RESPIRATORY PROTECTION PROGRAM FOR AIR POLLUTION CONTROL INSPECTORS

STUDENT'S MANUAL

Prepared by:

Pacific Environmental Services, Inc.
560 Herndon Parkway, Suite 200
Herndon, Virginia 22070
(703) 471-8383

Prepared for:

U. S. Environmental Protection Agency
Air Pollution Training Institute
Manpower and Technical Information Branch
MD-17
Research Triangle Park, NC 27711

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TABLE OF CONTENTS

HANDOUT SUMMARY STATEMENTS

Handout 1	Handout 1 contains a listing of acronyms and definitions of key terms used throughout this manual.
Handout 2	Handout 2 contains EPA Orders 1440.2 and 1440.3. EPA Order 1440.2 establishes policy, responsibilities and mandatory requirements for occupational health and safety training, certification, and occupational medical monitoring of EPA employees engaged in field activities. EPA Order 1440.3 establishes EPA policy, responsibility, and basic requirements for protection of employees whose jobs require the use of respiratory protection devices. This document also provides background information of respiratory hazards and protection factors.
Handout 3	Handout 3 contains a guideline which provides management with sufficient information to establish and operate an respiratory protection program as required under EPA Order 1440.3, Respiratory Protection, and by the OSHA regulation 29 CFR 1910. 134. This guideline describes elements of a respirator protection program and includes the following: administration of the program, selection and use of respirators, training and fitting of employees, inspection and maintenance of respirators, and medical surveillance.
Handout 4	Handout 4 contains a revision of NIOSH' initial Respirator Decision Logic first developed in 1975 as part of the NIOSH/-OSHA Standards Completion Program. the NIOSH Decision Logic provides a logical series of step by step questions designed to assist the reader in the selection of the proper respirator based upon the hazards of the work environment. This document also incudes information on such topics as oxygen-deficient atmospheres, warning properties, and protection factors.

Handout 5	Handout 5 contains the OSHA respiratory protection regulations as found in 29 CFR 1910.134. These regulations establish the minimum requirements under the law regarding employee protection from respiratory hazards. Areas covered by the standard include respirator selection, distribution, and maintenance. Medical and work area surveillance along with specific requirements for respirators are also reviewed.
Handout 6	Handout 6 contains the ANSI standard practices for respiratory protection. This standard sets forth accepted practices for respirator use, provides information and guidance on the proper selection, use, and care of respirators, and contains recommended requirements for establishing and regulating respirator programs. These guidelines are directed at persons responsible for establishing, maintaining, and administering an acceptable respirator program.
Handout 7	Handout 7 is the ANSI standard for respiratory protection, respirator use, and the physical qualifications of personnel required to use respiratory protection. This standard provides examiners with guidelines for medical examination of those persons required to use respiratory protection.
Handout 8	Handout 8 contains the OSHA permissible exposure levels (PELs) for substances found in 29 CFR Part 1910.1000. This standard lists the maximum concentrations of substances to which an employee can be exposed to over an 8 hour work shift. The standard also lists short term exposure limits (STELs) and ceiling limits for substances.
Handout 9	Handout 9 contains the chemical resistance chart for selected protective gloves. This chart provides guidance is selecting thee proper glove based upon the physical and chemical conditions to be encountered. The chart compares each glove with certain chemicals, and glove ratings are deter-

mined by the effect the chemical has on the glove.

Handout 10

Handout 10 contains the EPA's Health and Safety Guidelines for EPA Asbestos Inspectors. These guidelines are designed to reduce the likelihood of injury or illness to EPA asbestos inspectors. This guideline provides information on respiratory and personal protection. This guideline also assists inspectors in assessing an asbestos abatement for compliance with OSHA asbestos standards. Attachment 1 to Handout 10 is Chapter 3 of the Occupational Health and Safety Manual. This document establishes uniform requirements for collecting and compiling occupational health and safety accident and illness data for the EPA's Management Information System. Attachment 2 to Handout 10 is the non-mandatory Appendices E and F of the Construction Industry Standards for asbestos removal, renovation, and demolition operations. This guideline provides guidance in the proper equipment, methods and procedures that should be used in asbestos removal projects.

Handout 11

Handout 11 is OSHA's proposed safety requirements for entry into confined spaces. This proposed standard will minimize the dangers involved in confined space entry by stating employer responsibilities when employees work in confined spaces.

Handout 12

Handout 12 is OSHA's proposed guidelines on occupational exposure to bloodborne pathogens such as Hepatitis B Virus (HBV) and the Human Immunodeficiency Virus (HIV). This proposal provides discussions on the health risks of occupational exposure to bloodborne pathogens. Health effects of exposure to bloodborne pathogens and control methods which can be utilized to reduce the possibility of exposure are also provided.

Handout 13

Handout 13 is a copy of Title 30, Mineral Resources. This document contains the MSHA regulations, established procedures and prescribed requirements which must be met by manufacturers filing for joint approval by MSHA and NIOSH of respirators or modifications to respirators. This document establishes set fees to be charged each applicant for inspections, examinations, and testing conducted by NIOSH. This section also provides for the issuance of certificates of approval for respirators meeting NIOSH criteria.

Handout 14

Handout 14 contains the introduction to the NIOSH Pocket Guide to Chemical Hazards. This handout summarizes how NIOSH develops recommendations and how to use the pocket guide. This section also contains the introduction to OSHA permissible exposure limits and the ACGIH's 1990-91 introduction to Threshold Limit Values for Chemical Substances in the Work Environment.

LECTURE 1

INTRODUCTION

LECTURE 1

INTRODUCTION

WELCOME AND REGISTRATION

Objectives

The students will know why they are receiving the training, the background of the instructors, and course scheduling. The pretest is designed only to provide the instructor with a general idea of the knowledge of the students with regards to respiratory protection.

Background

This section of the course provides the students with the topics which will be covered when they are assembled for the first time.

COURSE PURPOSE AND SCOPE

Handout 1, 2 & 3

A critical element of the air pollution control program is the State enforcement system. These programs are directly responsible for the attainment and maintenance of the ambient air quality through the enforcement of construction and operating limits for each source.

States are required by the Clean Air Act and regulations to develop and maintain a system to control emissions from stationary sources. Inspectors are required to make inspections in and around equipment which may require respi ratory protection.

The purpose of this training course for state, local, and federal inspectors is to ensure that they know when, where, and how to use the appropriate respiratory protection. This course will provide attendees with information on the consequences of exposures to air pollution sources and the importance of minimizing health and safety risks during air pollution field activities. Attendees are also provided with a description of available personnel protective equipment, including the uses and limitations of respirators. Equipment familiarization is accomplished by a "hands-on" session during the qualitative and quantitative fit-testing of the respirators.

COURSE AGENDA

RESPIRATORY PROTECTION PROGRAM

<u>DAY 1</u>

1:00 p.m. **WELCOME AND REGISTRATION**

A. Registration
B. Purpose and Scope of Course
C. Speaker's Background and Experience
D. Course Administration
E. Description of Handouts
F. Pretest
G. Correction of Pretests

1:45 p.m. **THE CONSEQUENCES OF EXPOSURE TO AIR POLLUTION SOURCE HEALTH AND SAFETY RISKS**

A. Dose-Response Curve Relationships
   1. General effect of dose on the probability of disease
   2. Threshold and no-threshold agents
   3. Synergistic actions
      a. Cigarette smoking and asbestos
      b. Carbon black and polycyclic aro matics
   4. Hypersensitivity

2:30 p.m. **Break**

2:45 p.m. **THE CONSEQUENCES OF EXPOSURE TO AIR POLLUTION SOURCE HEALTH AND SAFETY RISKS (CONTINUED)**

B. The Respiratory System
   1. Function and protective systems
      a. Basic physiology
      b. Sites of contaminant deposition
         (1) Soluble and insoluble gases and vapors
         (2) Dust particles and fume particles
         (3) Fibers
      c. Contaminant translocation to other organs

Agenda
Day 1 (Continued)

3:05 p.m. **THE CONSEQUENCES OF EXPOSURE TO AIR POLLUTION SOURCE HEALTH AND SAFETY RISKS (CONTINUED)**

2. Lung defense mechanisms
    a. Nasopharyngeal filtration
    b. Mucociliary removal pathway
    c. Phagocyte cells
3. Respiratory diseases

C. Other Routes of Entry
    1. Skin
    2. Eyes
    3. Ingestion

3:20 p.m. **Break**

3:30 p.m. **THE FUNDAMENTAL IMPORTANCE OF PERSONAL PROTECTIVE EQUIPMENT AND ADMINISTRATIVE CONTROLS TO MINIMIZE HEALTH AND SAFETY RISKS DURING AIR POLLUTION CONTROL FIELD ACTIVITIES**

A. General Procedures and Guidelines
    1. Inspection preparation
        a. Source file review
        b. Selection of personal protection equipment
    2. Inspection/testing conduct
        a. Working at a controlled pace
        b. Exercising safety judgement
        c. Limiting scope
    3. Personal hygiene
        a. Avoiding contact with contaminated surfaces and materials
        b. Avoiding eye, nose, and mouth contact
        c. Washing hands
        d. Eating in uncontaminated areas

4:30 p.m. **Adjourn**

Agenda
DAY 2

8:30 a.m. **INTRODUCTION TO THE USE OF RESPIRATORS**

A. Videotape: "Respiratory Protection"
B. Importance of Equipment
   1. Minimize risk of illness
   2. Minimize severity of illness
   3. Conform with plant safety requirements
C. Summary of Respirator Regulatory Requirements and Certification Procedures
   1. Role of OSHA and NIOSH
   2. OSHA Regulation 29 CFR 1910.134
D. Fundamental Principles of Respirator Use
   1. Engineering and administrative controls
   2. Written procedures
   3. Selection principles

10:00 a.m. **Break**

10:15 a.m. E. Types of Respirators
   1. Half-mask cartridge respirators
   2. Full facepiece cartridge respirators
   3. Full facepiece canister respirators
   4. Powered air purifying respirators
   5. Escape respirators
F. General Fit Testing Requirements and Procedures

11:15 a.m. **USES AND LIMITATIONS OF RESPIRATORS**

A. General Concepts
   1. Exposure limits
      a. NIOSH RELs
      b. OSHA Revised PELs
      c. ACGIH TLVs
   2. Respirator limits
      a. Respiratory protection factor limits
      b. Maximum use concentration
      c. Cartridge and canister limits
   3. Service life during air pollution field activities
      a. Breakthrough times for various pollutants
      b. Effect of air temperature and humidity
      c. Estimating service life and using end-of-service-life indicators

12:00 **Lunch**

Agenda
DAY 2

1:00 p.m. **USES AND LIMITATIONS OF RESPIRATORS (CONTINUED)**

B. Videotape: "Proper Use & Care of Air Purifying Respirators"

1:45 p.m. **RESPIRATOR "HANDS-ON" EXERCISES**

A. Comfort of Various Styles of Half-Mask, Full Facepiece, and Powered Air Purifying Respirators
B. Half-Mask, Full Facepiece, and Powered Air Purifying Respirator Pre-inspection Checks and Replacement of Components
C. Half-Mask, Full Facepiece, and Powered Air Purifying Respirator Cleaning, Disinfection and Storage
D. Positive and Negative Pressure Fit Checks for Air Purifying Respirators
E. Qualitative Fit Test Procedure for Air Purifying Respirators

3:00 p.m. **Break**

4:30 p.m. **Adjourn**

DAY 3

8:30 a.m. **RESPIRATOR "HANDS-ON" EXERCISES**

(Continuation of exercises started on Day 2, conducted concurrently with fit testing program)

8:30 a.m. **QUANTITATIVE FIT TESTING FOR HALF-MASK, FULL FACEPIECE AND POWERED AIR PURIFYING RESPIRATORS**

A. Videotape: "Fit Test Procedures"
B. Explanation of Procedures
C. Individual Fit Testing

Agenda
DAY 3

11:00 p.m. **INTRODUCTION TO SELF-CONTAINED BREATHING APPARATUS RESPIRATORS (SCBAs)**

A. Videotape: "Confined Space Entry"
B. Types of SCBAs
C. Uses and Limitations of SCBAs

12:00 **Break**

1:00 p.m. **INTRODUCTION TO SELF-CONTAINED BREATHING APPARATUS RESPIRATORS (CONTINUED)**

D. Inspection, Cleaning, and Disinfection
   1. Routine inspection requirements
   2. Cleaning and disinfection procedures
   3. Recharging
E. Storage
F. Other Safety Considerations
   1. Buddy system
   2. Lower Explosive Limits (LELs)
   3. Monitoring equipment
   4. Accessories
G. Hands-on Exercises

1:30 p.m. **RESPIRATOR SCENARIOS**

2:15 p.m. **COURSE CRITIQUE AND FINAL TEST**

3:30 p.m. **Adjourn**

PRETEST

U.S. EPA REGION IV RESPIRATORY PROTECTION WORKSHOP

1. Negative pressure air-purifying respirators should be used in oxygen deficient environments.

    A. True

    B. False

2. OSHA has promulgated legal standards for employee exposures to airborne contaminants known as:

    A. Permissible Exposure Limits (PELs)

    B. Threshold Limit Values (TLVs)

    C. Recommended Exposure Limits (RELs)

    D. Legal Exposure Standards (LESs)

3. The type of respirator which should be selected when entering an area which is determined to be immediately dangerous to life and health (IDLH) is:

    A. Half-mask negative pressure air-purifying respirator with organic vapor cartridges.

    B. Powered-air purifying respirator with Type-H cartridges.

    C. Self-contained breathing apparatus.

    D. Any of the respirators listed above will adequately protect an inspector in an IDLH environment.

4. When conducting inspections at asbestos abatement sites, a disposable dust mask respirator should be used because it does not interfere with the wearer's vision.

    A. True

    B. False

5. A worker shall be issued a respirator when:

   A. He has been examined by a physician and deemed medically fit to wear a respirator.

   B. He asks for it.

   C. He has been properly trained and fit test ed.

   D. A and B

   E. A and C

6. The three general classifications of airborne contaminants which may be present in industrial environments are:

   A. Particulates, gases, and vapors.

   B. Dusts, mists, fumes.

   C. Fumes, aerosols, vapors.

   D. Gases, dusts, and mists.

7. List the two types of hazardous environments, from a respiratory standpoint, which may be encountered in industrial settings.

   A.

   B.

8. Although normal air contains approximately 21% oxygen, OSHA defines an oxygen deficient atmosphere as one containing less than 19.5%.

   A. True

   B. False

9. Powered-air purifying respirators have a protection factor of:

   A. 10

   B. 50

   C. 100

   D. 1000

10. Medical examinations are not necessary before respirators are issued to workers. If a person can work, he/she can wear a respirator.

A. True

B. False

11. Which of the following is the largest organ of the human body?

A. Skin

B. Liver

C. Kidney

D. Spleen

12. What size particle would be removed in the nasal chamber (upper respiratory system)?

A. 1 micron

B. 5 microns

C. 10 microns

D. 50 microns

13. Inhaled particles which penetrate to and are deposited in the pulmonary air spaces are sized between:

A. 5 10 microns

B. 1 2 microns

C. 10 15 microns

D. 20 50 microns

14. LD_{50} is defined as:

A. Latent Deficient, 50%.

B. Elevated Distress Factor.

C. Leak Detection, 50%

D. Lethal Dose, 50% probable.

15. Factor(s) which influence toxic action are:

A. Route of exposure.

B. Age.

C. Hereditary.

D. All of the above.

16. The ACGIH TLVs are well-documented values which can be used as "fine lines" between safe and dangerous concentrations.

A. True

B. False

17. Lung clearance is achieved by which of the following mechanisms?

A. Phagocytosis

B. Nasopharyngeal filtration

C. Mucociliary escalator

D. All of the above

18. Which USEPA Order specifies the requirements for respiratory protection?

A. Order 1440.2

B. Order 1440.3

C. Order 1910

D. Order 1926

19. What does LEL stand for?

A. Latent escalatory levels

B. Lower expulsive limit

C. Lower explosive limit

D. Lipid extraction level

20. The OSHA law which addresses respiratory protection (in general) is found in:

A. 29 CFR 1926.153

B. 29 CFR 1926.134

C. 29 CFR 1910.134

D. 29 CFR 1910.101

LECTURE 2

CONSEQUENCES OF EXPOSURE TO AIR POLLUTION HEALTH AND SAFETY RISKS

LECTURE 2

CONSEQUENCES OF EXPOSURE TO AIR POLLUTION HEALTH AND SAFETY RISKS

DOSE-RESPONSE RELATIONSHIPS

Objectives

Student understanding that the toxic potency of a chemical is defined by the dose (amount) of the chemical and the response produced in a biological system. Discussion of the concepts of threshold and no-threshold agents and NIOSH's interpretation of certain types of exposures.

Background — Transparency 2-1

The dose-response relationship is expressed as the product of a concentration (C) multiplied by the time duration (T) of exposure. All toxicological considerations are based on the dose-response relationship. By using test animals, data is collected and used to create a dose-response curve relating percent mortality to dose administered.

LECTURE NOTES

The toxic potency of a chemical is defined by the dose (amount) of the chemical and the response produced in a biological system.

LABORATORY TESTING

A dose of a particular contaminant is given to test animals and increased or decreased until a range is found where at the upper end all animals die and at the lower end all animals survive. The dose (amount) is expressed as amount per unit of body weight, such as mg/Kg. A dose-response curve is developed from the upper and lower data.

LD_{50}

LD is defined as lethal dose. LD_{50} is the calculated dose of a substance which is suspected of causing the death of 50% of a substance which is suspected of causing the death of 50% of a defined experimental animal population, as determined from the exposure to the substance, by any route other than inhalation.

LC_{50}

LC is defined as lethal concentration. LC_{50} is used for airborne materials, since LD_{50} is not useful for inhalation exposures. Laboratory animals are put in an exposure chamber and exposed to a concentration of a substance. LC_{50} is the point where half of the animals die. LC values should state the species, length of time exposure was given and length of time the animals were observed after being exposed. There must be a post-exposure time, since an observable response sometimes occurs after a long post-exposure period, not just immediately after exposure.

DOSE RESPONSE RELATIONSHIP

Transparency 2-2

The slope of a dose-response curve gives an index of the margin of safety of a substance, given the range of doses from a non-effective dose to a lethal dose. If the slope of the curve is steep, the margin of safety is low. One substance may be more toxic than another because of the shape and slope for the dose response curves.

