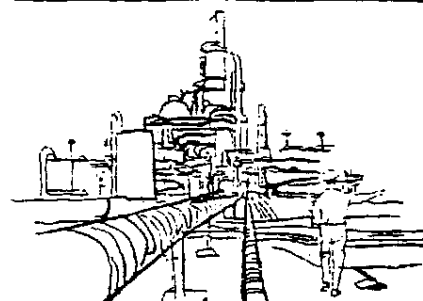


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# Monsanto Industrial Hygiene Bulletin

DEPARTMENT OF MEDICINE & ENVIRONMENTAL HEALTH  
Industrial Hygiene Section  
St. Louis, Missouri

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Bulletin 81-2

## MONSANTO RESPIRATOR

### PROGRAM GUIDE

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### Acknowledgements

Much of the material for this Bulletin was taken from the following publications:

American National Standards Institute, "Practices for Respiratory Protection" Z88.2-1980, ANSI - New York

ERDA - Energy Research and Development Administration, Division of Safety, Standards, and Compliance, Respirator Manual, Los Alamos Scientific Laboratory Report No. LA-6370-M, August, 1976.

NIOSH, "A Guide to Industrial Respiratory Protection", HEW Publications No. (NIOSH) 76-189.

OSHA - Industrial Hygiene Field Operation Manual, "Chapter III - OSHA Standard Method for Determination of Respirator Protection Program Acceptability", April 2, 1979.

Patty's Industrial Hygiene and Toxicology, Volumes I and III, Clayton (I), Cralley (III) ed's., Wiley Interscience, New York, 1978.

## I. INTRODUCTION

Providing respiratory protective equipment to the employees is only one aspect of Monsanto's responsibility pertaining to the use of respiratory protective equipment as a control measure. Respiratory protective equipment can be effective in protecting Monsanto employees from the inhalation of hazardous amounts of airborne contaminants. HOWEVER, THIS EFFECTIVENESS IS DEPENDENT ON THE RESPIRATOR BEING PROPERLY FITTED, MAINTAINED IN GOOD CONDITION, AND MOST IMPORTANTLY, ON THE USER KNOWING ITS PROPER USES AND LIMITATIONS.

To assure the effectiveness of the respiratory protective equipment used through Monsanto, a RESPIRATOR PROGRAM must be established at each location using this type of protective equipment. Development of such a program involves eleven (11) key points as discussed in detail in this bulletin.

It should be understood that CONTRACTORS must also meet OSHA 1910.134 respirator requirements outlined in this guide while operating in Monsanto plants.

Finally, it is important to note that the main purpose of this document is to spell out in detail OSHA 29 CFR 1910.134 REGULATIONS dealing with the use of respiratory protection and to provide technical information and recommendations which will assist locations in developing acceptable respiratory protection programs.

### A. HISTORY

The use of respirators has been known in history as early as Roman times. Scattered mention of them occurs in reports of industrial processes during the Middle Ages. Until the nineteenth century, all devices appear to be air-purifying devices intended to prevent the inhalation of aerosols. They were varied in design, ranging from animal bladders or rags wrapped around the nose and mouth to full face masks made of glass with air inlets covered by particulate

filters. During the 1800's, masks were produced that combined aerosol filters with vapor sorbents. These advances were made primarily for fire fighters.

When chemical warfare agents were introduced during World War I, attention was focused on the need for adequate masks to protect people from toxic gases and aerosols. In the United States this work was successfully carried out for the Army under the direction of the Bureau of Mines. After the war, misuse of surplus Army gas masks by civilians highlighted the need for respiratory protection standards. Again the Bureau of Mines was given the responsibility of setting these standards. Out of this effort grew the federal respirator approval system that is still in effect. Many of the respirator developments made during the decade following 1920 remain in use today.

#### B. DEVELOPMENT OF RESPIRATOR LEGISLATION

Until the enactment of the Williams and Steiger Occupational Safety and Health Act (OSHA) in 1970, most guidance on respiratory protective device (respirator) use in hazardous environments was advisory rather than mandatory. Now, OSHA Section 1910.134 (Appendix A of this guide) sets forth specific legal requirements for selection, use, and maintenance of respirators, and gives guidelines for establishing a respirator program to meet those requirements. This guide is written to describe methods for meeting the OSHA requirements, especially for those whose knowledge of respirators is limited. It is meant to complement, not replace, other publications such as the NIOSH "Guide to Industrial Respiratory Protection" publication #76-189, and the American National Standards Institute "Practices for Respiratory Protection", Z88.2 - 1969-1980.

#### C. BACKGROUND

American National Standard Institute (ANSI) Standard Z88.2-1969, "Practices for Respiratory Protection", is the origin of the first

six sub-sections of OSHA Section 1910.134, "Respiratory Protection". The seventh sub-section is a direct, complete inclusion of ANSI Standard K13.1-1969, "Identification of Gas Mask Canisters".

