only indicate surface contamination and not permeation (absorption) into clothing, tools, or equipment. Also, many contaminants are not easily observed.

B. One method for determining effectiveness of surface decontamination is swipe testing. Cloth or paper patches are wiped over predetermined surfaces of the suspect object and analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be swipe tested. Positive indications of both sets of swipes would indicate surface contamination has not been removed and substances have penetrated or permeated through the garment.

C. Determining permeation of contaminants into protective garments requires laboratory analysis of a piece of the material. Both swipe and permeation testing provide after-the-fact information. Along with visual observations, results of these tests can help evaluate the effectiveness of decontamination.

Exerpt from:
OSHA Technical Manual
SECTION VIII: CHAPTER 1

I. DECONTAMINATION PROCEDURES.

A. DEFINITION AND TYPES.

1. Decontamination is the process of removing or neutralizing *contaminants that have accumulated* on personnel and equipment. This process is critical to health and safety at hazardous material response sites. Decontamination protects end users from hazardous substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, tools, vehicles, and other equipment used in the vicinity of the chemical hazard; it protects all plant or site personnel by minimizing the transfer of harmful materials into clean areas; it helps prevent mixing of incompatible chemicals; and it protects the community by preventing uncontrolled transportation of contaminants from the site.

2. There are two types of decontamination:

   a. Gross decontamination: To allow end user to safely exit or doff the chemical protective clothing.

   b. Decontamination for reuse of chemical protective clothing.

B. PREVENTION OF CONTAMINATION.

The first step in decontamination is to establish Standard Operating Procedures that minimize contact with chemicals and thus the potential for contamination. For example:

1. Stress work practices that minimize contact with hazardous substances (e.g. do not walk through areas of obvious contamination, do not directly touch potentially hazardous substances).

2. Use remote sampling, handling, and container-opening techniques (e.g. drum grapples, pneumatic impact wrenches).

3. Protect monitoring and sampling instruments by bagging. Make openings in the bags for sample ports and sensors that must contact site materials.

4. Wear disposable outer garments and use disposable equipment where appropriate.

5. Cover equipment and tools with a strippable coating that can be removed during decontamination.

6. Encase the source of contaminants, e.g. with plastic sheeting or overpacks.

7. Ensure all closures and ensemble component interfaces are completely secured; and that no open pockets that could serve to collect contaminant are present.

C. TYPES OF CONTAMINATION.

1. Surface Contaminants. Surface contaminants may be easy to detect and remove.

2. Permeated Contaminants. Contaminants that have permeated a material are difficult or impossible to detect and remove. If contaminants that have permeated a material are not removed by decontamination, they may continue to permeate the material where they can cause an unexpected exposure.

3. Four major factors affect the extent of permeation:

   a. Contact time. The longer a contaminant is in contact with an object, the greater the probability and extent of permeation. For this reason, minimizing contact time is one of the most important objectives of a decontamination program.

b. Concentration. Molecules flow from areas of high concentration to areas of low concentration. As concentrations of chemicals increase, the potential for permeation of personal protective clothing increases.

c. Temperature. An increase in temperature generally increases the permeation rate of contaminants.

d. Physical state of chemicals. As a rule, gases, vapors, and low-viscosity liquids tend to permeate more readily than high-viscosity liquids or solids.

D. DECONTAMINATION METHODS.

1. Decontamination methods either (1) physically remove contaminants; (2) inactivate contaminants by chemical detoxification or disinfection/ sterilization; or (3) remove contaminants by a combination of both physical and chemical means.

2. In general, gross decontamination is accomplished using detergents (surfactants) in water combined with a physical scrubbing action. This process will remove most forms of surface contamination including dusts, many inorganic chemicals, and some organic chemicals. Soapy water scrubbing of protective suits may not be effective in removing oily or tacky organic substances (e.g. PCB's in transformer oil). Furthermore, this form of decontamination is unlikely to remove any contamination that has permeated or penetrated the suit materials. Using organic solvents such as petroleum distillates may allow easier removal of heavy organic contamination but may result in other problems, including:

a. Permeation into clothing components, pulling the contaminant with it;

b. Spreading localized contaminant into other areas of the clothing; and

c. Generating large volumes of contaminated solvents that require disposal.