In general, as the dose of a substance increases, the probability of disease increases. Different substances have different exposure concentrations in which adverse effects occur. Also, certain substances will produce the same effect if exposed to at high concentrations for a short time as a lower concentration would for a longer time. Dose response relationships may be useful in predicting safe limits for airborne contaminants in respect to environmental exposures.

THRESHOLD AND NO THRESHOLD AGENTS

Threshold agents are substances in which a "safe" exposure level has been determined. Threshold limit value (TLV) is defined as the exposure level for which most people can be exposed to 8 hours per day over extended periods of time without adverse effects.

NIOSH has established a "No Threshold" approach to respiratory protection for suspected and known carcinogens. NIOSH recommends that air-purifying respirators should not be used for these substances. Only the most reliable and protective respirators should be utilized. These respirators are:

- self-contained breathing apparatus (SCBA) with full facepiece operated in positive pressure mode, or

  supplied-air respirator with full facepiece operated in pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode

Some no-threshold agents that air pollution agency personnel may be exposed to include formaldehyde, flyash (inorganic arsenic) and asbestos.

SYNERGISTIC ACTIONS

Synergism is defined as the cooperative action of substances whose total effect is greater than the sum of their separate effects. Two examples of synergism are cigarette smoking and asbestos exposure/and carbon black and polycyclic aromatics exposure.

Cigarette Smoking and Asbestos Exposure

Cigarette smoking and asbestos exposure produce a synergistic effect in developing lung cancer. The airways of the upper respiratory tract are lined with cilia (hair-like protrusions) covered with a sheet of mucous. The cilia constantly sweep upward, bringing particles caught in the mucous into the back of the mouth. These particles are either swallowed or expelled. Cigarette smoking temporarily paralyzes the cilia, delaying the cleansing mechanism. Smoking several cigarettes paralyzes the cilia for several hours, sometimes taking an overnight period for the cilia to begin working again. The natural defense to expel asbestos fibers is hindered, creating a greater potential for asbestos fibers to get into the lungs.

Employees exposed to industrial concentrations of asbestos have a 5 times (5x) increased risk of developing lung cancer than the normal non-smoking population. Cigarette smokers have a 22 times (22x) risk. A cigarette smoker who works with asbestos has a 80 times (80x) chance to develop lung cancer than the normal non-smoking population.

Carbon Black and Polycyclic Aromatics

Carbon black has a 10 hour TWA of 3.5 mg/m^3 (NIOSH). In the presence of polycyclic aromatic hydrocarbons, the 10 hour TWA is 0.1 mg/m^3 (NIOSH). NIOSH considers carbon black to be carcinogenic when in the presence of polycyclic aromatic hydrocarbons. NIOSH suggests a "No-Threshold" approach to be taken in this situation.

HYPERSENSITIVITY

Hypersensitivity is defined as an adverse reaction to a substance resulting from a previous sensitization to the substance or to a structurally similar substance. Pre-exposure to the substance is required to produce a toxic effect. Hypersensitivity is also called an allergic reaction and sensitization reaction. Exposure to the particular substance results in an antigen-antibody interaction, which produces the typical symptoms of an allergy. It is dose related, an example being the allergic response to pollen in sensitized individuals which is related to the concentration of pollen in the air.

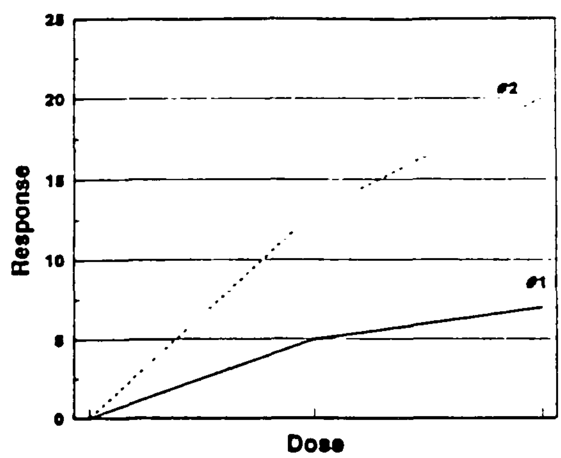
REVIEW QUESTIONS

DOSE-RESPONSE RELATIONSHIPS

1. LD_{50} is defined as:

   a. Latent Deficient, 50%
   b. Elevated Distress Factor
   c. Leak Detection
   d. Lethal Dose, 50% probable

2. Which compound is more toxic than the other?



3. LC_{50} is used for which type of entry?

   a. Inhalation
   b. Skin
   c. Eyes
   d. Ingestion

4. Explain the synergistic effect of cigarette smoking and asbestos exposure.

THE RESPIRATORY SYSTEM

Objective

Student understanding of the basic physiology of the respiratory system and its defense mechanisms. Review of other routes of entry by toxicants into a biological system.

Background

Without oxygen, you would die within a very few minutes. Your lungs take in this vital oxygen from the air you breathe. This makes them well worth protecting. In order to understand the importance of the respiratory system, an understanding of their basic function and how respiratory hazards such as oxygen-deficiency and contaminants can cause abnormal affects on the respiratory system and other organs of the body.

LECTURE NOTES

THE RESPIRATORY SYSTEM

The most essential input to the human system is oxygen. Oxygen is supplied by the respiratory system and eventually to the cells by the circulatory system, which also removes the carbon dioxide resulting from cell metabolism. Without food, one can exist for weeks, and without water, for many days, but without oxygen, for only a very few minutes.

BASIC PHYSIOLOGY

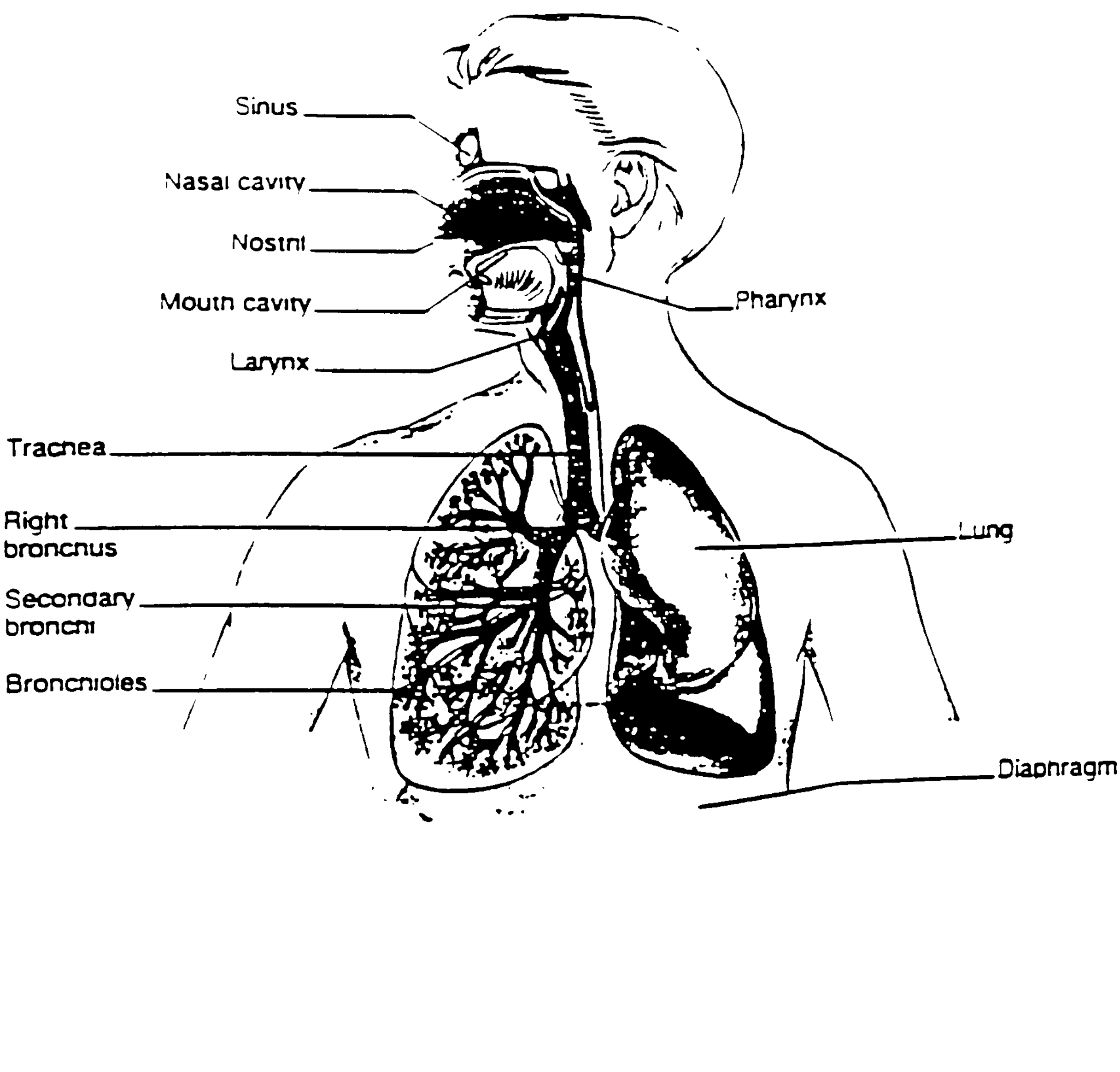
The primary function of the respiratory system is to supply body cells with oxygen and to excrete carbon dioxide. In addition, the respiratory organs filter particles from incoming air, help control the temperature and water content of the air, aid in producing the sounds used in speech, and play important roles in the sense of smell and regulation of pH.

Slide 2-4

The organs of the respiratory system include the nose, nasal cavity, sinuses, pharynx, larynx, trachea, bronchial tree, and lungs. See Diagram A.

Diagram A

THE RESPIRATORY SYSTEM



Air normally enters the body through the nostrils and passes through a web of nasal hairs and then flows through the narrow passages around the turbinates. The "inspired air" proceeds down the trachea which divides into branches or primary bronchi, leading in turn to upper and lower lobar bronchi to the right and left. The airway diameter and velocity decreases, but the number of tubes increases. Gas exchange occurs in the acini of the lung parenchyma. The respiratory bronchioles, alveolar ducts, atria, alveolus sacs, and the alveoli is referred to as the acinis. The system of airways leading to the acini does not participate in the gas exchange and is called the "dead space". In normal lungs, both the oxygen and carbon dioxide pass the membranes of the microscopic air sacs without difficulty. The blood carries oxygen from the lungs to the other organs of the body, where it picks up carbon dioxide to be returned to the lungs, and ultimately exhaled.

Gas exchange occurs between the air of the alveolus and the blood of the capillary as a result of differences in partial pressures. Gas molecules diffuse from regions where they are in higher concentrations toward regions where they are in lower concentration. Similarly oxygen will diffuse from higher pressure (in the alveolus) to lower pressure (in the capillary), at the same time carbon dioxide will diffuse from higher pressure (in the capillary) to lower pressure (in the alveolus). This movement will tend to equalize the partial pressures in the two regions. See Diagram B.

SITES OF CONTAMINANT DEPOSITION

Transparency 2-5

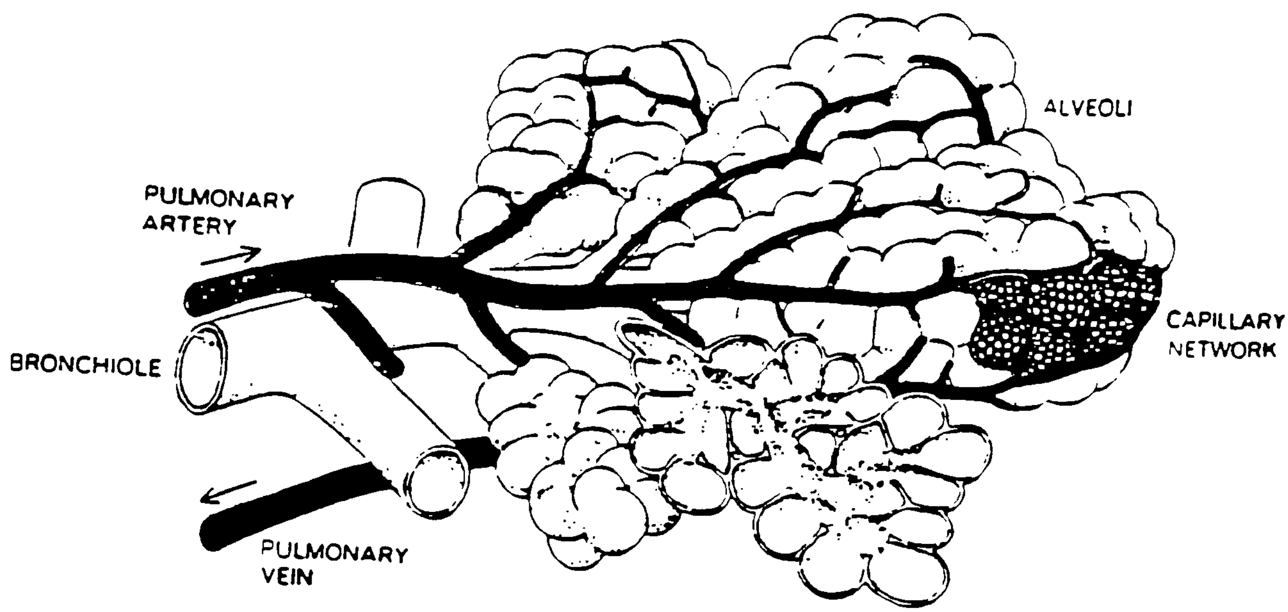
Inhalation of harmful materials may irritate the upper respiratory tract and lung tissue. Agents that enter the lungs may pass directly into the bloodstream and be carried to other parts of the body. The size, type, and solubility of an agent determines the site of deposition.

Soluble Gases and Vapors

Vapors are the volatile form of a substance that is normally in the solid or liquid state at room temperature and pressure. Solvents with low boiling points will volatize readily at room temperature. Gases are formless fluids that expand to occupy the space or enclosure in which they are confined. Examples are welding gases, exhaust gases, and air.

Diagram B

TERMINAL AIRWAY UNIT OF THE HUMAN LUNG



If a compound is very soluble, such as ammonia, formaldehyde, sulfuric acid, or hydrochloric acid, it is rapidly absorbed in the upper respiratory tract during the initial phases of the exposure and does not penetrate deeply into the lungs. Consequently the nose and throat may become very irritated. Vapors of low solubility can produce an immediate irritation and inflammation of the respiratory tract and pulmonary edema.

Insoluble Gases and Vapors

Compounds that are insoluble in body fluids cause considerably less throat irritation than the soluble ones, but may penetrate deeply into the lungs. A very serious hazard can be present and not immediately recognized because of a lack of warning that the local irritation would otherwise provide. Examples of such gases are nitrogen dioxide and ozone. The immediate danger of these compounds in higher concentrations is acute lung irritation or possibly chemical pneumonia. Other examples are:

- Carbon monoxide, a toxic gas, passes into the blood stream without harming the lungs. The carbon monoxide passes through the alveolar walls into the blood, where it ties up the hemoglobin so that it cannot accept oxygen thus causing oxygen starvation.

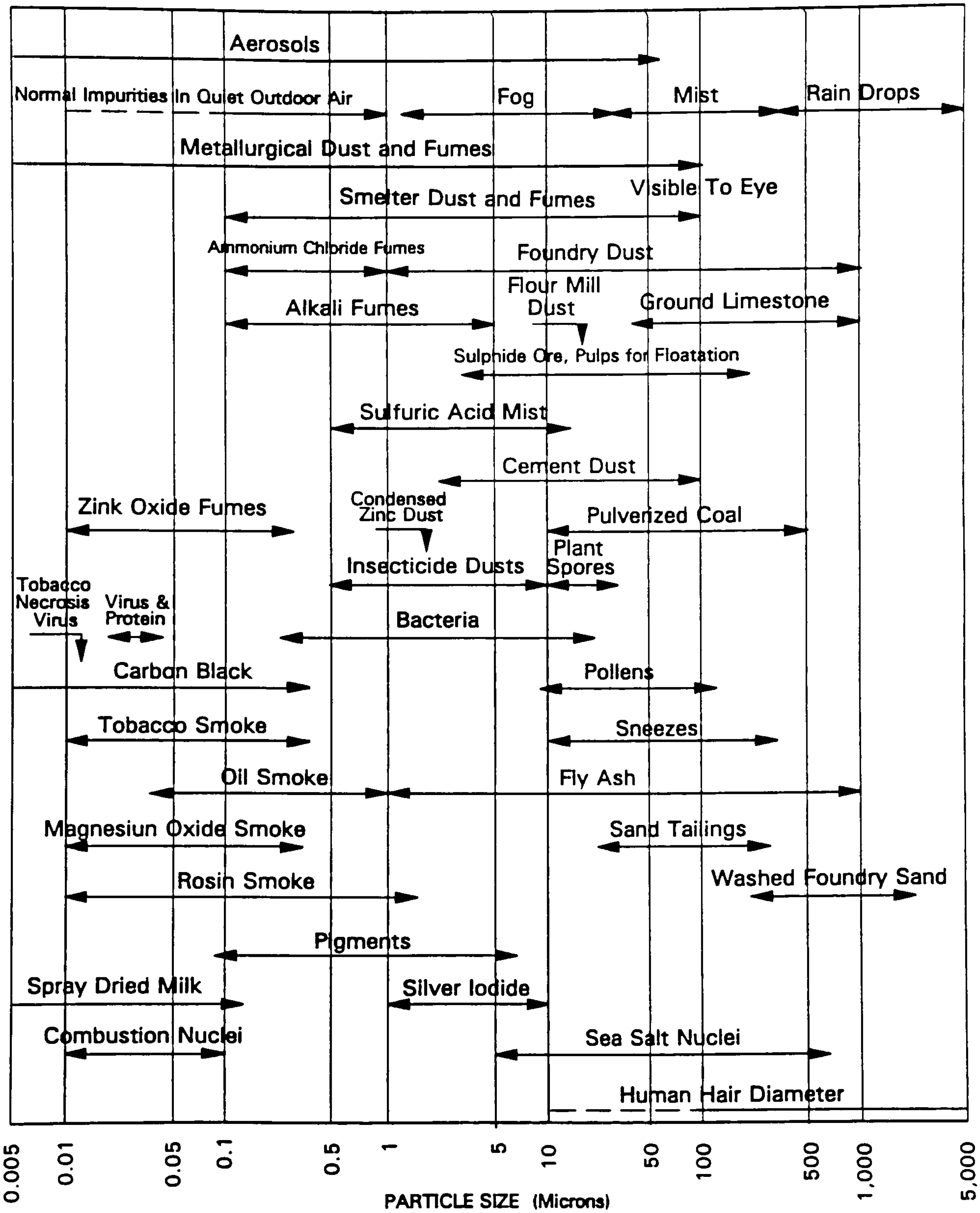
- Cyanide gas prevents enzymic utilization of molecular oxygen by cells.