Currently, Z88.2 is useful in explaining points in the OSHA standards, but it is an advisory document only, not a legal one. However, because insight into the OSHA standards may be gained by reading the corresponding parts of Z88.2, you are strongly urged to use a copy as a companion to this guide. It may be obtained from:

American National Standards Institute, Inc.  
1430 Broadway  
New York, NY 10018

#### D. AGENCY APPROVALS

The Bureau of Mines (BOM) began approving self-contained breathing apparatus and gas masks for mine rescue work in 1919 and has added approval schedules for other types of respirators over the years until NIOSH and MESA (which assumed the BOM mine health and safety responsibilities) started the present approval program in 1971. The Federal Mine Safety and Health Amendments Act of 1977 created in the U.S. Department of Labor, the Mining Safety and Health Administration (MSHA) which replaced the Mining Enforcement and Safety Administration (MESA) of the U.S. Department of Interior. Respirator approvals are now issued jointly by NIOSH and MSHA.

Contributing further to the confusion about respirator standards is the fact that still other federal regulations, military standards, advisory standards, etc. are made part of the OSHA requirements by reference. Figure 1 shows the interrelationship of all these standards.

## II. KEY ELEMENTS OF AN ACCEPTABLE RESPIRATORY PROTECTION PROGRAM

In order to provide Monsanto employees with adequate respiratory protection in those situations requiring such, and to comply with the OSHA

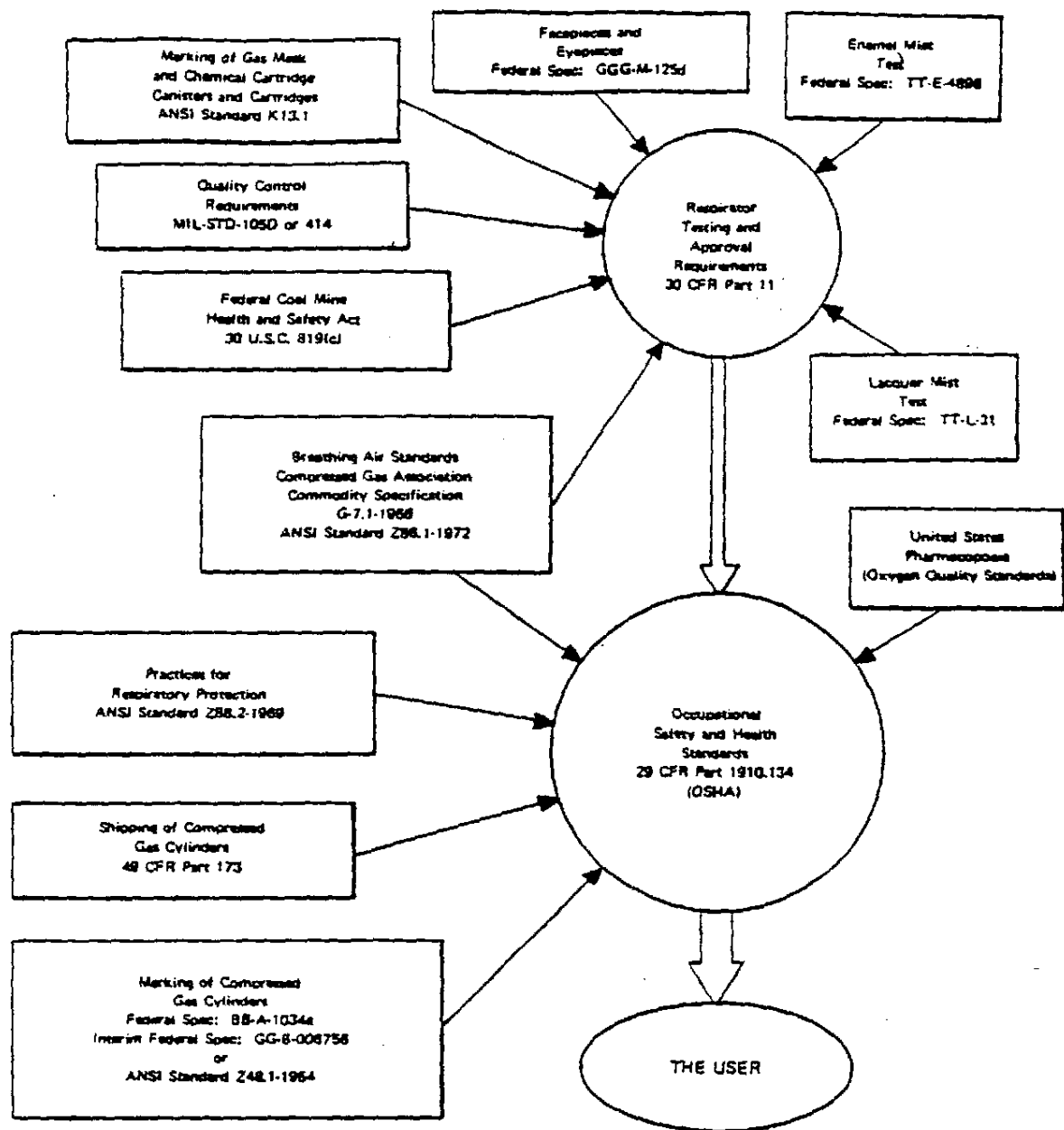


Figure 1  
Sources of the OSHA standards.

standards pertaining to industrial respiratory protection, a program must be established to define and monitor the use of respiratory protection.