3. One promising method for removing internal or matrix contamination is the forced circulation of heated air over clothing items for extended periods of time. This allows many organic chemicals to migrate out of the materials and evaporate into the heated air. The process does require, however, that the contaminating chemicals be volatile. Additionally, low level heat may accelerate the removal of plasticizer from garment materials and affect the adhesives involved in garment seams.

4. Unfortunately, both manufacturers and protective clothing authorities provide few specific recommendations for decontamination. There is no definitive list with specific methods recommended for specific chemicals and materials. Much depends on the individual chemical-material combination involved.

E. TESTING THE EFFECTIVENESS OF DECONTAMINATION.

1. Protective clothing or equipment reuse depends on demonstrating that adequate decontamination has taken place. Decontamination methods vary in their effectiveness and unfortunately there are no completely accurate methods for nondestructively evaluating clothing or equipment contamination levels.

2. Methods which may assist in a determination include:

a. Visual examination of protective clothing for signs of discoloration, corrosive effects, or any degradation of external materials. However, many contaminants do not leave any visible evidence.

b. Wipe sampling of external surfaces for subsequent analysis; this may or may not be effective for determining

levels of surface contamination and depends heavily on the material-chemical combination. These methods will not detect permeated contamination.

c. Evaluation of the cleaning solution. This method cannot quantify clean method effectiveness since the original contamination levels are unknown. The method can only show if chemical has been removed by the cleaning solution. If a number of garments have been contaminated, it may be advisable to sacrifice one garment for destructive testing by a qualified laboratory with analysis of contamination levels on and inside the garment.

F. DECONTAMINATION PLAN.

1. Decontamination plan should be developed and set up before any personnel or equipment are allowed to enter areas where the potential for exposure to hazardous substances exists. The decontamination plan should:

   a. Determine the number and layout of decontamination stations;

   b. Determine the decontamination equipment needed;

   c. Determine appropriate decontamination methods;

   d. Establish procedures to prevent contamination of clean areas;

   e. Establish methods and procedures to minimize wearer contact with contaminants during removal of personal protective clothing; and

   f. Establish methods for disposing of clothing and equipment that are not completely decontaminated.

2. The plan should be revised whenever the type of personal protective clothing or equipment changes, the use conditions change, or the chemical hazards are reassessed based on new information.

3. The decontamination process should consist of a series of procedures performed in a specific sequence. For chemical protective ensembles, outer, more heavily contaminated items (e.g. outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g. jackets and pants). Each procedure should be performed at a separate station in order to prevent cross contamination. The sequence of stations is called the decontamination line.

4. Stations should be separated physically to prevent cross contamination and should be arranged in order of decreasing contamination, preferably in a straight line. Separate flow patterns and stations should be provided to isolate workers from different contamination zones containing incompatible wastes. Entry and exit points to exposed areas should be conspicuously marked. Dressing stations for entry to the decontamination area should be separate from redressing areas for exit from the decontamination area. Personnel who wish to enter clean areas of the decontamination facility, such as locker rooms, should be completely decontaminated.

5. All equipment used for decontamination must be decontaminated and/or disposed of properly. Buckets, brushes, clothing, tools, and other contaminated equipment should be collected, placed in containers, and labeled. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags, pending further decontamination and/or disposal.

6. Decontamination of workers who initially come in contact with personnel and equipment leaving exposure or contamination areas will require more protection from contaminants than decontamination workers who are assigned to the last station in the

decontamination line. In some cases, decontamination personnel should wear the same levels of protective clothing as workers in the exposure or contaminated areas. In other cases, decontamination personnel may be sufficiently protected by wearing one level lower protection (e.g. wearing Level B protection while decontaminating workers who are wearing Level A).