Dust and Fume Particles

Dusts are solid particles generated by handling, crushing, grinding, rapid impact, detonation, and decrepitation of organic or inorganic materials such as rock, ore, metal, coal, wood, and grain. Airborne solid particle range in size. 0.1 to 25 micrometers. See Diagram C.

To evaluate dust exposure, knowledge of the chemical composition, particle size, concentration in air, how it is dispersed, and many other factors need to be known. Large particles, more than 10 micrometers in aerodynamic diameter, can be deposited in large ducts before reaching the very small sacs (alveoli). This can cause a person to choke or cough. Depending on the chemical composition, dust can cause an allergic reaction. Dust also can damage the vital internal tissues.

Diagram C



SIZES OF VARIOUS AIR-BORN CONTAMINANTS

Fumes are materials from a volatilized solid condensed in cool air. The solid particles make up a fume that is extremely fine. Solid particle sizes are usually less than 1.0 micron in diameter.

In most cases, hot vapor reacts with the air to form an oxide. Welding and other operations involving vapors from molten metals may produce fumes which may be harmful under certain conditions. Other toxic fumes, such as those formed when welding structures that have been painted with red lead, or when welding galvanized metal, may produce severe symptoms of toxicity unless the fumes are controlled with adequate, local exhaust ventilation, or the welder is protected by respiratory protective equipment.

Fibers

Fibrous materials, smaller than 5 micrometers in length penetrate to the alveoli or inner recess of the lungs.

Asbestos fibers cause fibrotic growth in the alveolar tissue, plugging the ducts or limiting the effective area of the alveolar lining.

CONTAMINANT TRANSLOCATION TO OTHER ORGANS

The initial site where a chemical localizes is dependent on the blood flow to the area, the permeability of the tissue to the toxicant, and the availability of binding sites.

Transparency 2-6

A toxic agent may pass through membranes of a number of cells before achieving a sufficient concentration in the target organ. A toxicant may pass through a membrane by one of two processes: 1) diffusion or passive transfer of the chemical, in which the cell expands no energy in its transfer; and 2) specialized transport, in which the cell takes an active part in the transfer of the toxicant through the membranes.

Small water soluble molecules are diffused through aqueous channels or pores in the cell membrane. Lipid-soluble molecules and ions of moderate size cannot enter cells easily except by special transport mechanisms. After a chemical enters the plasma by absorption, a toxicant is available for distribution (translocation) throughout the body. Translocation usually occurs rapidly, and the rate of distribution to the tissues of each organ is determined by the blood flow through the organ and the ease with which the chemical crosses the capillary bed and penetrates the cell of the particular tissue.

Toxicants are often concentrated in a specific tissue (see Diagram D). Some toxicants achieve their highest concentrations at their site of toxic action, such as carbon monoxide, which has a very high affinity for hemoglobin, and paraquat, which accumulates in the lung. Other agents concentrate at sites other than the site of toxic action. The compartment where the toxicant is concentrated can be thought of as a storage depot. While stored, the toxicant seldom harms the organism. The storage depot, therefore, could be considered as a protective mechanism, preventing the accumulation of high concentrations of the toxicant at the site of toxic action. As the chemical is biotransformed or excreted from the body, more of the toxicant is released from the storage depot, as a result the biologic half-life of stored compounds can be very long.

Major storage sites of toxicant are the plasma proteins, liver, kidney, fat, and bone.

Lung Defense Mechanisms

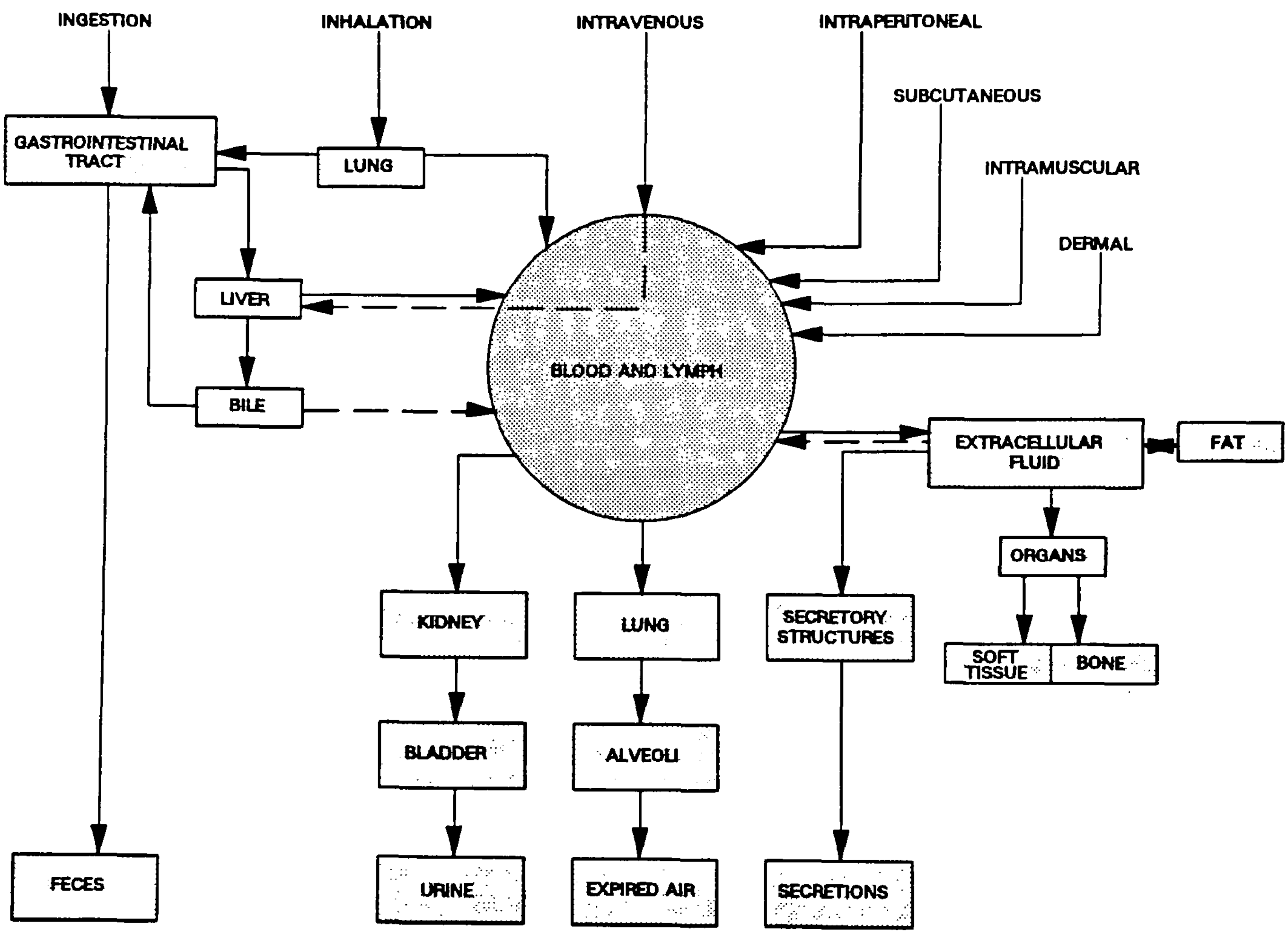
Transparency 2-7

The respiratory system has a unique set of mechanisms for protecting against insults. See Diagram E.

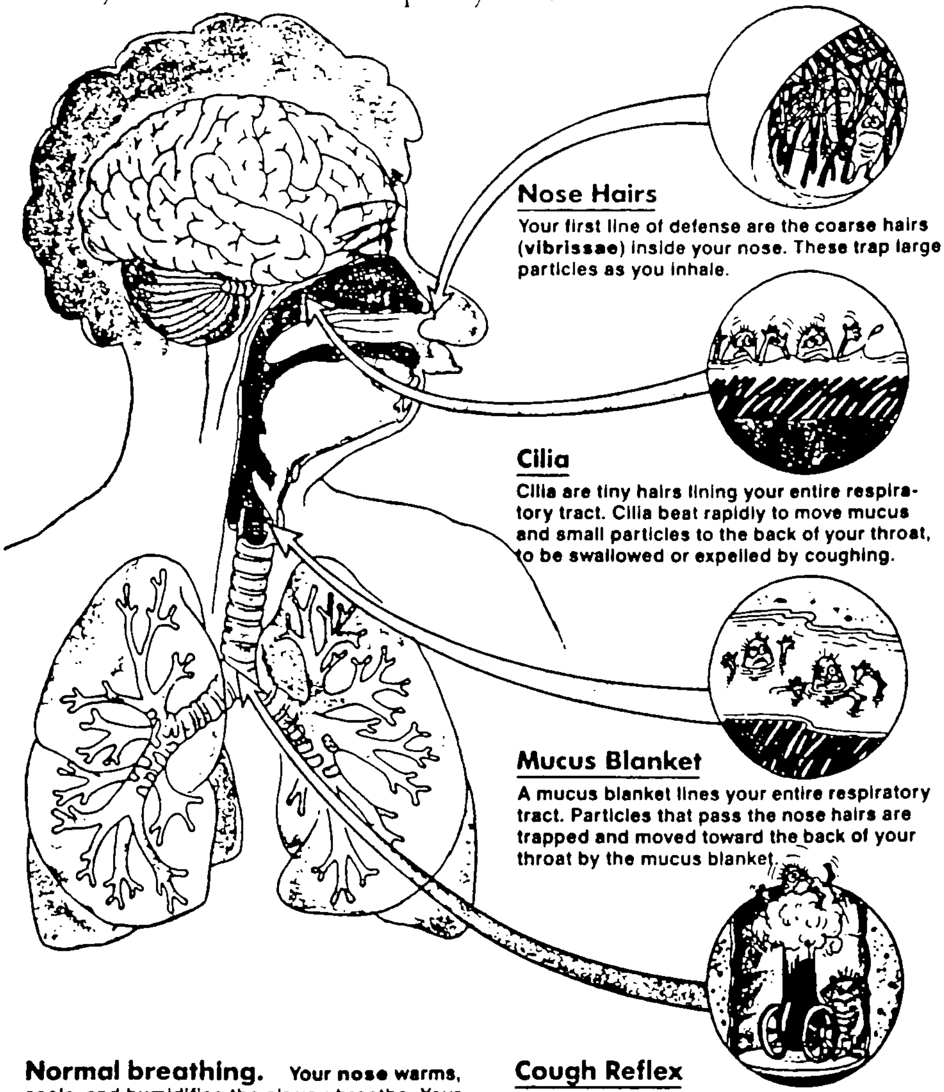
The upper respiratory tract acts as an air conditioner for the lungs. This is important for humidification and is designed to filter inspired gases. The nasopharyngeal complex helps in detecting odors. Upon irritation of gases or vapors, a muscular contraction of the bronchial tubes may occur. This reaction restricts the air flow and thus minimizes intake of the irritating substance. Coughing and sneezing, also tends to rid the upper respiratory tract of contaminants.

The mucous membrane lining the nasal cavity contains pseudostratified ciliated epithelium that is rich in mucus-secreting goblet cells. The sticky mucous secreted by the mucous membrane entraps dust and other small particles entering with the air. As the cilia move, a thin layer of mucus and any entrapped particles are pushed toward the pharynx for expulsion or swallowing. Any microorganism in the mucus that is swallowed is likely to be destroyed by the action of gastric juices.

Diagram D   Areas of Toxic Concentration



Your body has a wonderfully designed **respiratory system** to carry air and oxygen into your lungs and carry waste products out. Even when you're in clean, fresh air, your body's natural defenses constantly work to cleanse and purify the air.



Normal breathing. Your **nose** warms, cools, and humidifies the air you breathe. Your **upper airway** carries air to your **lungs**. Your **lower airway** branches out like a tree and ends in tiny air sacs called **alveoli**, where oxygen passes into your blood and wastes are returned to your lungs to be exhaled.

Mobile phagocyte cells descend on aerosols that are not removed from the alveolar lining. These cells are white blood cells capable of ingesting particles. Once laden with foreign matter they migrate to the small bronchioles, where the mucous lining carries them out of the system; or they pass through the alveolar membrane into the lymph vessels associated with the blood capillaries. They can also be destroyed (if contaminant is cytoxic) and break up, releasing the particles into the alveolar sac.

Respiratory Disease

Lungs, bloodstream, and the heart are closely interrelated elements of the entire oxygen-supply system. Disease or blockage in any part can result in serious illness or death. The skin, lungs and alimentary canal are the main barriers that separate humans from toxic substances. However these are not complete barriers, and toxicants do enter the body, resulting in potential injury. See Table 1.

Other Routes of Entry

Toxic materials can enter the body primarily in three ways: by ingestion, through the gastrointestinal tract; by absorption through the skin via cuts and punctures; and eyes.

Ingestion

A person can unknowingly eat or drink harmful chemicals. Inhaled toxic dust can also be ingested in amounts that may cause trouble. If toxic dust is swallowed with food or saliva and is not soluble in digestive fluids, it is eliminated directly through the intestinal tract. Toxic materials that are readily soluble in digestive fluids can be absorbed into the blood from the digestive system.

Absorption

Chemicals can absorb through the skin rapidly if the skin is abraded. Some substances are absorbed by way of openings for hair follicles and others dissolve in the fat and oil of the skin. Compounds that are good solvents for fats (such as toluene and xylene) also may cause problems by being absorbed through the skin. Many organic compounds can produce systemic poisoning by direct contact with the skin. The skin's defense mechanisms against primary irritants are the buffered acid mantle, the stratum corneum, thickening of the keratin material, and sweating.

TABLE 1

HAZARDOUS SUBSTANCES ASSOCIATED
DISEASES AND HEALTH EFFECTS

Hazardous Substance	Disease/Health Effect
Chromium	Hexavalent lung cancer; chromoholes
Beryllium	Beryllosis
Cadmium	Silver brazing
Mercury	Gingivitis; shifty eyes
Copper	Wilson's disease; hardening of arteries
Manganese	Fibrotic lung disease
Zinc	Oxide pox
Lithium Carbonate	Manic depression
Uranium	Leukemia
Cobalt	Heart muscle decay
Ozone	Pulmonary edema; chronic respiratory disease
Formaldehyde	Pulmonary irritation; broncho spasm; carcinogen ic; dermatitis
Fluorides	Calcification of ligaments,ribs, pelvis
Toluene	Lacrimation; photophobia; dermatitis; paresthe- sia
Phenol	Cyanosis; dermatitis; anorexia
Lead	Colic; anemia; gingival lead line
Sulfur dioxide	Bronchoconstriction; rhinorrhea
Selenium	Garlic breath; skin discoloration

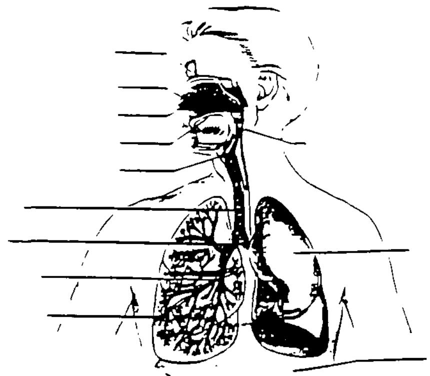
Eyes

Of all the major body organs prone to occupational injuries, the eye is perhaps the most vulnerable. Contamination of a chemical substance or foreign matter can cause minor irritation or complete loss of sight. In some instances, a chemical which does no damage to the eye can be absorbed in a sufficient amount so as to cause systemic poisoning. The eye does have a few natural defenses to protect itself. The eye has a blink reflex. The eye is also equipped with an automatic "windshield wiper and washer combination". The washers are the tear ducts, and the wiper is the blinking action. The function of the teary blink is to wash foreign bodies from the corneal or conjunctival surfaces before they can become imbedded. The triggering mechanism is irritation caused by the contaminant.

REVIEW QUESTIONS

THE RESPIRATORY SYSTEM

1. Label all the organs associated with the respiratory system on the diagram.



2. Explain the pathway of inspired air.

3. Explain the gas exchange mechanism in the alveolus.

4. Define:

   gas

   vapor

   dust

   fume

   fiber

5. Would a soluble or an insoluble gas/vapor cause an almost instantaneous reaction?

6. What effect does carbon monoxide have on oxygen?

7. Can dust particles > 10 micrometers reach the alveolar sacs?

8. What are a few controlled conditions that can decrease a fumes toxic effect?

9. Fibers <_____ micrometers can penetrate to the alveolus.

10. Explain the two processes by which a toxic agent passes through a membrane in order to reach a target organ?

11. How would a lipi-soluble molecule and ions of moderate size enter a cell?

12. Name a factor that could affect the rate of translocation.

13. Using Diagram C, name three hazardous substances that translocate to the heart?

14. What is meant by a storage depot?

15. Give two examples of a storage depot.

    a.

    b.

16. Name two mechanisms that occur in the upper respiratory tract that act as defense mechanisms.

    a.

    b.

17. The mucus lining flows upward by ____________________ action.

18. Define phagocyte.

19. Give one example of what can occur to foreign matter en gulfed by a phagocyte.

20. What are a few defense mechanisms of the skin?

21. Through what openings does a toxicant enter the skin?

22. If a toxicant is ingested, what is its fate?

23. What are the defense mechanisms of the eye?

LECTURE 3

IMPORTANCE OF PERSONAL PROTECTIVE EQUIPMENT AND ADMINISTRATIVE CONTROLS TO MINIMIZE RISKS

LECTURE 3

IMPORTANCE OF PERSONAL PROTECTIVE EQUIPMENT AND ADMINISTRATIVE CONTROLS TO MINIMIZE RISKS

INSPECTION PREPARATION

Objective

Student understanding that a source file review, the selection appropriate personal protective equipment, and the practice of personal hygiene can substantially minimize health and safety risks.