#### Minimum Acceptable Program Requirements Summary

Summarized below are DMEH minimum general requirements for respirator programs within Monsanto. Meeting these requirements will result in compliance with OSHA standard 1910.134 (Respiratory Protection). Details of these requirements are found in subsequent sections of this guide and in the legal requirements previously cited.

#### A. REQUIREMENTS FOR A MINIMAL ACCEPTABLE RESPIRATORY PROTECTION PROGRAM

- |                          |    |                                                                                                                                                                                                                                                                             |
|--------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Written SOP:             | 1. | Written standard operating procedures governing the selection and use of respirators shall be established.                                                                                                                                                                  |
| Selection:               | 2. | Respirators shall be selected on the basis of the hazards to which the worker is exposed.                                                                                                                                                                                   |
| Training:                | 3. | The user shall be instructed and trained in the proper use of respirators and their limitations.                                                                                                                                                                            |
| Individual Assignment:   | 4. | Where practicable, the respirators should be assigned to individual workers for their exclusive use.                                                                                                                                                                        |
| Cleaning & Disinfection: | 5. | Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use. |

- Storage: 6. Respirators shall be stored in a convenient, clean and sanitary location.
- Inspection: 7. Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use, such as self-contained devices, shall be thoroughly inspected at least once a month and after each use.
- Work Area Surveillance: 8. Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.
- Program Evaluation: 9. There shall be regular inspection and evaluation to determine the continued effectiveness of the program.
- Medical Surveillance: 10. Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically.
- Approved Equipment: 11. Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it was designed in accordance with standards established by competent authorities.

## 1. WRITTEN STANDARD OPERATING PROCEDURES

Without a definite chain of supervision, there is no assurance that the procedures and requirements of the OSHA standard and DMEH Guideline will be followed. THE RESPONSIBILITY FOR THE ENTIRE RESPIRATOR PROGRAM SHOULD BE ASSIGNED TO ONE PERSON; the plant industrial hygienist or location safety engineer is recommended.

The person selected to head the respiratory protection program should be adequately trained in all aspects of respiratory protection, and have the ability to administer this often complex program. The administrator's technical and professional background should enable him/her to make sound judgments based on hazard evaluation input from the workplace.

At plant locations where large numbers of respirators are used, it may be practical to have a staff of personnel involved in the respirator program, each with an individual area of responsibility, such as purchasing, recordkeeping, cleaning and maintenance, fitting, and training. Each of these people should report to one administrator who has overall responsibility for the program. Each plant will have to decide how its own program will be administered. It must be emphasized, however, THAT THE PROGRAMMATIC ADMINISTRATION OF A RESPIRATOR PROGRAM IS ESSENTIAL, AND THAT SUCH A PROGRAM WILL NOT OPERATE EFFECTIVELY WITHOUT PROPER MANAGEMENT.

Unfortunately, respirators sometimes are misused or taken too much on faith, primarily due to lack of knowledge. Such misuse can be avoided by establishing written procedures for respirator selection and use and through proper supervision of all aspects of the respirator program.

THE WRITTEN STANDARD OPERATING PROCEDURES SHOULD CONTAIN ALL INFORMATION NEEDED TO MAINTAIN AN

EFFECTIVE RESPIRATOR PROGRAM TO MEET THE USER'S INDIVIDUAL REQUIREMENTS. They should be written so as to be useful to those directly involved in the respirator program, the program administrator, those fitting the respirators and training the workers, respirator maintenance workers, and the supervisors responsible for overseeing respirator use on the job. It is not necessary that the operating procedures be written for the wearer himself, although in a very small program it may be desirable to direct their content to the wearer.

The procedures should contain all information needed to ensure proper respiratory protection of a specific group of workers against a specific hazard or several particular hazards. The hazard(s) must have been assessed thoroughly; otherwise the written procedures will have only limited validity. Generally, the procedures should contain the following:

- a. Guidance for selection of the approved respirator(s) for protection against particular hazard(s).
- b. Detailed instructions for training workers in proper use of the respirator(s), including respirator fitting.
- c. Detailed maintenance procedures for:
  - 1. Cleaning and disinfecting
  - 2. Drying
  - 3. Inspection
  - 4. Repair or replacement of worn or defective components
  - 5. Storage
- d. Administrative procedures for:
  - 1. Purchase of approved or accepted respirator(s), control of inventory of spare parts, new respirators, and respirators ready for reissue after maintenance.

2. Issuance of respirators to ensure use of the proper one for a given hazard.

3. Guidance of supervisory personnel in continued surveillance of respirator use and determination of workers' exposure to respiratory hazards.

4. Recordkeeping relative to:

(a) TRAINING AND FITTING RECORDS. Training and fitting records are necessary for all workers who might use respiratory protective equipment in order to schedule refresher courses and refitting, and to know what makes of masks each person can wear. In addition, it is recommended that each person be issued a wallet-sized card listing those devices which adequately fit him. The wallet cards can save time in the field, particularly in the event of an emergency, in checking for acceptable mask issuance.