G. DECONTAMINATION FOR PROTECTIVE CLOTHING REUSE.

Due to the difficulty in assessing contamination levels in chemical protective clothing before and after exposure, the responsible supervisor or safety professional must determine if the respective clothing can be reused. This decision involves considerable risk in determining clothing to be contaminant-free. Reuse can be considered if, in the estimate of the supervisor:

1. No "significant" exposures have occurred.
2. Decontamination methods have been successful in reducing contamination levels to safe or acceptable concentrations.

Contamination by known or suspected carcinogens should warrant automatic disposal. Use of disposable suits is highly recommended when extensive contamination is expected.

H. EMERGENCY DECONTAMINATION.

1. In addition to routine decontamination procedures, emergency decontamination procedures must be established. In an emergency, the primary concern is to prevent the loss of life or severe injury to personnel. If immediate medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. 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 or loss of life, decontamination should be continued.
2. If an emergency due to a heat-related illness develops, protective clothing should be removed from the victim as soon as possible to reduce the heat stress. During an emergency, provisions must also be made for protecting medical personnel and disposing of contaminated clothing and equipment.

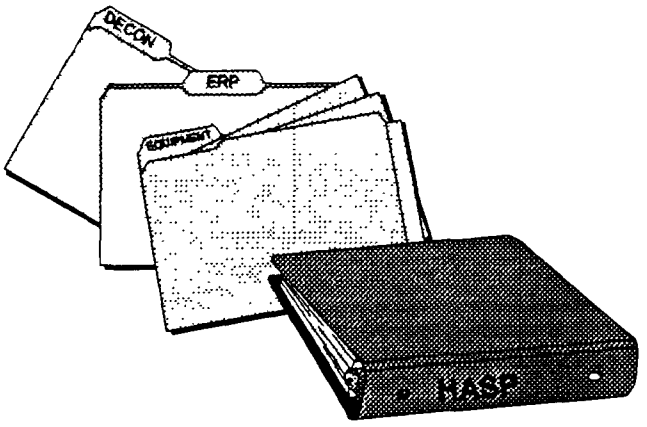
HEALTH AND SAFETY PLANS (HASP)

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Identify and describe all elements of health and safety plans where workers are engaged in hazardous waste operations.
2. Prepare a basic health and safety plan for site work.
3. Describe the objectives of health and safety plans required by 29 CFR 1910.120.

HEALTH AND SAFETY PLANS



OBJECTIVES

- Site specific
- Each phase of site operations
- Procedures to protect employees

ELEMENTS

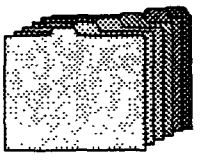
- Introduction
- Key personnel
- Health and safety risk analysis
- Training
- PPE
- Medical surveillance
- Air monitoring

ELEMENTS (cont.)

- Site control
- Decontamination plan
- Emergency response plan
- Confined space procedures
- Spill containment program
- Hazard communication

SITE CHARACTERIZATION PROCESS

- Initial draft of HASP
- Initial site entry
- Revision of HASP
- On-going monitoring



ACTION LEVELS

MONITORING EQUIPMENT	ACTION LEVEL
CGI – CONFINED SPACE	>25% LEL >10% LEL
OXYGEN	<19.5% AND >23.5%
RADIATION	>1mR/hr
TOXIC HAZARDS	PEL/TLV AND IDLH

Health and Safety Plans (HASP)

1. A site-specific HASP.

   A. HAZWOPER regulations at 29 CFR §1910.120(b)(4) require that a site-specific HASP be developed for each site where workers are engaged in hazardous waste operations. The purpose of the site-specific HASP is to address the health and safety hazards that may exist at each phase of site operations and to identify procedures for protecting employees.

2. HASP development.

   A. A new HASP should not be developed if new tasks or hazards are identified at a site; rather, the original HASP should be updated. If a subcontractor is working at a site, the subcontractor should carefully evaluate and identify all tasks associated with the subcontracted activities, and prepare a health and safety plan addressing any identified hazards. This plan should be submitted to the site manager, who will incorporate it into the general site HASP after it has been reviewed for concurrence with the site workplan.