Background

The air pollution control inspector can minimize health and safety risks during air pollution control field activities by performing certain tasks before and during the inspection process.

LECTURE NOTES

INSPECTION PREPARATION

Handout 10 & 12

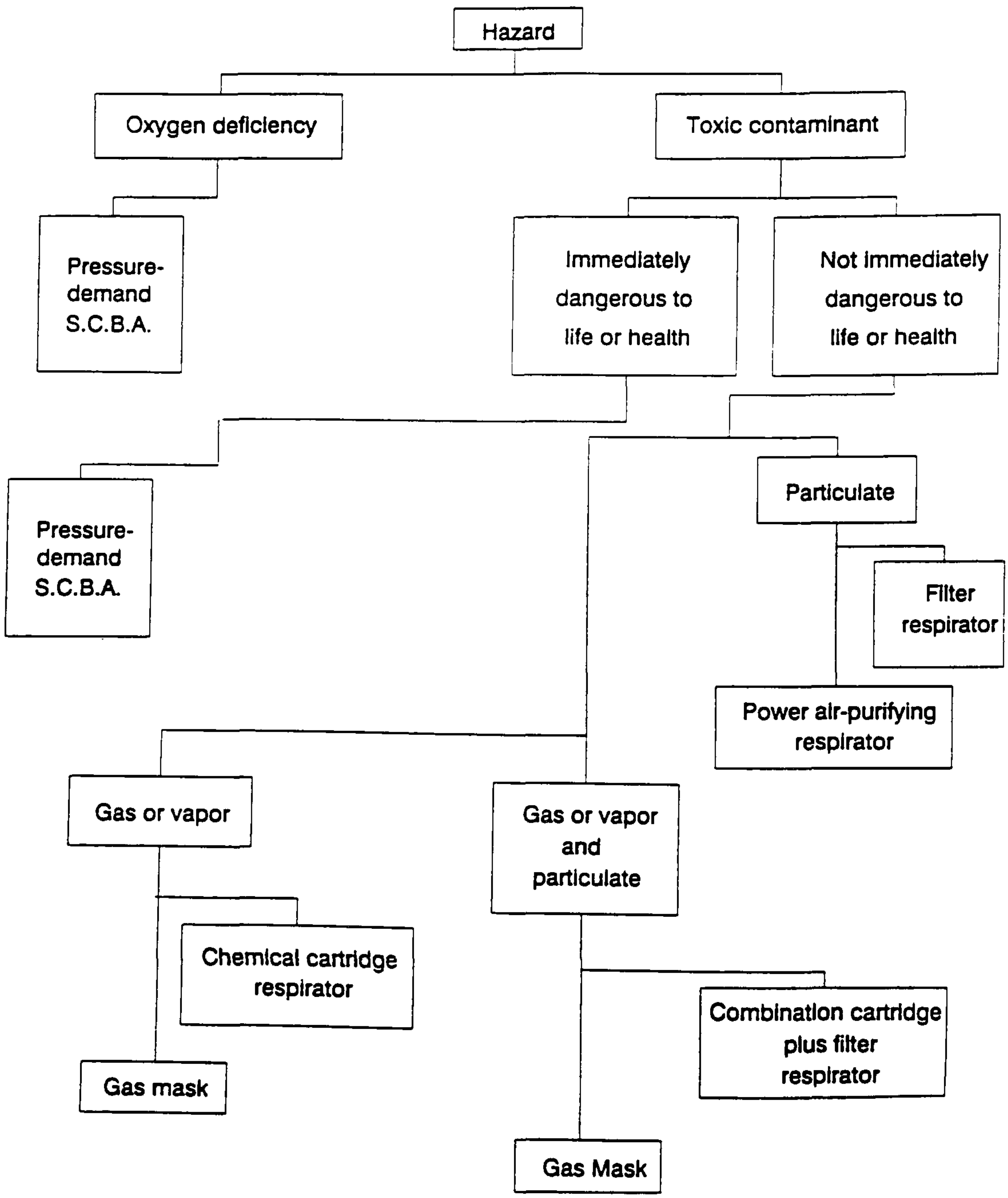
Source File Review A source file contains information about the company, chemicals and processes used, and amounts of chemicals. This file can be found at the local EPA office or county agency for hazardous materials. The company should also have Material Safety Data Sheets (MSDS) for on-site chemicals.

Transparency 3-1

Selection of Personal Protection Equipment (PPE) From the information found in the source file, determinations on the correct PPE to be utilized may be made.

1) Respirator: Information on each type of respirator will be discussed during this course. See Figure A.

Figure A Respiratory Selection for Routine Use of Respirators



2) Hearing Protection: See Figure B for typical noise levels. Exposure above 90 dbA per 8 hour shift will require the use of hearing protection depending on the time spent in the high noise area. There are various types of hearing protection available.

Aural Insert Types — **Transparency 3-2**

a. Formable Type disposable, expandable form or cotton plugs which fit into the ear canal.

b. Custom Molded made for each individual person.

c. Molded Type soft silicone rubber inserted into the ear canal.

Ear Muffs

a. Covers the entire face. The attenuation provided by the muff is dependent on size, shape, and muff material.

Attenuation: Most commercial earplugs if properly worn, will provide a 25-30 dB reduction of sound level. Combinations of earmuffs and earplugs offer the greatest protection.

3) Head Protection: Head protection may need to be considered in logging operations, construction, steel mills and other sites with overhead operations. All helmets should meet ANSI standards.

4) Eye Protection and Foot Protection: Eye protection and foot protection should also be worn. All equipment should meet ANSI standards.

5) Gloves: — **Handout 9**
Light Work: Canvas gloves are satisfactory and inexpensive.
Rough Work: Leather or cut-proof gloves are the best protection.

For chemicals and hazardous materials, use Figure C to determine the proper glove to use.

FIGURE B - Sound Pressure and Decible Values for Some Typical Sounds

Sound Pressure (microbars)	*Overall Sound Pressure Level (dB re 0.0002 microbar)*	*Example*
0.0002	0	Threshold of hearing
0.00063	10	
0.002	20	Studio for sound pictures
0.0063	30	Soft whisper (5 feet)
0.02	40	Quiet office
		Audiometric testing booth
0.063	50	Average residence
		Large office
0.2	60	Conversational speech (3 feet)
0.63	70	Freight train (100 feet)
1.0	74	Average automobile (30 feet)
2.0	80	Very noisy restaurant
		Average factory
6.3	90	Subway; Printing press plant
20	100	Looms in textile mill
		Electric furnace area
63	110	Woodworking
		Casting shakeout area
200	120	Hydraulic press
		50 hp siren (100 feet)
2000	140	Jet plane
200.000	180	Rocket launching pad

Note that doubling any *sound pressure* corresponds to an increase of 6 dB in the sound pressure level. A change of sound pressure by a factor of 10 corresponds to a change in sound pressure level of 20 dB.

FIGURE C - Choosing The Right Glove

This table shows the relative resistance ratings of various glove materials to some solutions commonly used in industry

The listings were gleaned from various glove manufacturer guides When selecting one for an application not shown you are urged to write the manufacturer of your choosing giving as much detailed information as possible according to the following points:

1 Ability of glove to resist penetration of the chemical thus insuring the protection of the wearer
2 Chemical composition of the solution
3 Degree of concentration
4 Abrasive effects of materials being handled
5 Temperature conditions
6 Time cycle of usage
7 Specify in purchase order what materials are to be handled
8 Cost.

CHEMICAL RESISTANCE CHART

Glove Material	mineral acids	organic acids	caustics	alcohols	aromatics	petroleum	ketonic solvents	chlorinated solvents
	Hydrochloric	Acetic	Sodium Hydroxide	Methanol	Toluene	Naphtha	Methyl Ethyl Ketone	Perchlor-ethylene
Natural Rubber	G	E	E	E	P	E	G	NR
Neoprene	E	E	E	E	F	E	G	F
Buna-N	E	E	E	G	F	E	F	F
Butyl	G	E	E	E	F	F	E	NR
Polyvinyl Chloride	G	E	G	E	P	P	NR	NR
Polyvinyl Alcohol	P	F	P	F	P	P	F	E
Polyethene	G	E	E	E	E	E	G	G
NBR*	E	G	G	E	E	E	F	G

MISCELLANEOUS

Glove Material	Lacquer Thinner	Benzene	Formal-dehyde	Ethyl Acetate	Vegetable Oil	Animal Fat	Turpen-tine	Phenol
Natural Rubber	F	NR	E	F	G	P	F	F
Neoprene	NR	P	E	G	E	E	G	E
Buna-N	NR	G	E	F	E	E	E	G
Butyl	F	NR	E	G	G	G	F	G
Polyvinyl Chloride	F	F	E	P	G	G	F	G
Polyvinyl Alcohol	E	E	P	F	E	E	E	P
Polyethene	F	F	E	G	E	E	G	E
NBR*	F	G	F	F	E	E	E	NR

PHYSICAL PERFORMANCE CHART

Coating	Abrasion Resist-ance	Cut Resist-ance	Puncture Resist-ance	Heat Resist-ance	2Flex-ibility	Dry Grip	Wet Grip
Natural Rubber	[illegible]	[illegible]	E	E	F	E	G
Neoprene	F	E	E	E	G	G	F
Buna-N	G	E	G	F	F	G	G
Butyl	G	G	G	P	G	F	F
Polyvinyl Chloride	G	F	F	P	F	E	E
Polyvinyl Alcohol	G	E	E	F	F	E	E
Polyethene	E	F	E	P	G	G	G
NBR*	E	E	E	F	G	G	F

*Nitrile-Butadiene Rubber

KEY TO CHARTS

E—Excellent G—Good F—Fair P—Poor NR—Not Recommended

INSPECTION/TESTING CONDUCT

Working at Controlled Pace

Working in cold or hot temperature extremes can place a strain on the human body. Physiological changes occur in hot and cold weather. Internal body temperature, heart beat, respiration rate, and the body's need to heat or cool it itself is changed. The American Conference of Governmental Industrial Hygienists (ACGIH) have a guide for heat and cold stress. The information provided explains monitoring, work time limits, human response to heat buildup, and a wind speed index chart for wind chill factors.

Exercising Safety Judgement

Safety judgement is quite often common sense. Do not do or try anything that seems unsafe. Always follow safety procedures at all times. When in doubt, ask questions.

Limiting Scope

Before the job begins, a plan should be made on how the inspection is to be done. Do not attempt to finish in a hurry. A rushed job will result in a less accurate survey and more chances of an injury. Decide on what is to be done during the day and judge your time accordingly.

PERSONAL HYGIENE

Avoid contact with contaminated surfaces and materials. If the proper respirator, protective clothing, gloves, and eye protection are properly utilized, the chances of exposure will be greatly reduced. If any spills, leaks, puddles are present, avoid them, and have them cleaned up as soon as possible.

Eye, nose and mouth contact can be avoided with the proper use of full facepiece respirators. When respiratory protection is not utilized, do not touch your mouth, face, or eyes; or eat food or smoke cigarettes until you are out of the area. Wash your hands thoroughly.

Washing Hands

Washing hands should be done before eating, smoking, going to the bathroom, or leaving the work site. Many commercial hand cleaners are available. Grease cleaners, anti-biological cleaners, and soaps with skin conditioners are available for use.

Eating in Contaminated Area

Eating in contaminated areas should not be done at any time.

INSPECTION PREPARATION

1. What is a Source File Review?

2. If the noise measured in an area where a source inspection is to take place is known to be 95 dBA, how long can an inspector remain in the area without hearing protection?

3. An inspector is going to inspect an operation which uses chlorinated solvents. The inspector plans to use the butyl rubber gloves for hand protection.

LECTURE 4

INTRODUCTION TO THE USE OF RESPIRATORS

LECTURE 4

INTRODUCTION TO THE USE OF RESPIRATORS

INTRODUCTION TO RESPIRATORS (Video Tape)

<u>Objectives</u>

Student understanding of the evolution of respiratory protection standards and guidelines and the importance of utilizing the appropriate respiratory protection when its use is indicated in the field.

<u>Background</u>

The use of respiratory protection is not a recent development. It has evolved over many years and has undergone many changes.

SUMMARY OF RESPIRATOR REGULATORY REQUIREMENTS AND CERTIFICATION PROCEDURES

<u>Objective</u>

Student understanding of respirator regulatory requirements.

<u>Background</u>

The Occupational Safety and Health Administration (OSHA) jurisdictions include promulgation and enforcement of respiratory standards. The National institute for Occupational Safety and Health (NIOSH) is responsible for research and for making recommendations concerning respirator use.

LECTURE NOTES

ROLE OF THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) — **Transparency 4-1**

OSHA has developed maximum exposure standards for many airborne toxic materials. OSHA has regulations that require engineering or work-practice controls be used to reduce exposures as low as possible. If these controls are not feasible , or while they are being instituted, appropriate respirators shall be used. OSHA views respirators as the least satisfactory means of exposure control, because they provide good protection only if they are properly fitted, worn by employees, and replaced when their service life is over. Also, some employees may be unable to wear a respirator.

OSHA has the authority to inspect and evaluate the effectiveness of respirator protection programs. Citations may be issued for inadequacy of written procedures.

The OSHA Respiratory Protection Standard, 29 CFR 1910-.134 will be discussed later in this section.

ROLE OF THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

Transparency 4-2

NIOSH is the testing agency for respirator approval. Under authorization of the Coal Mine Health and Safety Act of 1969 and the Federal Mine Safety and Health Act of 1977, NIOSH has established an evaluation and certification program for respirators. All certifications are issued jointly with the Mine Safety and Health Administration (MSHA). NIOSH certification evaluations include: laboratory evaluation of the respirator, evaluation of the manufacturer's quality control (QC) program, audit testing of certified respirators and investigations of problems with NIOSH/MSHA certified respirators.

Handout 13

Respirators must meet the minimum performance requirements which are in Title 30, Code of Federal Regulations, Part II (30 CFR 11). This is found in Handout 13.

NIOSH will approve only if the entire respirator assembly, including cartridges, filters and hoses, passes the test. Then NIOSH and MSHA will issue a joint approval number for that specific respirator assembly. NIOSH lists approved respirators and cautions and limitations for specific respirator classes in the NIOSH Certified Equipment List.

NIOSH also monitors respirators over the lifetime of their certification. Respirators are evaluated after a period of time in NIOSH laboratories in order to see if they still meet applicable minimum performance requirements.

Handout 4

NIOSH recommendations are based on the Respirator Decision Logic, found in Handout 4. This was developed jointly in 1975 by NIOSH and OSHA and has been updated to reflect new developments. The latest decision logic (1987) differs from the original in five areas: odor warning properties with respect to air-purifying cartridge/canister respirators, recognition of the problems in assigning protection factors, changes in protection factors for certain respirator classes, respirator recommendations for carcinogens, and medical recommendations. NIOSH also performs in-plant QC audits of respirator manufacturers.

OSHA REGULATION 29 CFR 1910.134

Handout 5

This regulation is OSHA's Respiratory Protection Standard. It states when respirators should be used, requirements for a minimal acceptable respiratory program, selection of respirators, air quality (breathing air from cylinders or air compressors), use of respirators, maintenance and care of respirators, and identification of gas mask canisters. 29 CFR 1910.134 is found in Handout 5.

REVIEW QUESTIONS

RESPIRATOR REGULATORY REQUIREMENTS

1. Certifications for respirators are issued by which agency?

   a. NIOSH
   b. OSHA
   c. MSHA
   d. NIOSH and MSHA
   e. NIOSH and OSHA

2. The OSHA law which addresses respiratory protection (in general) is found in:

   a. 29 CFR 1926.153
   b. 29 CFR 1926.134
   c. 29 CFR 1910.134
   d. 29 CFR 1910.101

3. Minimum performance requirements for respirators are found in:

   a. 29 CFR 1910.134
   b. 29 CFR 1926.153
   c. 29 CFR 1910.101
   d. 30 CFR 11
   e. 30 CFR 15

4. Respirators are the best means of exposure control.

   a. True
   b. False

FUNDAMENTAL PRINCIPLES OF RESPIRATOR USE

Objectives

Student understanding that respiratory protection should be the third option behind engineering controls and administrative controls when protecting against inhalation hazards. Discussion of varying types of controls.

Background

Respiratory protection is considered to be the third option behind engineering controls and administration controls when controlling employee exposures.

LECTURE NOTES

Transparency 4-3

The order of preference for minimizing respiratory hazards is engineering controls, administrative controls and respiratory protection.

After hazards have been identified and evaluated and information for informed decisions has been provided, the next process involves the actual installation of control measures. Controls are of two kinds; administrative (i.e., through personnel management, monitoring, limiting worker exposure, measuring performance, training and education, housekeeping and maintenance, purchasing) and engineering (i.e., isolation of source, design, process or procedural changes, monitoring and warning equipment, chemical or material substitution).

There are three areas where hazards can be controlled; the source of the hazard; the path between the hazard source and the worker; and at the area of the worker. Engineering controls attempt to either eliminate the hazard at its source, or cut off its path to the worker. This can be done through ventilation, isolation or chemical substitution.

Administrative controls attempt to allow as little worker exposure to the source as possible. This can be done by setting up job procedures which limit the amount of time a worker can spend in the hazardous area, training, and educating the employees in the hazards they work with.

Respiratory protection attempts to control the hazard in the area of the worker, or in the worker's "breathing zone". One of the most important aspects of administering a Respiratory Protection Program is the development of written guidelines describing all facets of the selection, use and maintenance of respirators. In addition, contingency plans should be included to minimize confusion and provide instruction in emergency situations.

Transparency 4-4
Handout 6&7

The formula for implementation is practical and will work for any personal safety equipment program in any size organization. The program consists of:

- Thorough evaluation of the hazard and need for protection.
- Strong management support.
- Local union support.
- The mandatory involvement of supervision.
- A complete and honest personal communication with all personnel involved.
- A comprehensive training and educational program in the use, care and maintenance of the safety equipment.
- An effective system of evaluating the program.