(b) EVALUATION OF ADEQUACY OF RESPIRATOR PROGRAM.

Such analysis can only be made by periodic review of respirator usage including identification of the hazard, specification and use of the respirators, and analysis of results of air sampling programs.

(c) PURCHASING INFORMATION. Periodic review of respirator usage is needed to provide information for reordering of canisters and other replacement parts and to establish a replacement table for respirator components where needed.

5. Instructions for respirator use during emergencies, including fire, which can create an atmosphere immediately hazardous to life and health.

6. Guidelines for medical surveillance of workers, including pre-employment physical examinations to restrict those physically or psychologically unable to wear respirators, and periodic physical examinations to review the overall effectiveness of the respirator program on the basis of physiological factors.
7. Procedures for evaluating the respirator program's effectiveness.

Obviously, the above list essentially restates the OSHA requirements for a minimal acceptable respirator program. THE POINT IS THAT ALL THE INFORMATION NEEDED TO ESTABLISH AND MAINTAIN AN ADEQUATE RESPIRATOR PROGRAM MUST BE WRITTEN DOWN.

The exact format of written standard operating procedures may vary widely. In general, the complexity of the procedures increases as respirator use increases. The procedures also become more extensive as the toxicity of the respiratory hazard(s) increases, demanding better and more reliable protection. It is better to be overly detailed in developing written operating procedures than not detailed enough.

Particularly important are procedures for respirator use during emergencies such as fire, large spillage of toxic material, accidental release of a potentially lethal substance, or failure of a ventilation system. All possible emergencies must be considered in advance and prepared for in the written procedures because in the stress of an emergency, memories may be faulty. Furthermore, these emergency procedures should be used in training emergency response teams.

## 2. RESPIRATOR SELECTION

The selection of the proper type of respirator shall be based upon: (a) the nature of the hazardous operation or process, (b) the type of respiratory hazard (including physical properties, physiological effects on the body, concentration of toxic material or airborne radioactivity level, current permissible time-weighted average concentration for the toxic material, and established immediately dangerous to life or health concentration for the toxic material), (c) the location of the hazardous area in relation to the nearest area having respirable air, (d) the period of time for which respiratory protection must be provided, (e) the activities of workers in the hazardous area, (f) the physical characteristics and functional capabilities and limitations of the various types of respirators, and (g) the respirator protection factor.

Following are sections which discuss how respiratory hazards are classified, the various types and classes of respiratory equipment, and questions which have to be considered in selecting the correct respirator for the hazard.

### a. Classification of Respiratory Hazards

The purpose of this section is to list and briefly describe various categories of respiratory hazards that might be encountered and which may require use of respirators. The information provides a general background for relating the guidance in subsequent sections to the type of hazard encountered. The respirator program administrator, however, may find it necessary to consult references on industrial hygiene and toxicology and your assigned DMEH industrial hygienist to develop the necessary comprehensive information on specific airborne contaminants.

(I) Respiratory hazards for the purpose of this guide are classified as follows:

(A) Oxygen Deficiency

- (1) Immediately dangerous to life or health
- (2) Not immediately dangerous to life or health

(B) Gas and Vapor Contaminants

- (1) Immediately dangerous to life or health
- (2) Not immediately dangerous to life or health

(C) Particulate Contaminants (aerosols including dust, fog, fume, mist, smoke, and spray)

- (1) Immediately dangerous to life or health
- (2) Not immediately dangerous to life or health

(D) Combination of Gas, Vapor, and Particulate Contaminant

- (1) Immediately dangerous to life or health
- (2) Not immediately dangerous to life or health

Respirators may afford some protection against high temperature atmospheres. Information on the hazards of and use of respirators in high temperatures is presented in a National Fire Protection Association publication, Fire Officers Guide to Breathing Apparatus for the Fire Service, published in 1975.

#### CLASSIFICATION AND DESCRIPTION OF RESPIRATORY HAZARDS

Basic respiratory hazards are classified in Table 1 according to expected biological effects of the contaminants. Many respirators, particularly air-purifying respirators, are designed and selected on the basis of chemical and physical properties of the air contaminants. Therefore, gas, vapor,

Table 1  
Classification of Respiratory Hazards According to Their Biological Effect