3. Preliminary Evaluation.

   A. The first step in developing a HASP is to perform a preliminary evaluation (PE) of the site's characteristics. The PE must be accomplished off-site, so as not to endanger the health and safety of site workers. The purpose of the PE is to obtain preliminary information to help identify the specific hazards at the site and determine the appropriate health and safety control procedures (e.g., engineering controls, personal protective equipment (PPE), and any additional medical surveillance needs) that are necessary to ensure the protection of employees who perform tasks on-site.

4. Initial draft of the HASP.

   A. Once the PE is completed and the appropriate information has been obtained, the information is used to develop the initial draft of the site-specific HASP. Specifically, it must identify each work operation or activity, and describe how those hazards will be eliminated or controlled.

   B. It must also indicate that employees have received training and are enrolled in a medical surveillance program. In addition, the HASP should identify appropriate monitoring procedures and PPE for the initial site entry. The HASP must remain on-site at all items and only one HASP should be developed for each site.

5. Initial site entry.

   A. Once the HASP has been developed and implemented, the second stage of the site characterization and analysis (i.e., initial site entry) may begin. The purpose of the initial site entry is to gather additional information and further evaluate the site-specific risks and hazards for use in selecting and developing appropriate engineering controls, site controls, medical monitoring plans, and PPE.

6. The sample HASP Table of Contents are listed in Table 1.

TABLE 1
Sample HASP Table of Contents

1.0 INTRODUCTION
1.1 Scope of Applicability of the Site Health and Safety Plan
1.2 Visitors

2.0 KEY PERSONNEL/IDENTIFICATION OF HEALTH AND SAFETY PERSONNEL
2.1 Key Personnel
2.2 Site-Specific Health and Safety Personnel
2.3 Organizational Responsibility

3.0 TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS
3.1 Historical Overview of Site
3.2 Task-by-Task Risk Analysis

4.0 PERSONNEL TRAINING REQUIREMENTS
4.1 Pre-assignment and Annual Refresher Training
4.2 Site Supervisors Training
4.3 Training and Briefing Topics

5.0 PERSONAL PROTECTIVE EQUIPMENT TO BE USED
5.1 Levels of Protection
5.2 Level A Personal Protective Equipment
5.3 Level B Personal Protective Equipment
5.4 Level C Personal Protective Equipment
5.5 Level D Personal Protective Equipment
5.6 Reassessment of Protection Program
5.7 Work Mission Duration
5.8 Chemical Resistance and Integrity of Protective Material
5.9.5 SCBA Inspection and Checkout
5.10.1 Inspection

6.0 MEDICAL SURVEILLANCE REQUIREMENTS
6.1 Baseline or Pre-assignment Monitoring
6.2 Periodic Monitoring
6.3 Site-Specific Medical Monitoring
6.4 Exposure/Injury/Medical Support
6.5 Exit Physical

TABLE 1 (cont.)

7.0	**FREQUENCY AND TYPES OF AIR MONITORING/SAMPLING**
7.1	Direct-Reading Monitoring Instruments
7.3.1	Site Air Monitoring and Sampling Procedures
8.0	**SITE CONTROL MEASURES**
8.1	Buddy System
8.2	Site Communications Plan
8.3	Work Zone Definition
8.4	Nearest Medical Assistance
8.5	Safe Work Practices
8.6	Emergency Alarm Procedures
9.0	**DECONTAMINATION PLAN**
9.1	Standard Operating Procedures
9.2	Levels of Decontamination Protection Required for Personnel
9.3	Equipment Decontamination
9.4	Disposition of Decontamination Wastes
10.0	**EMERGENCY RESPONSE REQUIREMENTS**
10.1	Pre-Emergency Planning
10.2	Personnel Roles and Lines of Authority
10.3	Emergency Recognition/Prevention
10.4	Evacuation Routes/Procedures
10.7	Emergency Contact/Notification System
10.8	Emergency Medical Treatment Procedures
10.9	Fire or Explosion
10.10	Spill or Leaks
10.11	Emergency Equipment/Facilities
11.0	**CONFINED SPACE ENTRY PROCEDURES (29 CFR §1910.146)**
11.1	Definitions
11.2	General Provisions
11.3	Procedures for Confined Space Entry
11.4	Confined Space Observer (Stand-by Person)
12.0	**SPILL CONTAINMENT PROGRAM**
13.0	**HAZARD COMMUNICATION**

This sample HASP Table of Contents reflects health and safety considerations for a sample hazardous waste site. The site-specific HASP must address site-specific hazards and activities.