Transparency 4-5

Once a respiratory protection program begins, a major part of the program involves respirator selection. Among the many factors to be considered in the selection of the proper respiratory protective device for any given situation involving air contamination are the following:

- The nature of the hazardous operation or process.
- The type of air contaminant, including its physical properties, chemical properties, physiological effects on the body, and its concentration.
- The period of time for which respiratory protection must be provided.
- The location of the hazard area with respect to a source of uncontaminated respirable air.
- The state of health of personnel involved.
- The function and physical characteristics of respirators.

HALF-MASK RESPIRATORS

Transparency 4-6

Objectives

Student understanding of limitations, care, and fit-testing procedures for half-mask respirators.

Background

The half-mask respirator is the simplest form of an airpurifying respirator device. Its small compact size makes it ideal for compact work areas, but its lower protection factor against hazardous elements limits its use.

LECTURE NOTES

INTRODUCTION TO THE HALF-MASK RESPIRATOR

The basic purpose of any respirator is to protect the respiratory system from inhalation of hazardous atmospheres. There are three families of respirators: air-purifying respirators, air-line or supplied-air respirators, and self-contained breathing apparatus.

The half-mask respirator is an air-purifying respirator. It covers half the face from under the chin to the bridge of the nose. The half-mask respirator removes contaminants from the breathing air before it is inhaled. See Figure A.

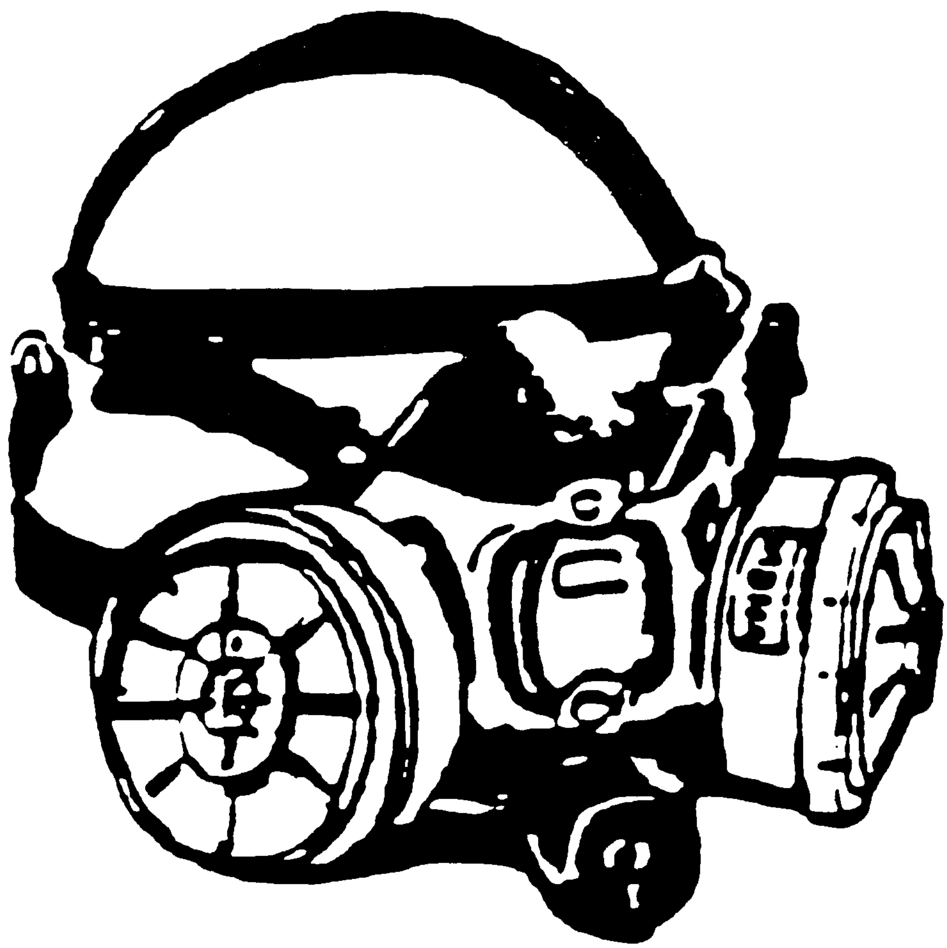
1. Selection

The proper selection of a respirator involves two steps:

a. Identification and evaluation of the hazard.
b. Selection of approved respirator based on the first consideration.

The half-mask respirator has many uses and limitations. The half-mask does not protect the wearer from eye irri tants. Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal. A poor seal will permit contaminated air to enter the facepiece. These respirators remove limited concentrations of air contaminants from the breathing air, therefore they can only be used where air contaminants do not exceed the specified range of the respirator and cartridge. These types of respirators should not be used in operations where the air might be oxygen-deficient such as

Figure A



TYPICAL HALF MASK RESPIRATOR

fire fighting rescue work. The half-mask respirator can protect against low concentrations of organic vapors, pesticides, alkaline gases, acid gases, mercury vapors, organic vapors or gases combined with acid or alkaline gases, and any of the above materials combined with dust, fumes, or mist. In general, half-mask units can be used up to 10 times the substance PEL or 1000 ppm, whichever is lower. The half-mask respirator does not restrict wearer's mobility.

2. Maintenance and Care

In order to keep your respirator operating at its optimum level, a certain amount of care and maintenance needs to be exercised by the user.

Routine inspection:

OSHA requires that all respirators be leak checked as part of an inspection program. The person who is to use the respirator is responsible for inspecting it. Respirators for normal, non-emergency work must be inspected before and after each use. Emergency respirators must be inspected after each use and at least once a month.

During a routine inspection the facepiece should be checked for excessive dirt, distortion from improper storage, cracks, tears, or holes. The head strap should also be checked for loss of elasticity, broken or malfunctioning buckles or attachments, or tears. The inhalation valves and exhalation valves should be checked for dust particles or dirt; cracks, tears or distortion in the valve seat; and missing or distorted valve covers. Filter elements should be checked for approval designation (TC X X X ID# X X X), missing or worn gaskets, worn threads, and cracks or dents in filter housing.

Cleaning and disinfecting:

When cleaning and disinfecting your respirator:

* Remove excess contaminants
* Remove filters, screens, and head band.
* Scrub the respirator in detergent and warm water. Use any good detergent or mild cleaning solution containing a bactericide.
* Submerge facepiece and scrub gently with soft brush or sponge.
* Rinse cleaned and disinfected respirator thoroughly in plain water to remove all detergent and disinfectant.

* If reusing filters, clean outer surfaces with a damp cloth or sponge saturated with mild cleaning solution.
* Air dry at room temperature on clean surface. Do not dry rubber parts under heat or sunlight.
* Never use solvents to clean plastic or rubber.

Inspection of the respirator should be done before and after cleaning. Follow the same procedures discussed under routine inspection.

Respirator storage:

Respirators should be stored in a heat-sealed or reusable plastic bag inside a rigid container, keeping facepiece away from dust, sunlight, extreme cold, excessive moisture and damaging chemicals. Facepieces should be placed in a normal position to prevent the rubber or plastic from being permanently distorted.

Respirator repair:

OSHA standards state that "replacement or repair shall be done by experienced persons with parts designated for the respirator". Parts should never be substituted from a different brand or type of respirator. Faulty equipment should never be accepted.

3. Different Styles

There are basically two different styles of the half-mask respirator. One is the mechanical-filter respirator. It is designed specifically for removing particles out of the air (e.g., dust). The second type of half-mask respirator is the chemical-cartridge respirator. This type of respirator can be used for such hazards as low concentrations of organic gases, paint vapors, and pesticides. It also has cartridges available for hazardous fiber conditions, such as asbestos.

4. Types of Cartridges (Discussed in Lecture 5).

5. Fit Testing

Pre-inspection:

Before each use of a respirator, OSHA requires a pre-inspection be performed. The inspection outlined under the routine inspection section should be performed. Also check that the proper cartridge for the hazardous element has been selected.

Field inspection:

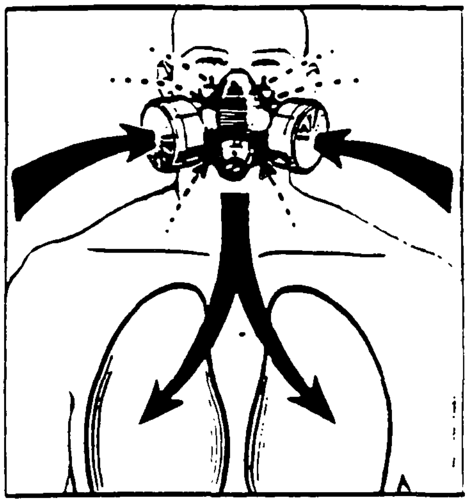
After a pre-inspection has been performed, the field inspection can be conducted. This involves a negative and positive pressure check. To perform a negative pressure check, the wearer must close off the inlet of the facepiece; inhale so that the facepiece collapses against face; and hold breath for approximately ten seconds. If facepiece does not remain collapse, readjust headstraps and repeat the above steps. If adjusting headstraps does not give proper seal, check facepiece for leaks. To perform a positive pressure check the wearer must close off the exhalation valve, and gently exhale into facepiece. The fit test passes if positive pressure builds up inside the facepiece without air leaking from around the facepiece. (See Figure B).

Post inspection:

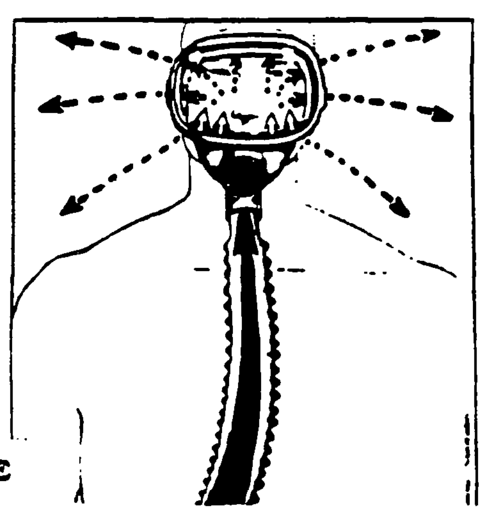
After a respirator has been used in the field, a post-inspection should be performed. OSHA requires that all respirators be inspected after each use. Follow the same procedures discussed under routine inspection.

Figure B - Respirator Field Inspection

NEGATIVE PRESSURE



NEGATIVE PRESSURE TEST



POSITIVE PRESSURE

Positive-Pressure Test

REVIEW QUESTIONS

HALF-MASK RESPIRATORS

1. The half-mask respirator is a supplied air respirator. T or F

2. The half-mask respirator removes contaminants from the breathing air after it is inhaled. T or F

3. Name two steps involved in respirator and cartridge selection.

   a.

   b.

4. Name two limitations of the half-mask respirator.

   a.

   b.

5. Half-mask respirator can protect against high concentrations of gases and vapors. T or F

6. Half-mask units can be used up to ______ times the substance PEL or 1000 ppm, whichever is lower.

FULL FACEPIECE RESPIRATORS

Transparency 4-7

Objectives

Student understanding of limitations, care,and fit-testing procedures for full facepiece respirators.

Background

Full facepiece, air purifying respirators can be utilized for protection against low concentrations of organic vapors, acid gases, dusts, mists and fumes. The type and level of protection depends on the rating of the cartridges or canister used in conjunction with the full facepiece respira-tor. Advantages of utilizing the full facepiece respirator instead of the half-mask respirator are 1) a higher protection factor and 2) eye protection.

LECTURE NOTES

The basic purpose of any respirator is to protect the respiratory system from inhalation of hazardous atmospheres. There are three families of respirators: air-purifying respirators, air-line or supplied-air respirators, and self-contained breathing apparatus.

The full facepiece is an air purifying respirator. It covers the whole face from under the chin to the top of the forehead. The full facepiece respirator removes contaminants from the breathing air before it is inhaled.

1. Selection

   The proper selection of a respirator involves two steps:

   - Identification and evaluation of the hazard.
   - Selection of an approved respirator based on the first consideration.

   The full facepiece respirator can restrict the users peripheral vision. The full facepiece respirator has many uses and limitations. Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal. A poor seal will permit contaminated air to enter the facepiece. Full facepiece respirators remove limited concentrations of air contaminants from the breathing air, therefore they can only be used where air contaminants do not exceed the specified range of the respirator and cartridge. These types of respirators should not be used in operations where the air might be oxygen-deficient such as fire fighting rescue work. Full facepiece respirators should not be used for exposures to contaminants easily detected by odor or irritations.

The full facepiece respirator provides eye protection unlike the half-mask respirator. The full face respirator can protect against low concentrations of organic vapors, pesticides, alkaline gases, acid gases, mercury vapors, or gases combined with acid or alkaline gases, and any of the above materials combined with dust, fumes, or mist. In general, full facepiece units can be used up to 50 times the substance PEL or 1000 ppm, whichever is lower. The full facepiece respirator does not restrict the wearer's mobility.

2. Maintenance and Care

In order to keep your respirator operating at its optimum level, a certain amount of care and maintenance needs to be exercised by the user. If properly performed, inspections will identify damaged or malfunctioning respirators before they can be used.

Routine inspection

OSHA requires that all respirators be leak checked as part of an inspection program. The person who is to use the respirator is responsible for inspecting it. Respirators for normal, non-emergency work must be inspected before and after each use. Emergency respirators must be inspected after each use and at least once a month.

OSHA requires that respirators be inspected before and after each use. During a routine inspection the facepiece should be checked for excessive dirt, distortion from improper storage, cracks, tears, or holes. The head straps should also be checked for loss of elasticity, broken or malfunctioning buckles or attachments, or tears. The inhalation valves and exhalation valves should be checked for dust particles or dirt; cracks, tears or distortion in the valve seat; and missing or distorted valve covers. Filter elements should be checked for approval designation (TC XXX ID# XXX), missing or worn gaskets, worn threads, and cracks or dents in the filter housing(s).

Cleaning and disinfecting:

When cleaning and disinfecting your respirator:

- Remove excess contaminants
- Remove filters, screens and head band.
- Scrub the respirator in detergent and warm water. Use any good detergent or mild cleaning solution containing a bactericide.
- Submerge facepiece and scrub gently with soft brush or sponge.
- Rinse and clean and disinfect respirator thoroughly in water to remove all detergent and disinfectant.
- If reusing filters, clean outer surfaces with a damp cloth or sponge saturated with a mild cleaning solution.
- Air dry at room temperature on a clean surface. Do not dry rubber parts under heat or sunlight.
- Never use solvents to clean plastic or rubber.

Inspection of the respirator should be performed before and after cleaning. Follow the same procedures discussed under routine infection.

Respirator storage:

Respirators should be stored in a heat-sealed or reusable plastic bag inside a rigid container, keeping the facepiece away from dust, sunlight, extreme cold, excessive moisture, and damaging chemicals. Respirators should be placed in a normal position to prevent the rubber or plastic from being permanently distorted.

Respirator repair:

OSHA standards state that "replacement or repair shall be done by experienced persons with parts designated for the respirator". Parts should never be substituted from a different brand or type of respirator. Faulty equipment should never be accepted.

3. Different Styles

There are basically two different styles of the full facepiece respirator. One is the mechanical-filter respirator. It is designed specifically for removing particles out of the air (e.g., dust). the second type of full facepiece respirator is the chemical-cartridge respirator. This type of respirator can be used for such hazards as low concentrations of organic gases, paint vapors, and pesticides. It also has cartridges available for hazardous fiber conditions, such as asbestos.

4. Types of Cartridges (Discussed in Lecture 5).

5. Fit Testing

Pre-Inspection:

Before each use of a respirator, OSHA requires a pre-inspection be performed. The inspection outlined under the routine inspection section should be performed. Also check that the proper cartridge for the hazardous element has been selected.

Field Inspection:

After a pre-inspection has been performed, the field inspection can bed conducted. This involves a negative and positive pressure check. To perform a negative pressure check, the wearer must 1) close off the inlet of the facepiece, 2) inhale so that the facepiece collapses against face, and 3) hold breath for approximately ten seconds. If facepiece does not remain collapse, readjust headstraps and repeat the above steps. If adjusting headstraps does not give proper seal, check facepiece for leaks. To perform a positive pressure check, the wearer must close off the exhalation valve, and gently exhale into facepiece. The fit test passes if positive pressure builds up inside the facepiece without air leaking from around the facepiece.

Post Inspection:

After a respirator has been used in the field, a post-inspection should be performed. OSHA requires that all respirators be inspected after each use. Follow the same procedures discussed under routine inspection.

REVIEW QUESTIONS

FULL FACEPIECE RESPIRATORS

1. The full facepiece respirator is a supplied-air respirator. T or F.

2. Name two limitations of the full facepiece respirator.

   a.

   b.

3. Full facepiece respirators can be used up to __ times the substance PEL or 1000 ppm, whichever is lower.

4. What is one major advantage that the full facepiece respirator offers over the half-mask respirator, not including the advantage of an increased PF?

POWERED AIR PURIFYING RESPIRATORS

Transparency 4-8

Objective

Student understanding of the limitations, care, and fit-testing of PAPRs. Discussion of NIOSH's studies on PAPRs PFs.

Background

A powered air purifying respirator (PAPR) uses a blower and portable, rechargeable battery pack to pass contaminated air through an element that removes the contaminants and supplies the purified air to a respiratory inlet covering. PAPRs were considered positive pressure devices until recently. Field studies conducted by NIOSH and others have shown that PAPRs are not positive pressure respirators and that their assigned protection factors are too high. NIOSH now recommends much lower protection factors.

LECTURE NOTES

USES AND LIMITATIONS OF POWERED AIR PURIFYING RESPIRATORS

Uses

PAPRs protect the wearer against particulates and/or gases and vapors. The air purifying element may be a filter to remove particulates, a cartridge to remove vapors and gases, or a combination filter and cartridge, canister, or canister and filter. The decreased inhalation resistance makes PAPRs more comfortable to wear than normal negative pressure air purifying respirators. In addition, the airstream through the mask provides a cooling effect in warm temperatures. PAPRs with loose fitting hoods or helmets are advantageous for people who cannot wear a tight-fitting facepiece. This type of respirator is used in operations involving abrasive blasting, grinding, pesticide spraying, and asbestos.