| Oxygen Deficiency                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Gas and Vapor Contaminants                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Particulate Contaminants<br>(Dust, fog, fume, mist, smoke, and spray)                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Minimum legal requirements: 19.5% by volume for respirable air at sea-level conditions. (See Note 1.)<br>(Occurrences: Confined or unventilated cellars, wells, mines, ship holds, tanks, burning buildings, and enclosures containing inert atmospheres.)<br>Atmosphere: oxygen content (percent by volume) versus expected conditions:<br>20-9%: Oxygen content of normal air at sea-level conditions.                                                                                                                                   | Asphyxiants: Interfere with utilization of oxygen in the body.<br>Simple asphyxiants: Physiologically inert substances that dilute oxygen in the air (for example: nitrogen, hydrogen, helium, methane). See Oxygen Deficiency, Column 1.<br>Chemical asphyxiants: Low concentrations interfere with supply or utilization of oxygen in the body (for example: carbon monoxide, hydrogen cyanide, cyanogen, and nitrites).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Relatively inert: May cause discomfort and minor irritation, but generally without injury at reasonable concentrations (for example: marble, gypsum).<br>Pulmonary fibrosis-producing: Produce nodulation and fibrosis in the lung, possibly leading to complications (for example: quartz, asbestos).<br>Carcinogens: Produce cancer in some individuals after latent period (for example: asbestos, chromates, radioactive particulates).                                                            |
| <i>Physiological Effects</i><br>16%-17%: loss of peripheral vision, increased breathing volume, accelerated heartbeat, impaired attention and thinking, impaired coordination.<br>12%-10%: Very faulty judgment, very poor muscular coordination, muscular exertion causes fatigue that may cause permanent heart damage, intermittent respiration.<br>10%: 6%: Nausea, vomiting, inability to perform vigorous movement, unconsciousness followed by death.<br>Less than 6%: Spasmodic breathing, convulsive movements, death in minutes. | Irritants: Corrosive in action. May cause irritation and inflammation of parts of the respiratory system (also skin and eyes) and pulmonary edema (for example: ammonia, hydrogen chloride, formaldehyde, sulfur dioxide, chlorine, ozone, nitrogen dioxide, phosgene, and arsenic trichloride).<br>Anesthetics: Cause loss of feeling and sensation with unconsciousness and death possible (for example: nitrous oxide, hydrocarbons, and others). Some anesthetics injure body organs (for example: carbon tetrachloride [liver and kidneys], chloroform [liver and heart], benzene [bone marrow], and carbon disulfide [nervous system]).<br>Sensitizers: Cause increased probability of physiological reactions (for example: isocyanates, epoxy resin systems).<br>Systemic poisons: Damage organs and systems in the body (for example: mercury [nervous system and various organs], phosphorus [bone], hydrogen sulfide [respiratory paralysis], and arsenic [red blood cells and liver]).<br>Carcinogens: Produce cancer in some individuals after a latent period (for example: vinyl chloride, benzene). | Chemical irritants: Produce irritation, inflammation, and ulceration in upper respiratory tract (for example: acidic mists, alkalies).<br>Systemic poisons: Produce pathologic reactions in various systems of the body (for example: lead, manganese, cadmium).<br>Allergy-producing: Produce reactions such as itching, sneezing, and asthma (for example: pollens, spores, and animal fur).<br>Fetile-reaction-producing: Produce chills followed by fever (for example: fumes of zinc and copper). |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Combinations of Gas, Vapor, and Particulate Contaminants                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Combinations of contaminants may occur simultaneously in the atmosphere. Contaminants may be entirely different substances (dusts and gases from blasting) or the particulate and vapor forms of the same substance. Synergistic effects (joint action of two or more agents that results in an effect which is greater than the sum of their individual effects) may occur. Such effects may require extraordinary protective measures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

NOTE 1: See definition in Appendix I for "oxygen deficiency -- not immediately dangerous to life or health" and "oxygen deficiency -- immediately dangerous to life or health," and Appendix J.

**Table 2**  
**Classification of Respiratory Hazards According to Their Properties Which Influence Respirator Selection**

| Gas and Vapor Contaminants                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Particulate Contaminants                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| <p><b>Inert:</b> Substances that do not react with other substances under most conditions, but create a respiratory hazard by displacing air and producing oxygen deficiency (for example: helium, neon, argon).</p> <p><b>Acidic:</b> Substances that are acids or that react with water to produce an acid. In water, they produce positively charged hydrogen ions (<math>H^{+}</math>) and a pH of less than 7. They taste sour, and many are corrosive to tissues (for example: hydrogen chloride, sulfur dioxide, fluorine, nitrogen dioxide, acetic acid, carbon dioxide, hydrogen sulfide, and hydrogen cyanide).</p> <p><b>Alkaline:</b> Substances that are alkalies or that react with water to produce an alkali. In water, they result in the production of negatively charged hydroxyl ions (<math>OH^{-}</math>) and a pH greater than 7. They taste bitter, and many are corrosive to tissues (for example: ammonia, amines, phosphine, arsine, and silbino).</p> <p><b>Organic:</b> The compounds of carbon. Examples are saturated hydrocarbons (methane, ethane, butane), unsaturated hydrocarbons (ethylene, acetylene), alcohols (methyl ether, ethyl ether), aldehydes (formaldehyde), ketones (methyl ketone), organic acids (formic acid, acetic acid), halides (chloroform, carbon tetrachloride), amides (formamide, acetamide), nitriles (acetonitrile), isocyanates (toluene diisocyanate), amines (methylamine), epoxies (epoxyethane, propylene oxide), and aromatics (benzene, toluene, xylene).</p> <p><b>Organometallic:</b> Compounds in which metals are chemically bonded to organic groups (for example: ethyl silicate, tetraethyl lead, and organic phosphate).</p> <p><b>Hydrides:</b> Compounds in which hydrogen is chemically bonded to metals and certain other elements (for example: diborane and tetraborane).</p> | <p>Particles are produced by mechanical means by disintegration processes such as grinding, crushing, drilling, blasting, and spraying; or by physiochemical reactions such as combustion, vaporization, distillation, sublimation, calcination, and condensation. Particles are classified as follows:</p> <p><b>Dust:</b> A solid, mechanically produced particle with sizes varying from submicroscopic to visible or macroscopic.</p> <p><b>Spray:</b> A liquid, mechanically produced particle with sizes generally in the visible or macroscopic range.</p> <p><b>Fume:</b> A solid condensation particle of extremely small particle size, generally less than one micrometer in diameter.</p> <p><b>Mist:</b> A liquid condensation particle with sizes ranging from submicroscopic to visible or macroscopic.</p> <p><b>Fog:</b> A mist of sufficient concentration to perceptibly obscure vision.</p> <p><b>Smoke:</b> A system which includes the products of combustion, pyrolysis, or chemical reaction of substances in the form of visible and invisible solid and liquid particles and gaseous products in air. Smoke is usually of sufficient concentration to perceptibly obscure vision.</p> |