Student Exercise

1. The preliminary evaluation is performed:

   a. Off-site
   b. On-site

2. The oxygen level is 15% and the Combustible Gas Indicator shows 0% LEL. Can a combustible hazard be ruled out?

   a. Yes
   b. No

3. The health risk of a toxic chemical would be evaluated in this element of the HASP:

   a. PPE
   b. Health and safety risk analysis
   c. Air monitoring

4. The CGI action level for routine site work on a Superfund site is 25% LEL.

   a. True
   b. False

MEDICAL SURVEILLANCE

Student Performance Objectives

Upon completion of this unit, students will be able to:

1. Identify medical monitoring requirements for workers on Superfund sites.

MEDICAL SURVEILLANCE

MEDICAL SURVEILLANCE

Objectives of medical surveillance:

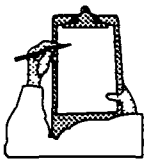
- Monitoring site worker health
- Determine medical condition
- Minimize site worker exposure
- Helps to establish duties and PPE limitations

MEDICAL SURVEILLANCE (cont.)

- Base line examination
- Annual examination
  - More frequent
  - Every two years
- Physician must use HAZWOPER standard
- Reassignment
- Termination examination

MEDICAL SURVEILLANCE (cont.)

- Based on results of exam and tests
- Recommendations for duties
- Recommendations for PPE and use of respirators



Medical Surveillance

1. Medical Surveillance Requirements.

   A. All employees who are required by HAZWOPER to participate in a medical surveillance program must undergo a baseline medical examination prior to a field assignment. After this initial examination, employees must have a follow-up medical exam at least once per year, unless an attending physician believes a longer interval is appropriate. This longer interval, however, cannot exceed 2 years.

   B. Once an exam has been completed, the physician must submit a written opinion to the employer who then has the responsibility to provide that opinion to the employee. The opinion must contain:

      (1). The results of the medical examination and tests;

      (2). Any recommended work limitations; and

      (3). The physician's opinion concerning the medical condition of the employee, including any conditions that need further examination and treatment, or that would place the employee at an increased risk of injury from respirator use or work in a hazardous substance environment.

2. Baseline Screening.

   A. Pre-placement or baseline screening has two major functions: (1) to determine an individuals's fitness for duty, including the ability to work while wearing protective equipment; and (2) to provide baseline data for comparison with future medical data. To ensure that prospective employees are able to meet work requirements, the pre-placement screening should focus on the following areas:

3. Termination Examination.

   A. At the end of employment as a hazardous waste site worker, all personnel should have a termination medical examination. A full examination is necessary at the termination of employment if any of the following criteria are not met:

      (1). The last full medical examination was within the last 6 months;

      (2). No exposure occurred since the last examination; and

      (3). No symptoms associated with exposure occurred since the last examination.

4. Retention of Medical Records.

   A. Medical records for employees must be maintained for at least 30 years after employment is terminated. These records must include the name and social security number of the employee, the physician's written opinions including recommended occupational limitations and results of examinations and tests, any employee medical complaints related to occupational hazardous substance exposure, and a copy of the material that the attending physician was provided before the examination.

Excerpt from: 29 CFR §1910.134 (e) Medical Evaluation 1910.134(e)

(e) Medical evaluation. Using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee. Accordingly, this paragraph specifies the minimum requirements for medical evaluation that employers must implement to determine the employee's ability to use a respirator.

(e)(1) General. The employer shall provide a medical evaluation to determine the employee's ability to use a respirator, before the employee is fit tested or required to use the respirator in the workplace. The employer may discontinue an employee's medical evaluations when the employee is no longer required to use a respirator.