Limitations

PAPRs cannot be used in oxygen deficient atmospheres (less than 19.5% oxygen) or in atmospheres immediately dangerous to life or health (IDLH). They should not be used for protection against gases or vapors with poor warning properties except for escape only or where permitted by a regulatory agency, and the respirator is equipped with an end of service life indicator for the particular substance. The respirator user should always read the NIOSH/MSHA approval label concerning cartridge and canister limitations. PAPR filters do not remove poisonous gases or vapors from the air supply. No filter is designed for all substances. The filter element may be degraded by extreme humidity and temperature and the cost of replacement elements can be high.

The nickel-cadmium battery packs must be recharged periodically. These batteries have a limited useful life and battery replacement cost may be expensive. The blower has a high speed motor which will eventually wear out and must be replaced periodically.

If hot or very cold air is in working area, there is the problem of this air blowing into the respiratory inlet covering, making it uncomfortable for the wearer.

CARE AND MAINTENANCE OF PAPRs

Routine Inspection

The facepiece should be checked for excessive dirt, cracks, tears, or holes; distortion from improper storage; cracked, scratched, or loose fitting lens; and broken or missing mounting clips.

Headstraps should be checked for breaks or tears; loss of elasticity; broken or malfunctioning buckles or attachments; and excessively worn serrations of the head harness which might allow the facepiece to slip.

Inhalation and exhalation valves should be checked for detergent residue; dust particles or dirt on the valve seat; cracks, tears, or distortion in the valve material or valve seat; and missing or defective valve cover.

The filter elements should also be checked for the following: proper filter for the hazard; approval designation (TC X X X ID# X X X); missing or worn gaskets; worn threads; and cracks or dents in the filter housing.

If the PAPR includes a hood or helmet, the headgear suspension should be checked, and adjusted, if required. The facepiece should be inspected for cracks and breaks.

Cracks or other damage to the flexible air hose and clamps should also be checked.

Cleaning and Disinfecting

Before cleaning, remove any excess contaminant from the respirator. Disconnect the breathing tube from the facepiece. The facepiece may be washed by hand or in a commercial dishwasher or clothes washer with a rack installed to hold the facepieces in a fixed position. Domestic dishwashers are not preferred because they do not immerse the facepiece. When handwashing, submerge the facepiece and scrub gently until clean with a soft brush or sponge. Use any good detergent or mild cleaning solution with water or a detergent containing a bactericide. The cleaning water should be between 120°F and 140°F to ensure adequate cleaning. If a dishwasher is used, eliminate the drying cycle, because the extreme temperature may damage the facepiece.

After cleaning, follow with a disinfecting rinse. Disinfectant must be added to the rinse cycle if a dish or clothes washing machine is used. Rinse the cleaned and disinfected respirator thoroughly in plain water (140°F maximum) to remove all detergent and disinfectant, as it may irritate the wearer's face.

Separate the motor-blower, battery pack and filters. Use a damp cloth or sponge saturated with a mild cleaning solution to wipe the breathing tube, motor-blower, and battery pack cases clean. If reusing filters, clean the outer surfaces with a damp cloth or sponge saturated with a mild cleaning solution. Wash the support belt with a soft brush or sponge and mild cleaning solution.

Air dry the respirator at room temperature on a clean surface. Take care not to damage or distort the facepiece when hanging to dry. A commercial, electrically heated steel storage cabinet, with a built in circulating fan may be utilized to dry respirators. If using this cabinet, replace the shelves with steel mesh.

Inspect the entire PAPR during and after cleaning. Since the respirator is usually disassembled during cleaning, it is a good time to inspect each part. Follow the procedures for routine inspection. Inspect all parts of the PAPR following cleaning and reassembly. OSHA requires that all respirators be leak-checked as part of an inspection program. Do this after cleaning and reassembly is complete. This procedure will show if the complete reassembly is air tight.

Storage

The clean facepiece should be stored in a heat-sealed or reusable plastic bag inside a rigid container, keeping the facepiece away from dust, sunlight, extreme cold, excessive moisture, and damaging chemicals. Store in a clean, dry location away from direct sunlight. The facepiece and exhalation valve should be placed in a normal position to prevent rubber or plastic from being permanently distorted.

Store the charged PAPR battery pack within a temperature range suggested by the manufacturer for maximum battery life. Storing at higher temperatures will shorten the battery life. Lower temperatures will decrease the capacity, and the operating time will be reduced.

Maintenance and Repair

OSHA standards state that "replacement or repair shall be done by experienced persons with parts designed for the respirator." Parts must not be substituted from a different brand or type of respirator for the following reasons: it is contrary to OSHA standard; invalidates NIOSH/MSHA approval; and wearer may be improperly protected.

The battery pack requires special attention. Nickel-cadmium batteries may develop a "memory" when they are partially discharged and then recharged continuously. The battery pack should be used for the rated time, then recharged. Do not charge indefinitely; run down battery periodically and fully recharge it. Follow the manufacturer's recommendations for the entire PAPR (including battery pack).

DIFFERENT STYLES

There are three main types of powered air-purifying respirators. The first type is with the air-purifying element(s) attached to a small blower which is worn on the belt and connected to the respiratory inlet covering with a flexible tube. The second is with the air-purifying element attached to a stationary blower, powered by a battery or an external power source and connected by a long flexible tube to the respiratory inlet covering. The third type of PAPR is a helmet or facepiece to which the air-purifying element and blower are attached, with the battery worn on the belt.

The respiratory inlet covering can be a tight fitting half-mask or full facepiece, or a loose fitting hood or helmet. A PAPR with a tight fitting mask must deliver at least 6 f^3/min (170 l/min).

TYPES OF CARTRIDGES

(Discussed in Lecture 5.)

FIT TESTING

Pre-Use Inspection

OSHA requires that all respirators be inspected before each use. This inspection should be performed as outlined under routine inspection. Check the battery pack to make sure it is fully charged. Check for proper connection of the breathing tube to the facepiece. The air-purifying element must also be checked. Make sure it is the proper element for the hazard and that it is connected correctly.

Field Checks (done without breathing tube connected to the facepiece)

One of the field checks that must be done is the negative pressure check. The inlet must be closed off first. Inhale so that the facepiece collapses against the face and hold breath for approximately ten seconds. If the facepiece does not remain collapsed, readjust the headstraps and repeat the above steps. If adjusting the headstraps does not give a proper seal, check the facepiece. Do not use a facepiece that does not seal properly.

After Use Inspection

OSHA requires that all respirators be inspected after each use. Perform the inspection as outlined under routine inspection and follow the procedures listed in inspecting the respirator during and after cleaning.

REVIEW QUESTIONS

POWERED AIR PURIFYING RESPIRATORS

1. According to NIOSH, powered air purifying respirators have a protection factor of:

   a. 10
   b. 25
   c. 50
   d. 100
   e. 1000

2. PAPRs can be worn in oxygen deficient atmospheres

   a. True
   b. False

3. PAPR filter will remove poisonous gases or vapors from the air supply

   a. True
   b. False

4. Why does one need to run down a nickel-cadmium battery pack periodically and recharge it?

5. What is the minimum air flow a tight fitting half-mask or full-facepiece must deliver?

   a. 2 ft^3/min
   b. 4 ft^3/min
   c. 6 ft^3/min
   d. 10 ft^3/min

6. One must perform a positive and negative pressure check with a PAPR before going into a contaminated area.

   a. True
   b. False

ESCAPE RESPIRATORS

Transparency 4-9

Objective

Student understanding of limitations, care, and styles of escape respirators.

Background

Escape respirators are respirators whose single function is to allow a person working in a normally safe environment sufficient time to escape from suddenly occurring respiratory hazards.

LECTURE NOTES

USES AND LIMITATIONS OF ESCAPE RESPIRATORS

Uses

The single function of an escape respirator is to allow a person working in a normally safe environment sufficient time to escape from suddenly occurring respiratory hazards.

Limitations

Escape respirators are not to be used for entry into contaminated atmospheres. The appropriate escape respirator must be selected for the anticipated respiratory hazard (each type is designed for a specific use only). SCBA escape respirators only provide 5 to 15 minutes of respiratory protection. Air-purifying escape respirators cannot be used in oxygen deficient atmospheres (less than 19.5% oxygen). Mouthpiece respirators are only good for short periods of escape from low concentrations of organic vapor or acid gas. Gas masks and other air-purifying respirators cannot be used if the exposure concentration is above the limitations of the canister or cartridge.

CARE AND MAINTENANCE

Inspection

Routine procedures should be followed after each use. OSHA requires that escape respirators be inspected once a month and that "a record shall be kept of inspection dates and findings for respirators maintained for emergency use." NIOSH recommends that inspections be conducted at least weekly, in order that loss of breathing gas from emergency SCBAs does not go undetected.

Escape Gas Mask (Canister) and Mouthpiece Respirators

The facepiece should be checked for excessive dirt, cracks, tears, or holes; distortion from improper storage; cracked, scratched, or loose fitting lens; and broken or missing mounting clips. Check the headstraps for breaks or tears; loss of elasticity; broken or malfunctioning buckles or attachments; and excessively worn serrations of the head harness which might allow the facepiece to slip. The inhalation and exhalation valves should be checked for detergent residue; dust particles or dirt on the valve seat; and missing or defective valve cover. Examine the filter elements for proper filter for the hazard (proper air-purifying element or chemical canister); approval designation (TC X X X ID# X X X); missing or worn gaskets; worn threads; and cracks or dents in the filter housing.

Self-Contained Breathing Apparatus (SCBA), Open-Circuit

The facepiece should be checked for excessive dirt; cracks, tears, or holes; distortion from improper storage; cracked, scratched or loose fitting lens; and broken or missing mounting clips. Examine the headstraps for breaks or tears; loss of elasticity; broken or malfunctioning buckles or attachments; and excessively worn serrations of the head harness which might allow the facepiece to slip. Check the inhalation and exhalation valves for detergent residue; dust particles or dirt on the valve seat; cracks, tears, or distortion in the valve material or valve seat; and missing or defective valve cover.

Hood-type SCBA: Examine the hood for rips and tears, seam integrity, etc.

Examine the air supply systems for integrity and condition of the air supply lines and hoses, including attachment and fittings; good working order of regulators and gauges; and check to ensure that the cylinder is fully charged. The charging of a cylinder depends on the model.

DIFFERENT STYLES OF ESCAPE RESPIRATORS

Mouthpiece Respirators

Mouthpiece respirators consist of a mouthpiece held in the teeth (lips seal around it) and a clamp that closes the nostrils (see Figure C). Communication is eliminated and mouthpiece respirators may cause fatigue. They provide no eye protection. Mouthpiece respirators are designed specifically for use in the chemical industry, pulp and paper industries, or other industries where acid gas contamination may occur. They must be equipped with a cartridge or canister for specific contaminants, and may not be used in oxygen-deficient atmospheres. These respirators are available for carbon monoxide, chlorine, ammonia, organic vapors, and acid gases.

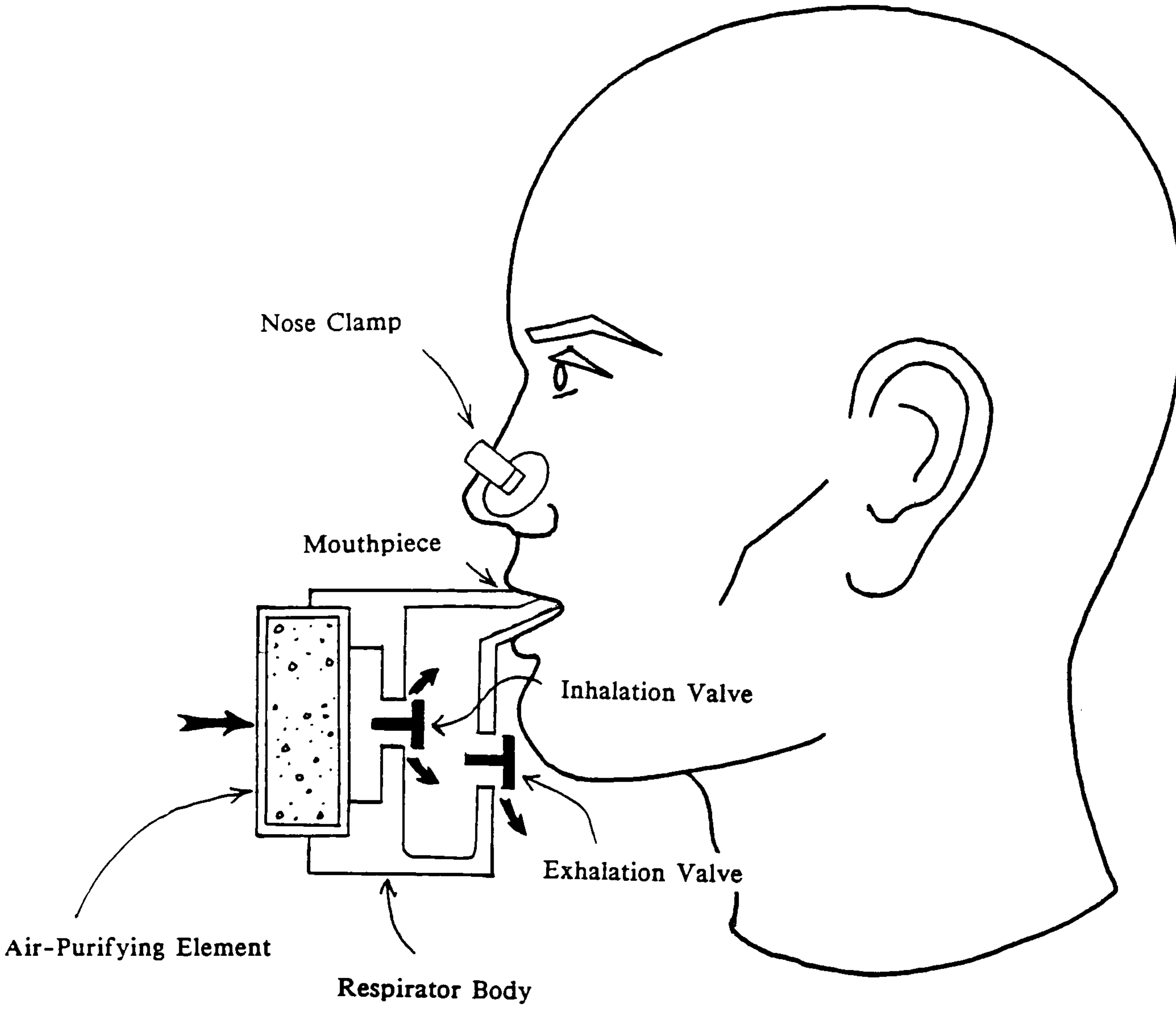
Escape Gas Mask (Canister) Respirator

An escape gas mask respirator consists of a facepiece or mouthpiece, canister, and associated connections. They are certified under 30 CFR 11, Subpart I. These respirators may not be used in oxygen-deficient atmospheres. An example of an escape gas mask respirator is the "filter" self rescuer. It is a mouthpiece device designed to protect specifically against less than 1% carbon monoxide. These respirators are used in escaping from mines.

Escape-Only Self-Contained Breathing Apparatus (ESCBA), Open Circuit, 5 to 15 Minutes Supply

This is a small sized, low weight SCBA. The compressed-air container is usually hip- or back-mounted with the air valve in an accessible position. The facepiece may be put on quickly by tightening the headband straps. The different styles are full mask, half-mask, and mouthpiece styles. They also are available in a hood-style for quick donning.

Figure C - Typical Mouthpiece Respirator



Self-Contained Self-Rescuer (SCSR), Closed Circuit

These respirators are certified for use in underground mines in emergency situations. There are compressed-oxygen and oxygen-generating types. Most SCSR have a one hour duration. They feature a mouthpiece instead of a facepiece and have no structural breathing bag protection. SCSR with pressure vessels use active pressure gauge indicators. Chemical SCSR use passive storage life color indicators and inspection procedures. MSHA has strict enforceable storage and location requirements for SCSR, indicating specific daily and 90 day required SCSR inspection periods and procedures.

REVIEW QUESTIONS

ESCAPE RESPIRATORS

1. How often does OSHA require inspections to be performed for escape respirators?

   a. once per week
   b. daily
   c. once per month
   d. twice per year

2. How often does NIOSH recommend escape respirators to be inspected?

   a. once per month
   b. once per week
   c. twice per month
   d. twice per year

3. Escape respirators are designed for a broad range of hazards.

   a. True
   b. False

4. Air-purifying escape respirators can be worn in oxygen deficient atmospheres.

   a. True
   b. False

5. Escape respirators are respirators which are worn into IDLH atmospheres.

   a. True
   b. False

LECTURE 5

USES AND LIMITATIONS OF RESPIRATORS

LECTURE 5

USES AND LIMITATIONS OF RESPIRATORS

EXPOSURE LIMITS

Transparency 5-1

Objective

Student understanding of the origin and current use of the RELs, PELs, and TLVs.

Background

Prior to 1970, State agencies used the Threshold Limit Value (TLV) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) as guidelines for exposures to toxic materials. After 1970, Congress enacted several new safety and health laws, one of which was the "OSHA Act" under which NIOSH was established.

LECTURE NOTES

GENERAL CONCEPTS

Transparency 5-2

Prior to 1970, governmental regulations of safety and health matters were concerns of state agencies. Most states adopted as guidelines the Threshold Limit Values (TLV) for exposure to toxic materials as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Enforcement of those guidelines were minimal. In 1970 Congress enacted new safety and health laws, one of which was the Public Law 91-596, the Occupational Safety and Health Act of 1970 or "OSHA Act". One of the key provisions was the establishment of the National Institute of Occupational Safety and Health (NIOSH).

NIOSH RELs

Handout 14

The National Institute for Occupational Safety and Health (NIOSH) is the principle government agency engaged in the national effort to eliminate on-the-job hazards to the health and safety of workers. Acting under the Occupational

Safety and Health Act 1970 (Public Law 91-596), NIOSH develops and periodically revises recommended exposure limits to potentially hazardous substances and conditions in the work place.

OSHA Revised PELs

The Occupational Safety and Health Administration (OSHA) is amending its existing Air Contaminants standard 1910.1000 including Tables 2-1, 2-2, 2-3. This amendment is lowering 212 Permissible Exposure Limits (PELs) listed for these three tables; setting new PELs for 164 substances not currently regulated by OSHA; and maintaining other PELs unchanged. The changes also include inclusion of Short Term Exposure Limits (STELs) to complement the 8 hour time-weighted average (TWA) limits, where applicable. Many of OSHAs PELs were promulgated initially from the American Conference of Governmental Industrial Hygienists (ACGIH) 1968 Threshold Limit Values (TLV) list; PELs are not updated annually as is the TLV list. As law, however, they represent the legal maximum levels of contaminants in work room air. Section 17 contains the 1989 revision of the OSHA PELs.