and particulate contaminants are presented in Table 2 according to their physical and chemical properties.

b. Respiratory Equipment Classification

The basic purpose of any respirator is, very simply, to protect the respiratory system from harmful airborne physical or chemical agents. It provides this protection by removing the contaminant from the air before it is inhaled or by supplying an independent source of respirable air. Basically, a respirator is an enclosure (in 30 CFR Part 11 terms, a respiratory inlet covering) that covers the nose and mouth or the entire face or head. They are of two general types, tight fitting and loose fitting. Tight-fitting ones are generally a molded, impervious rubber or plastic facepiece that covers the nose and mouth or the entire face. In the latter case, the facepiece has a lens or eye-pieces. Sometimes these coverings are called "masks" or more technically, "oronasal masks".

Loose-fitting respirators include hoods, helmets, blouses, or full suits, all of which cover the head completely. Their configuration varies widely depending on the use for which they are designed.

Attached to the coverings are the elements for removing contaminants from the air (in tight-fitting facepieces only), or hoses to supply respirable air (in both tight- and loose-fitting coverings). It is these accessories that divide respirators into two major classes. If the device removes contaminants, it is an AIR-PURIFYING RESPIRATOR (see Figure 2 a,b,c.). THESE DEVICES DO NOT SUPPLY OXYGEN, SO THEY CANNOT BE USED IN OXYGEN-DEFICIENT ATMOSPHERES. THIS POINT MUST NEVER BE FORGOTTEN. A wide variety of air-purifying elements are available to tailor

respirators for protection against specific contaminants. These also fall into two subclasses; particulate removing elements that intercept particles before they enter the face-piece, and vapor- and gas-removing elements that entrap gas and vapor molecules. Here we call particulate-removing elements "filters" and vapor- and gas-removing elements either "chemical cartridges" or "canisters". Combination elements for protection against both particulates and vapors and gases are also available.

If, instead of cleaning the air, the accessory attached to the respirator provides respirable air from a source other than the surrounding atmosphere, the respirator is called ATMOSPHERE-SUPPLYING (see Figure 3 a,b,c).

These respirators are generally complex and come in many configurations. Because THEY SUPPLY BREATHABLE AIR THEY MAY BE USED IN OXYGEN-DEFICIENT ATMOSPHERES (subject to some limitations) as well as against particulates, vapors, and gases.

Provided is a description of the various types of respirators, including their limitations and capabilities, as a background for understanding their selection, use, and maintenance. This information is presented in two tables. Table 3 covers the classification and description of respirators according to the general classifications concerning mode of operation. Table 4 covers capabilities and limitations of respirators arranged to correspond to the subject headings in Table 3.

Respirators fall into the following general classifications, according to mode of operation:

- (1) Atmosphere-supplying respirators
  - (a) self-contained
  - (b) supplied air