(e)(2) Medical evaluation procedures.

(e)(2)(i) The employer shall identify a physician or other licensed health care professional (PLHCP) to perform medical evaluations using a medical questionnaire or an initial medical examination that obtains the same information as the medical questionnaire.

(e)(2)(ii) The medical evaluation shall obtain the information requested by the questionnaire in Sections 1 and 2, Part A of Appendix C of this section.

(e)(3) Follow-up medical examination.

(e)(3)(i) The employer shall ensure that a follow-up medical examination is provided for an employee who gives a positive response to any question among questions 1 through 8 in Section 2, Part A of Appendix C or whose initial medical examination demonstrates the need for a follow-up medical examination.

(e)(3)(ii) The follow-up medical examination shall include any medical tests, consultations, or diagnostic procedures that the PLHCP deems necessary to make a final determination.

(e)(4) Administration of the medical questionnaire and examinations.

(e)(4)(i) The medical questionnaire and examinations shall be administered confidentially during the employee's normal working hours or at a time and place convenient to the employee. The medical questionnaire shall be administered in a manner that ensures that the employee understands its content.

(e)(4)(ii) The employer shall provide the employee with an opportunity to discuss the questionnaire and examination results with the PLHCP.

(e)(5) Supplemental information for the PLHCP.

(e)(5)(i) The following information must be provided to the PLHCP before the PLHCP makes a recommendation concerning an employee's ability to use a respirator:

(e)(5)(i)(A) The type and weight of the respirator to be used by the employee;

(e)(5)(i)(B) The duration and frequency of respirator use (including use for rescue and escape);

(e)(5)(i)(C) The expected physical work effort;

(e)(5)(i)(D) Additional protective clothing and equipment to be worn; and

(e)(5)(i)(E) Temperature and humidity extremes that may be encountered.

(e)(5)(ii) Any supplemental information provided previously to the PLHCP regarding an employee need not be provided for a subsequent medical evaluation if the information and the PLHCP remain the same.

(e)(5)(iii) The employer shall provide the PLHCP with a copy of the written respiratory protection program and a copy of this section. Note to Paragraph (e)(5)(iii): When the employer replaces a PLHCP, the employer must ensure that the new PLHCP obtains this information, either by providing the documents directly to the PLHCP or having the documents transferred from the former PLHCP to the new PLHCP. However, OSHA does not expect employers to have employees medically reevaluated solely because a new PLHCP has been selected.

(e)(6) Medical determination. In determining the employee's ability to use a respirator, the employer shall:

(e)(6)(i) Obtain a written recommendation regarding the employee's ability to use the respirator from the PLHCP. The recommendation shall provide only the following information:

(e)(6)(i)(A) Any limitations on respirator use related to the medical condition of the employee, or relating to the workplace conditions in which the respirator will be used, including whether or not the employee is medically able to use the respirator;

(e)(6)(i)(B) The need, if any, for follow-up medical evaluations; and

(e)(6)(i)(C) A statement that the PLHCP has provided the employee with a copy of the PLHCP's written recommendation.

(e)(6)(ii) If the respirator is a negative pressure respirator and the PLHCP finds a medical condition that may place the employee's health at increased risk if the respirator is used, the employer shall provide a PAPR if the PLHCP's medical evaluation finds that the employee can use such a respirator; if a subsequent medical evaluation finds that the employee is medically able to use a negative pressure respirator, then the employer is no longer required to provide a PAPR.

(e)(7) Additional medical evaluations. At a minimum, the employer shall provide additional medical evaluations that comply with the requirements of this section if:

(e)(7)(i) An employee reports medical signs or symptoms that are related to ability to use a respirator;

(e)(7)(ii) A PLHCP, supervisor, or the respirator program administrator informs the employer that an employee needs to be reevaluated;

(e)(7)(iii) Information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee reevaluation; or

(e)(7)(iv) A change occurs in workplace conditions (e.g., physical work effort, protective clothing, temperature) that may result in a substantial increase in the physiological burden placed on an employee.