ACGIH TLVs

The American Conference of Governmental Industrial Hygienists (ACGIH) developed a list of Threshold Limit Values (TLVs) that refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Because of wide variation in individual susceptibility, a small % of workers may experience discomfort from some substances at concentrations at or below the threshold limit.

Cartridge Life

Areas of high humidity and temperature can substantially reduce cartridge life by tying up the activation sites of the adsorbent material in the cartridge. Some cartridge and canister manufacturers have engineered "sight devices" into the cartridge which change color when its effectiveness is substantially reduced or totally eliminated. These devices are also known as end-of-service of life indicators. These indicators can also be audible in nature, such as the warning bell on a SCBA indicating that the air cylinder needs replacing or recharging. Different air contaminants will have varying breakthrough times. The user must utilize the manufacturer's recommendations, possible olfactory warning properties, and other information to determine when cartridges or canisters require replacement.

REVIEW QUESTIONS

EXPOSURE LIMITS

1. What agency develops and periodically revises recommended exposure limits to potentially hazardous substances and conditions in the work place?

2. What agency was NIOSH formed under?

3. What does PEL stand for?

4. Prior to 1970, what did state agencies use as guidelines for recommended exposures to toxic materials?

5. What does ACGIH stand for?

USES AND LIMITATIONS OF RESPIRATORS

Objectives

Student understanding of the differing levels of protection offered by different respiratory protection devices. Calculations of PFs and MUCs.

Background

Respirators offer varying degrees of protection against different contaminants. One must understand the differences between different types of respirators. Comparisons of respirators can be done by using the concept of protection factors (PFs). Maximum Use of Concentration (MUC) is determined by TLV x PF.

LECTURE NOTES

PROTECTION FACTORS (PFs)

Transparency 5-3

Protection factor (PF) is defined as the concentration of a contaminant measured outside the respirator divided by the concentration found inside the respirator. It is a measure of the degree of protection provided to the wearer. The protection factor depends greatly on the fit of the respirator to the wearer's face. The PF offered by any one respirator will be different for each individual. The protection constantly changes depending on the worker's activities and shaving habits.

Protection factors, based on extensive research, have been developed for different categories of respirators. See Table 1. PF are based on quantitative fit testing of respirators, and not based on a sufficient amount of workplace testing.

The range of all potential exposures should be determined for all workers and for all circumstances that can be reasonably anticipated. The highest anticipated exposure for each respirator wearer should be used to compute the protection factor required for each wearer. One can determine the PF needed by using the following formula:

Table 1 Respiratory Protection Factors

Type of Respirator	Protection Factor	Facepiece Pressure
AIR PURIFYING		
Single-use, dust, dust/mist, and dust/mist/fume	5	Negative
Half-mask	10	Negative
Full facepiece	50	Negative
Powered air purifying, tight fitting	50	Negative
Powered air purifying, loose fitting	25	Negative
ATMOSPHERE-SUPPLYING		
Self-Contained Breathing Apparatus (SCBA): Open-circuit, pressure-demand, full facepiece	10,000	Positive

$$\text{PF needed} = \frac{\text{Concentration of contaminant outside mask}}{\text{Concentration of contaminant desired inside mask}}$$

Required PF should be used with caution. The following tables show Protection Factors for different types of respirators.

MAXIMUM USE CONCENTRATION (MUC) **Transparency 5-4**

Maximum Use Concentration (MUC) is defined as the maximum ambient air concentration of an air contaminant in which a respirator can be used. It is determined by the following formula:

$$MUC = TLV \times PF$$

See Table 2 for an example of the use of this formula.

The MUC cannot be applied if the calculation yields a value close to or exceeding an IDLH level for a particular air contaminant.

TABLE 2 Example of Maximum Use Concentration Determination

What is the MUC for a half-mask respirator with dust/mist filters for copper dust?
TLV for copper dust: 1 mg/m^3 **PF for half-mask respirator with dust/mist filter:** 10 MUC = TLV × PF = 1 mg/m^3 × 10 = 10 mg/m^3
If air-sampling indicates an ambient concentration greater than 10 mg/m^3, this respirator does not provide sufficient protection!

REVIEW QUESTIONS

USES AND LIMITATIONS OF RESPIRATORS

1. What is the formula used to determine the protection factor of a respirator?

2. Are protection factors based on qualitative or quantitative fit testing of respirators?

3. What is the protection factor of a half-face respirator?

   a. 5
   b. 10
   c. 20
   d. 50
   e. 100

4. Is the protection factor for a certain respirator going to be the same for all individuals?

   a. Yes
   b. No

5. What is the MUC for a full facepiece respirator with organic vapor cartridges for methyl chloroform?

PROPER USE AND CARE OF AIR-PURIFYING RESPIRATORS (Video Tape)

Objectives

Student understanding of the general maintenance and storage requirements for respirators.

Background

To prepare the student for Lecture 6, the general requirements and procedures in maintaining respirator's is discussed.

LECTURE 6

RESPIRATOR "HANDS-ON" EXERCISES

LECTURE 6

RESPIRATOR "HANDS-ON" EXERCISE

RESPIRATOR EXERCISE

Objectives

Student familiarization with different types of respirators. Student practice performing field checks and respirator inspections.

Background

It is important for students to be thoroughly familiar with the respirators to ensure comfort and acceptance of the devices.

FIT-TESTING (Video Tape)

Objective

Student understanding of the necessity for, and the procedures for, qualitative and quantitative fit-testing.

Background

OSHA requires that the seal of the respirator facepiece with the face of the wearer be verified with standard fit-testing procedures.

LECTURE 7

INTRODUCTION TO SELF-CONTAINED BREATHING APPARATUS RESPIRATORS

LECTURE 7

INTRODUCTION TO SELF-CONTAINED BREATHING APPARATUS RESPIRATORS

SELF-CONTAINED BREATHING APPARATUS (SCBA)

Objective

Student understanding of the limitations, care, use, and types of SCBAs.

Background

A self-contained breathing apparatus (SCBA), while providing the greatest protection to the wearer, is by far the most complex respirator in use today. SCBA training is essential. SCBAs can provide respiratory protection in oxygen deficient environments and in situations where high or unknown concentrations of toxic gases, vapors or particulate are present. When using a SCBA, the wearer is independent of the surrounding atmosphere, because he/she is breathing within a closed system. The type of SCBA that will be addressed and used in this class is a pressure demand, open circuit system supplied by cylinder-stored compressed air.

LECTURE NOTES

USES AND LIMITATIONS **Handout 11**

All SCBAS may be used in oxygen deficient environments. However, if used in a IDLH environment only a positive pressure unit can be used. Demand devices have protection factors no greater than air purifying devices with the same facepiece.

Under emergency conditions. Any SCBA may be used for escape and rescue.

The pressure-demand unit that we will use in this class can provide up to 30 minutes of breathing time, much less under extreme exertion.

SCBA with less than 15 minute air supply may be used for emergency escape only.

All SCBA equipment must have a functioning warning device that alarms when only 20-25% of service time remains.

SCBA are approved as systems. The interchanging of parts from one manufacturer's unit to another will void the approval as in all other types of respirators.

Oxygen must not be used to fill SCBA tanks. Tanks must be filled by qualified personnel.

When using SCBA equipment, the use of a buddy system and/or other safety considerations are required when working in IDLH environments.

Where contaminants pose a hazard through skin absorption, precautions must be taken to cover all exposed skin surfaces with impermeable clothing.

Always follow manufacturers' instructions for SCBA use and cylinder recharging and testing.

SCBAs should not be worn in areas in which explosive contaminants are potentially present at concentrations equal to or above 10% of the lower explosive limit (LEL).

Only trained persons should wear a SCBA as the equipment is bulky and the air cylinders' service life is dependent on the individual wearer's physical conditioning and ability to perform the work required when wearing a SCBA.

COMPONENT(S) CHECKLIST **Transparency 7-1**

<u>Facepiece Assembly</u>

The facepiece assembly consists of a facepiece, rubber mask assembly, speaking diaphragm, exhalation valve and a breathing tube. Lens fogging is reduced by the flow of cool, dry air directed across the lens through inlet ducts located in the facepiece. A speaking diaphragm may be mounted in the front of the facepiece; its housing may contain the exhalation valve or the exhalation valve may be mounted separately.

Fastened to the facepiece, by a threaded connector, is a corrugated breathing tube. The other end of which attaches to the regulator by means of a coupling nut.

The facepiece must seal on the wearer to ensure safety in hazardous atmospheres. The head band must be tight to maintain that seal. The seal may be broken by head movement, facial movement, exhalation valve not seating, speaking diaphragm in poor condition, damage to the facepiece, facial structure, missing gaskets, and any facial or head hair that comes in contact with any part of the facepiece that seals against the face and forehead. This seal can be checked by a negative pressure test by placing palm over the end of the corrugated breathing tube and inhaling. If this does not create negative pressure in the mask, try to adjust it or do not use that facepiece.

Carrier and Harness Assembly

The carrier is the means of mounting the cylinder on the apparatus. It consists of a metal back plate against which the cylinder rests, and which has an opening at the bottom for insertion of the cylinder neck and valve. The cylinder is held in place by a curved, metal bank fitted to the back plate.

The harness is the means by which the apparatus is worn. It consists of two shoulder straps, a chest strap, and a waist strap. The carrier and harness should be checked for loose belts and worn straps.

Audible Alarm

The audible alarm rings to indicate low cylinder air pressure. It is a warning device that is connected between the cylinder and demand regulator on the high pressure hose. A loud ringing sound indicates a low air pressure below 540 psi or 1,000 psi depending on the model. They will ring continuously when the cylinder pressure reaches the preset pressure for approximately 4 to 6 minutes rated time. Operational time would be approximately 2 to 3 minutes or less. This is the amount of air remaining. This alarm should be checked before every use or during the monthly check.

Remember, the audible alarm is indicating low air pressure, and it is imperative, when it does ring, that the wearer leave the area to obtain another cylinder. Do not remain in the area.

Pressure-Demand Regulator

The pressure-demand regulator reduces the cylinder pressure to a breathable pressure and supplies the wearer with air in direct response to breathing requirements. All entry or re-entry into immediately dangerous or hazardous atmospheres require the use of the pressure-demand regulator. The regulator is the heart of the SCBA and should only be worked on by trained personnel. The pressure-demand regulator can be checked by putting on the SCBA and breaking the seal between the rubber mask assembly and your face. There should be a flow of air coming through the break in the seal to demonstrate positive pressure in the facepiece.

In the event that the automatic mechanism of the regulator fails, an emergency bypass valve, which is distinguished by its red handwheel and octagon shape, can be used. This valve, which is usually tapped into the inlet side of the regulator, routes the flow of air through a special passageway in the regulator, so that it enters the breathing tube and facepiece independent of the automatic phase of the regulator.

Since the bypass valve is a constant flow device, it should be used only when the demand regulator fails to operate. When the bypass valve is used the supply of air will be reduced to approximately ten minutes duration with a full cylinder. This bypass valve should be checked before using a SCBA.

<u>High Pressure Flexible Hose</u>

The high-pressure hose is a flexible hose that routes the compressed air from the cylinder to the regulator. The connection to the cylinder is made with a fitting that is hand-tightened or tightened with a wrench. The connection is made in a brass cone fitting using an O-ring gasket as the seal between the male and female sections. This gasket should be checked periodically and spare parts kept for replacement as needed.

<u>Cylinder</u>

The cylinder has a 45 cubic feet capacity at 2216 psi and a 30 minute duration rating when full. The rated duration of the SCBA is determined by NIOSH/MSHA in their testing procedures. The true time duration of the cylinder will depend on several operational factors.

1. Physical activity of the user.
2. Physical condition of the user.
3. The user's training or experience with the SCBA.
4. The emotional condition of the user. (e.g., excitement or fear).
5. The condition of the SCBA and the amount of air in the cylinder.

The cylinder should be charged only by qualified personnel. The cylinder should also have a hydrostatic test performed every five years by a qualified person. Extra cylinders should be available to deal with emergency situations. No cylinder should be used below 1500 psi. Only Grade D air should be used when refilling cylinders.

Routine Inspection

Inspection for Defects

The most important part of a respirator maintenance program is the continual inspection of the devices. If properly performed, inspections will identify damaged or malfunctioning respirators before they can be used. The OSHA standard outlines two types of inspections.

a. While the respirator is in use.
b. While it is being cleaned.

In plants where the workers maintain their own respirators, the two types of inspections become essentially one.

Frequency of Inspection

OSHA requires that "All respirators be inspected before and after each use" and that those not used routinely, i.e., emergency escape and rescue devices, "shall be inspected after each use and at least monthly ..." Obviously, emergency escape and rescue devices do not require inspection before use. Records of inspections should be kept on appropriate Forms. See Figure I.

Inspection Procedures

Transparency 7-2

The OSHA standard states that the respirator inspection shall include checking of:

a. Tightness of the connections.
b. Facepiece.
c. Valves.
d. Connecting tubes.
e. Canisters, filters, and cartridges.

In addition, the standard also states that the regulator and warning devices on a SCBA shall be checked for proper functioning.

Field inspection of respirators should be checked as follows before and after each use:

1. Examine the facepiece for:
   a. Excessive dirt.
   b. Cracks, tears, holes or physical distortion of shape from improper storage.
   c. Inflexibility of rubber facepiece.
   d. Cracked or badly scratched lenses in full facepieces.
   e. Incorrectly mounted full facepiece lenses, or broken or missing mounting clips.
   f. Cracked or broken air-purifying element holder(s) and badly worn threads or missing gasket(s).

2. Examine the head straps or head harness for:
   a. Breaks.
   b. Loss of elasticity.
   c. Broken or malfunctioning buckles and attachments.
   d. Excessively worn serrations on the head harness, which might permit slippage (full facepieces only).

3. Examine the exhalation valve for the following after removing its cover:
   a. Foreign material, such as detergent residue, dust particles or human hair under the valve seat.
   b. Cracks, tears or distortion in the valve material.
   c. Improper insertion of the valve body in the facepiece.
   d. Cracks, breaks or chips in the valve body, particularly in the sealing surface.
   e. Missing or defective valve cover.
   f. Improper installation of the valve in the valve body.

4. If the device has a corrugated breathing tube examine it for:
   a. Broken or missing end connectors.
   b. Missing or loose hose clamps.
   c. Deterioration, determined by stretching the tube and looking for cracks.

5. Examine the air supply systems for:
   a. Integrity and good condition of air supply lines and hoses, including attachment and end fittings.
   b. Correct operation and condition of all regulators and other air flow regulators.

6. The high pressure cylinder of compressed air or oxygen is sufficiently charged for the intended use, preferably fully charged.

7. On osed circuit SCBA, a fresh canister of CO_2 (carbon dio, de) sorbent is installed.

8. On open circuit SCBA, the cylinder has been recharged if less than 25% of the useful service time remains.

9. All SCBAs are required to have a warning device that indicates when the 25% level is reached. However, it is recommended that an open-circuit SCBA be fully charged before use.

NON-ROUTINE USE OF AIR-PURIFYING OR ATMOSPHERE SUPPLYING DEVICES

When air-purifying or atmosphere supplying devices are used non-routinely, all the above procedures should be followed after each use. OSHA requires that devices for emergency use be inspected once a month and that "a record shall be kept of inspection dates and findings for respirators maintained for emergency use."

Defects Found in Field Inspection

If defects are found during any field inspection, two remedies are possible. If the defect is minor, repair and/or adjustment may be made immediately. If it is major, the device should be removed from service until it can be repaired. A spare unit should replace the unit removed from service. Under no circumstances should a device that is known to be defective remain in the field.

Cleaning and Disinfecting

OSHA 1910.134 states "routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to ensure that proper protection is provided . ." and that emergency use respirators "shall be cleaned and disinfected after each use".

The actual cleaning may be done in a variety of ways. It is recommended that a commercial dishwasher be used. A standard domestic clothes washer may also be used if a rack is installed around the agitator to hold the facepieces in fixed positions. If the facepieces are placed loose in the washer, the agitator may damage them. A standard domestic dishwasher may be used, but is not preferred, because it does not immerse the facepieces. Any good detergent may be used followed by a disinfecting rinse or a combination disinfectant-detergent for a one stop operation. However, where individual issue is not practical, disinfection is strongly recommended. Reliable, effective disinfectants may be made from readily available household solutions, including:

a. Hypochlorite solution (50 ppm of chlorine) made by adding approximately two milliliters of bleach (such as Chlorox) to one liter of water, or two teaspoons of bleach per gallon of water. A two minute immersion disinfects the respirators.

b. Aqueous solution of iodine (50 ppm of iodine) made by adding approximately 0.8 milliliters of tincture of iodine per liter of water, or one teaspoon of tincture of iodine per gallon of water. A two-minute immersion is sufficient to disinfect the respirators.

If the respirators are washed by hand, a separate disinfecting rinse may be provided. If a washing machine or dishwasher is used, the disinfectant must be added to the rinse cycle. The amount of water in the machine at that time will have to be measured to determine the correct amount of disinfectant.

To prevent damaging the rubber and plastic in the respirator facepieces, the cleaning water should not exceed 140° F, but it should not be less than 120°F to ensure adequate cleaning. In addition, if commercial or domestic dishwashers are used, the drying cycle should be eliminated, since the temperatures reached in these cycles may damage the respirators.

Rinsing

The cleaned and disinfected respirators should be rinsed thoroughly in water (140°F maximum) to remove all traces of detergent and disinfectant. This is very important for preventing dermatitis to the wearer.

Drying

The respirators may be allowed to dry in room air on a clean surface. They may also be hung from a horizontal wire, but care must be taken not to damage or distort the facepieces. Another method is to equip a standard steel storage cabinet with an electric heater that has a built-in circulating fan, and to replace the solid steel shelves with steel mesh.

Reassembly and Inspection

The clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area to avoid contamination. The inspection procedures have been discussed. Special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve and can cause valve leakage or sticking.