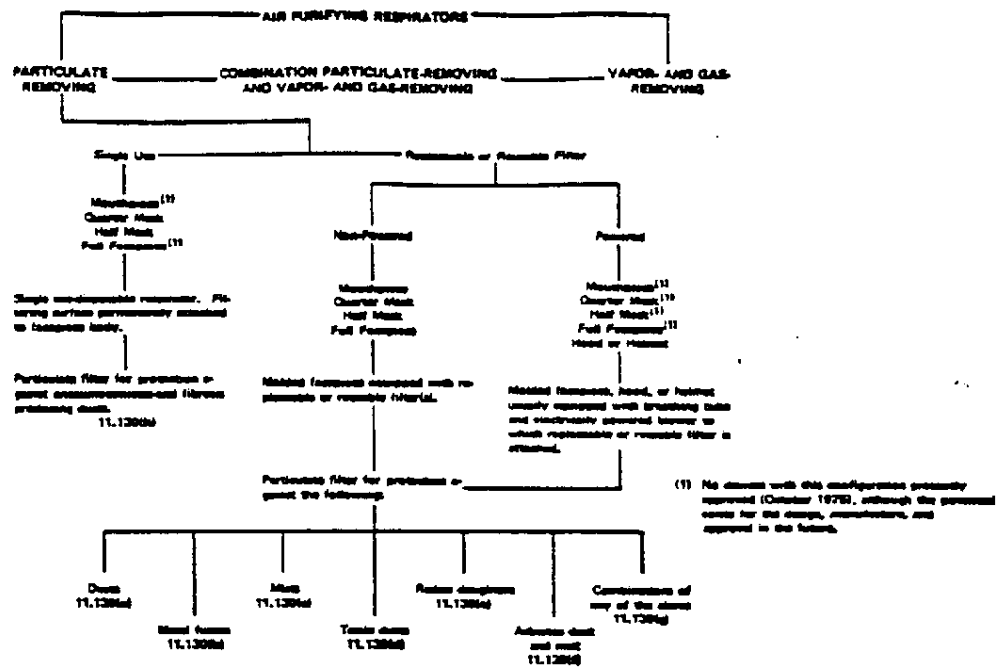


Figure 2(a).  
Particulate removing respirators.

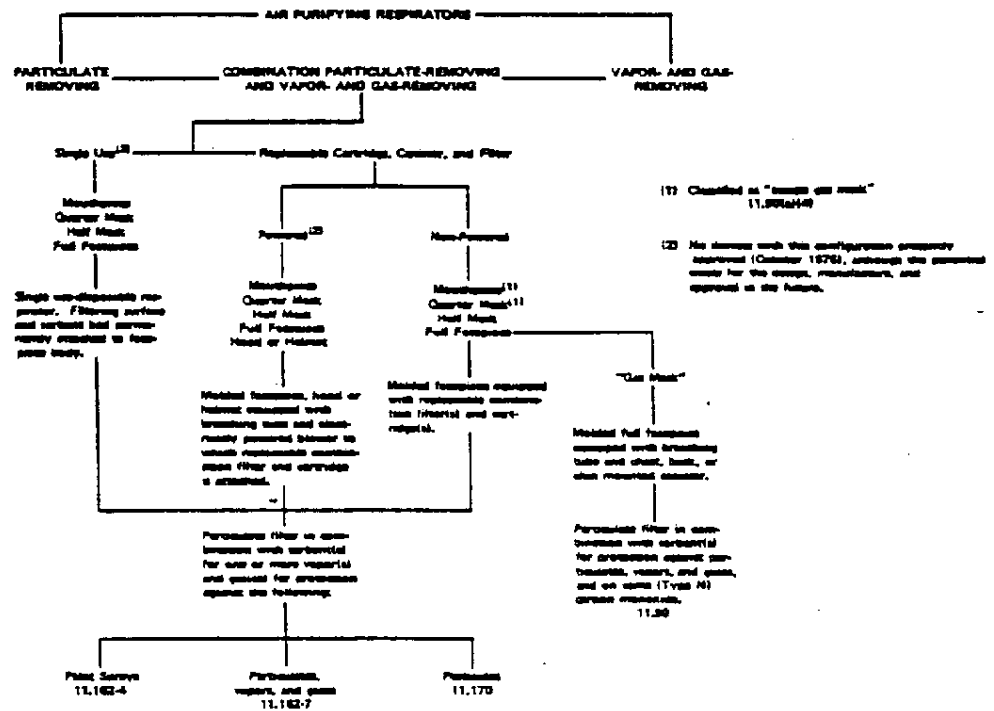


Figure 2(b).  
Combination particulate- and vapor- and gas-removing respirators.

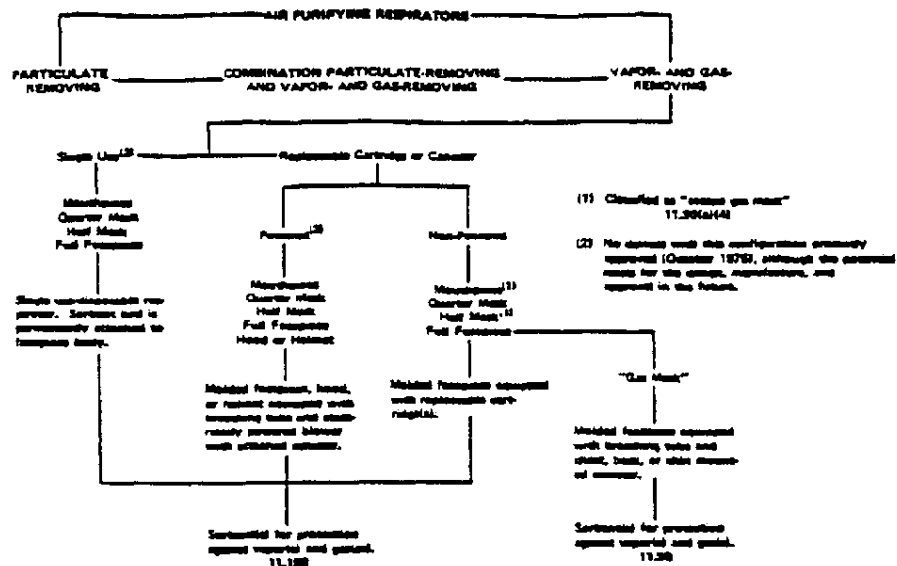


Figure 2(c).  
Vapor- and gas-removing respirators.