The facepiece should be combined with the tested regulator and the fully charged cylinder, and an operational check performed.

Inspection During Cleaning

Because respirator cleaning usually involves some disassembly, it presents a good opportunity to examine each respirator thoroughly. The procedures outlined above for a field inspection should be used. Respirators should be inspected after cleaning operations and reassembly have been accomplished.

OSHA requires, as part of an inspection program, that all respirators be leak checked to determine that the complete assembly is air tight. Follow field inspection procedures to examine the freshly cleaned, reassembled respirator.

Respirator Storage

Transparency 7-3

OSHA requires that respirators be stored to protect against:

a. Dust
b. Sunlight
c. Heat
d. Extreme cold
e. Excessive moisture
f. Damaging chemicals
g. Mechanical damage

Damage and contamination of respirators may take place if they are stored on a workbench, or in a tool cabinet or toolbox, among heavy tools, greases and dirt.

Freshly cleaned respirators should be placed in heat-sealed or reusable plastic bags until reissued. They should be stored in a clean, dry location away from direct sunlight. They should be placed in a single layer with the facepiece and exhalation valve in an undistorted position to prevent rubber or plastic from taking a permanent distorted "set".

Air-purifying respirators kept ready for non-routine or emergency use should be stored in a cabinet with individual compartments. The storage cabinet should be readily accessible, and all workers should be made aware of its location. Preventing serious injury from the inhalation of a toxic substance depends entirely on how quickly workers can get to the emergency respirators.

A chest or wall-mounted case may be purchased from the respirator manufacturer for storing SCBAs for use in emergencies. Again, the location of SCBAs should be well known and clearly marked. They should be located in an area that will predictably remain uncontaminated. Putting on a SCBA in a highly contaminated atmosphere such as might be created by a massive release of a toxic material, may take too long a time to perform safely in that area. Therefore, the first reaction should be to escape to an uncontaminated area, then put on the SCBA, and re-enter the hazardous area for whatever task must be done. Exceptions to this rule may be encountered, and only a thorough evaluation of the process and escape routes, will permit a final decision about the correct storage location for SCBAs.

Respirators should be stored in a plastic bag inside a rigid container.

If the worker is trained adequately, he/she should develop a respect for respirators which will be an automatic incentive to protect them from damage. Besides providing an assurance of adequate protection, this training will lower maintenance costs by decreasing damage.

Maintenance and Repair

The OSHA standard states that "replacement or repair shall be done by experienced persons with parts designed for the respirator." Besides being contrary to OSHA requirements, substitution of parts from a different brand or type of respirator invalidates approval of the device.

Maintenance personnel must be thoroughly trained. They must be aware of the SCBA's limitations and never try to replace components or make repairs and adjustments beyond the manufacture's recommendations, unless they have been specially trained by the manufacturer.

These restrictions apply primarily to maintenance of the more complicated devices, especially closed and open-circuit SCBA, and more specifically, regulator valves and low pressure warning devices. These devices should be returned to the manufacturer or to a trained technician for adjustment or repair.

Types of SCBAs

Transparency 7-4

There are two categories of SCBAs. The first category is the closed circuit SCBA. Another name for the closed-circuit SCBA is the "rebreather" device which is indicative of the mode of operation. The breathing gas is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored by a compressed or liquid oxygen source or an oxygen generating solid substance. This category of SCBA can be used for one to four hours. There are some positive pressure closed-circuit SCBA that can be used in IDLH environments. Most closed-circuit SCBAs are negative pressure and should be used in atmospheres Immediately Dangerous to Life or Health (IDLH) only where their long term use is necessary as in mine rescue. All closed-circuit SCBAs can be used in oxygen deficient atmospheres.

Two basic types of closed-circuit SCBA are presently available. One uses a cylinder of compressed oxygen and the other a solid oxygen generating substance. On a typical closed-circuit SCBA with a small cylinder of compressed oxygen breathing air is supplied from an inflatable bag. The exhaled air passes through a granular solid adsorbent that removes the carbon dioxide, thereby reducing the flow back into the breathing bag. The bag collapses so that a pressure plate bears against the admission valve which opens and admits more pure oxygen that reinflates the bag. Thus the consumed oxygen is replaced.

The second type of closed-circuit SCBA uses an oxygen-generating solid, usually potassium superoxide (KO_2). The H_2O and CO_2 in the exhaled breath react with the KO_2 to release O_2. Oxygen is continually released at a high flow rate into the breathing bags which act as a reservoir to accommodate breathing fluctuations. A pressure relief valve and saliva trap, release the excess pressure created in the facepiece by oxygen flow and nitrogen buildup. This type of SCBA is lighter and simpler than the cylinder type. However, it is useful for only about one hour and once initiated, cannot be turned off.

An open-circuit SCBA is the other category of SCBA. They are SCBAs that exhaust the exhaled air to the atmosphere instead of recirculating it. Most of these SCBAs are filled with compressed air and some have compressed oxygen. Compressed oxygen can never be used in a device unless it is specifically designed for that purpose. A cylinder of high pressure (2000-4500 psi) compressed air, supplies air to a regulator that reduces the pressure for delivery to the facepiece on demand. Because it has to provide the total breathing volume requirements, since there is no recirculation, the service life of the open-circuit SCBA is usually shorter than the closed-circuit SCBA. Most open-circuit SCBA have a service life of 30 to 60 minutes based on NIOSH breathing machine tests as prescribed in 30 CFR 11. Open-circuit SCBA are widely used in firefighting and for industrial emergencies.

Fit-Testing of SCBAs

The full facepiece of the SCBA can be qualitatively and quantitatively fit-tested as previously discussed in this manual.

Other Safety Considerations

Transparency 7-5

1. Buddy System

   OSHA requires in CFR 29 1910,134 (e)(3) (ii) that when SCBAs are used in atmospheres immediately dangerous to life and health (IDLH), standby men must be present with suitable rescue equipment. One method of the buddy system consists of first attaching a life line to the person entering the IDLH area. The other end of the life line is manned by a standby person outside of the IDLH area with an unobstructed view of the person inside the IDLH area. This way if the person in the IDLH area is overcome he can be pulled to safety. Another method is to have a standby person wearing and SCBA stationed outside the entrance to the IDLH area ready for immediate emergency rescue.

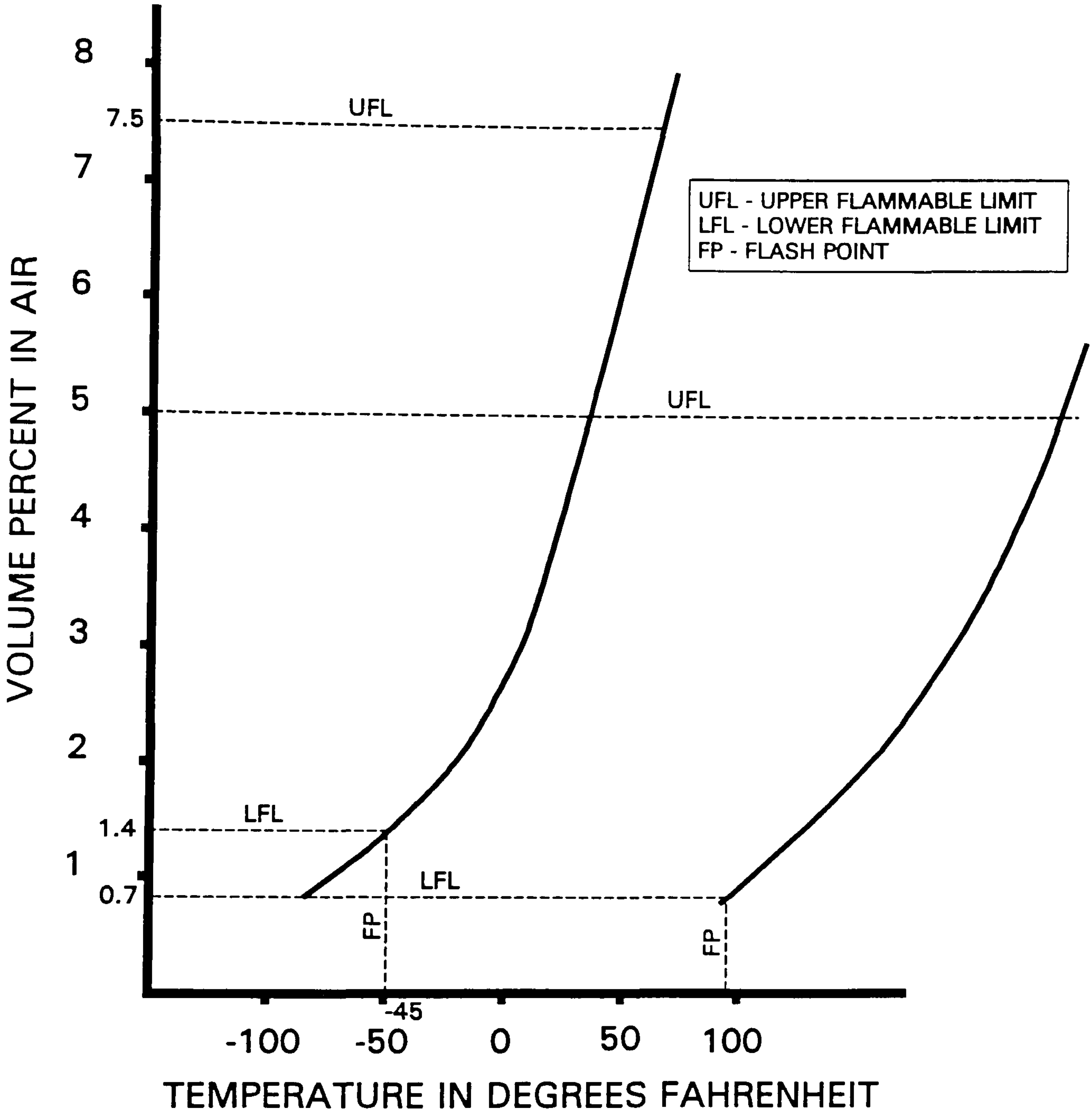
2. Lower Explosion Limits (LEL)

   The lower explosion limit is the minimum volume percentage of a material in air that can be ignited to cause self-sustaining flame. Concentrations in excess of LEL are considered to be immediately dangerous to life or health. When concentration of a substance are at or above the LEL, respirators must provide maximum protection. See Figure A.

3. Monitoring Equipment

   Mixtures of combustible gas and air cannot be ignited to cause self sustaining flame unless the concentration of gas exceeds the LEL. Explosimeters or combustible gas indicators are usually battery powered, portable direct reading instruments used to detect the presence of explosive or combustible gases in the

Figure A Exposure Limits



air. Normally a probe is used to draw in the air to be sampled. Most models provide either a direct reading, or have an audible alarm. Most instruments do not distinguish between different types of gases or vapors, however, it is usually not necessary to know the exact identity of a gas to evaluate its fire and explosion risk.

4. Accessories

Corrective goggles or spectacles worn inside the facepiece the respirator should be mounted to the facepiece or bridge of the nose. Corrective spectacles must not affect the fit of the facepiece.

Safety harnesses or safety lines used for lifting or removing persons from hazardous atmospheres should be sturdy and in good condition.

REVIEW QUESTIONS

SELF-CONTAINED BREATHING APPARATUS (SCBA)

1. The rated duration of the SCBA cylinder is tested and determined by:

   A. OSHA
   B. ACGIH
   C. NIOSH/MSHA
   D. EPA
   E. All of the above

2. The operational duration of the SCBA cylinder is dependent on which of the following factors?

   A. The emotional status of the user
   B. Physical activity of the user
   C. User's experience with the SCBA
   D. Physical condition of user
   E. All of the above

3. A hydrostatic test should be performed every:

   A. 2 years
   B. 1 year
   C. 10 years
   D. 5 years

4. The cylinder should not be used if it is:

   A. Less than 2217 psi
   B. Less than 1500 psi
   C. Filled with Grade D Air
   D. Colored yellow

5. Which components reduces the cylinder pressure to a breathable pressure and supplies the wearer with air in direct response to breathing requirements?

   A. High pressure hose
   B. Pressure-demand regulator
   C. Audible alarm
   D. Cylinder

RESPIRATOR SCENARIOS

Objectives

Student use of concepts learned during this training program.

Background

These six scenarios allow the students to utilize previ ously learned concepts.

SCENARIOS

Question 1: Transparency 7-6

An inspection is to be made at a hazardous waste site containing drums with organics which have been partially identified and the ground is contaminated. The work being done on the site is removing contamina-ted earth. When going into the exclusion zone, the inspector should wear:

a. Only an SCBA.
b. Only a powered air purifying respirator with an organic vapor cartridge.
c. Whatever respirator is called for in the existing site safety plan prepared by a CIH with adequate training under OSHA standards.
d. Cannot enter the exclusion zone until all the unknown contaminants are identified.
e. Can enter the site with less protective respiratory protection than called for in a site safety plan, if inspector has evaluated all the data and determines that it is safe to do so.

Question 2: **Transparency 7-7**

An inspection is to be made in an oil refinery where the inspector observes a process stream leak from a vacuum distillation tower. The small stream is shooting out about 1 foot laterally at a rate of about a gallon every 20 minutes and is spreading out over the cement ground. The leak appears to be very recent and the temperature is 60°F and a nice breeze is present at this outdoor location. What respiratory protection should the inspector wear in documenting the leak?

a. SCBA.
b. Full facepiece air purifying respirator with organic vapor cartridges.
c. Full facepiece air purifying gas mask with an organic vapor canister.
d. No respiratory protection would be necessary if the inspection will take less than 15 minutes.
e. Either B or C depending on the professional judgement of the inspector of potential exposures.

Question 3:

An inspection is going to be made at an outdoor pesti cide manufacturing plant that uses phosgene (in large compressed cylinders) to make organophosphate pesticides. The plant safety designee hands the inspector a mouth breather escape respirator in case there is a phosgene release (this is plant policy and part of their written respirator program). What should the inspector do?

a. Can't use that particular respirator because he or she was not fit tested for that type of respirator.
b. After checking to make sure the cartridge is correct for phosgene, the inspector should accept it and carry it with him or her into the plant knowing other respiratory protection may be necessary.
c. Mouth breathing escape respirators offer no protection, and the inspector should refuse to accept and must use an escape type SCBA.
d. If the plant is running normally and no phosgene leaks have occurred in the past five years, the inspector does not need an escape respirator for phosgene.
e. None of the answers is correct.

Question 4:

In making an inspection of an underground tank, an inspector will have to enter and travel through an underground crawl space. There are no provisions to check air quality and the inspector is alone. What respiratory protection should the inspector use to enter the crawl space?

a. SCBA.
b. Full facepiece gas mask with canister for protection against gases and vapors.
c. Any supplied air respirator in case there is lack of oxygen.
d. Cannot enter the space with any type of respiratory protection because not all requirements for entering a confined space have been met.
e. Cannot enter the space with any type of respiratory protection because the space was not checked for adequate amounts of oxygen.

Question 5:

You are going to conduct a NESHAP inspection of an asbestos removal project. You will be entering the envelope during active removal. You notice that there is no shower facility, no negative pressure systems, and debris is seen outside the airlock. What respiratory protection would you select?

a. SCBA.
b. Full face, HEPA cartridges, air purifying respirator.
c. Powered air purifying respirators with HEPA filters.
d. No respiratory protection is required if the time spent in the enclosure is 15 minutes or less.
e. A supplied air positive pressure type C respirator using the removal firm's air supply hoses and manifolds.

Question 6:

You are inspecting a chemical plant in a remote area by yourself when you see an employee enter a tank through a hatch on top of the tank. You climb on top of the tank and see that the man has collapsed and is lying on the bottom of the empty tank about 10 feet below the hatch. You are carrying an organic cartridge full facepiece gas mask. You should:

a. Put on the gas mask, enter the tank, and rescue the employee.
b. Ignore the situation because the tank was not part of your inspection.
c. Close the hatch so that whatever caused the employee to collapse will not contaminate the environment.
d. Run and get help.
e. Check the tank from the outside to make sure all lines to the tank are shut, open any other hatches you see on the tank, and then go get help.

LECTURE 8

COURSE CONCLUSION

LECTURE 8

COURSE CONCLUSION

COURSE CRITIQUE AND FINAL TEST

Objectives

Provide students the opportunity to critique the strengths and weaknesses of the program materials and the course instructors. Students take the final test and obtain their grades before leaving the classroom.

Background

To determine program and instructor effectiveness, a feedback mechanism is required.

STUDENT COURSE CRITIQUE

Course No. ___ Date: ______ Student name (optional): ____________

For each statement circle the response(s) that is (are) the closest to your opinion.

1. The course objectives were:
    1. clearly stated or written
    2. stated or written, but not all of them were clear to me
    3. stated or written, but most of them were not clear to me
    4. neither stated nor written

2. Course content was:
    1. useful for my professional growth
    2. too complex
    3. too simple
    4. what I had expected

3. Course contained a sufficient amount of practice exercises.
    1. agree
    2. disagree
    3. no opinion

4. The amount of time allotted for this course was:
    1. sufficient
    2. too long, should be ___ days
    3. too short, should be ___ days

5. Overall, I think the course was:
    1. excellent
    2. good
    3. fair
    4. poor

6. Generally, the course was presented in an interesting manner.
    1. agree
    2. disagree
    3. no opinion

7. The course content was well-coordinated among the instructors.
    1. agree
    2. disagree
    3. no opinion

8. The instructors wee well prepared for most class sessions.
    1. agree
    2. disagree
    3. no opinion

9. The instructors were quite knowledgeable about their subject areas.
   1. agree
   2. disagree
   3. no opinion

10. The questions raised during the lectures (and laboratories) were usually answered to my satisfaction.
    1. agree
    2. disagree
    3. no opinion

11. The teaching methods used int his course were effective for my learning.
    1. agree
    2. disagree
    3. no opinion

12. the audio-visual materials aided my understanding of the topics presented.
    1. agree
    2. disagree
    3. no opinion

13. The classroom environment and facilities were:
    1. excellent
    2. adequate
    3. poor

    Please comment: ______________________________

14. Overall, the course instructors were:
    1. excellent
    2. good
    3. fair
    4. poor

    Please comment: ______________________________

The most needed improvements in this course are: ______________________________

____

____

The "best" parts of this course were: ______________________________

____

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Additional comments: ______________________________

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