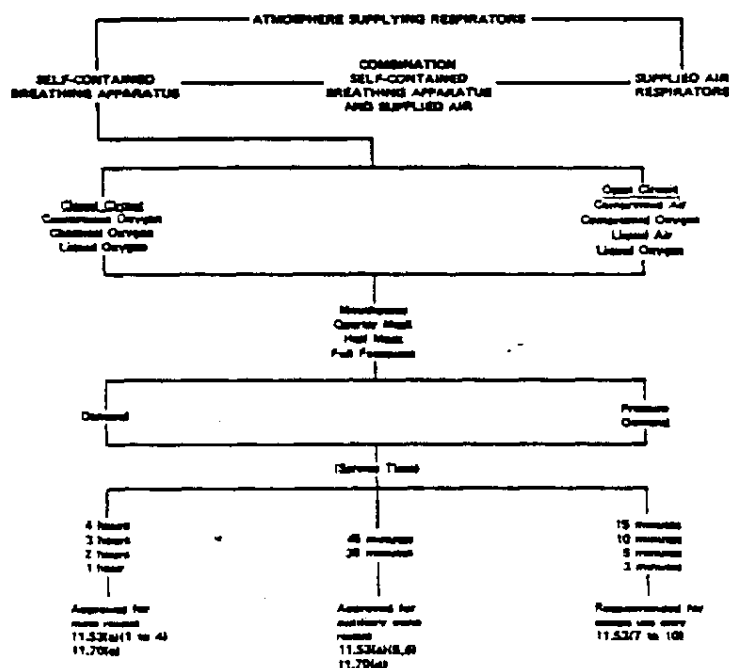


Figure 3(a).  
Self-contained breathing apparatus.

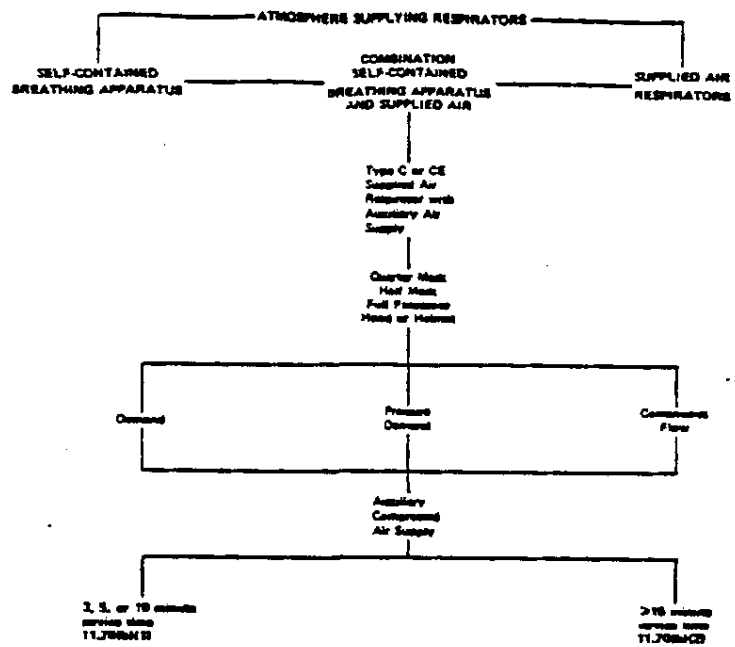
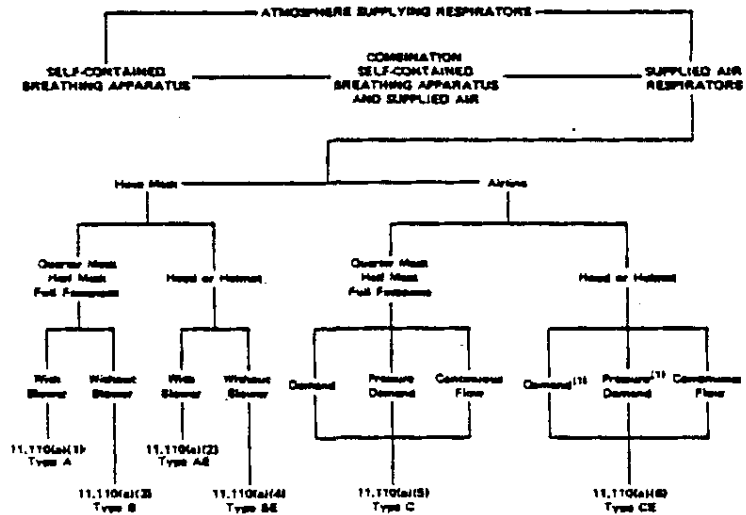


Figure 3(b).  
Combination SCBA and supplied air respirators.



(11) No device with this configuration presently approved (October 1975), although the proposed units for the design, manufacture, and approval in the future.

Figure 3(c).  
Supplied air respirators.

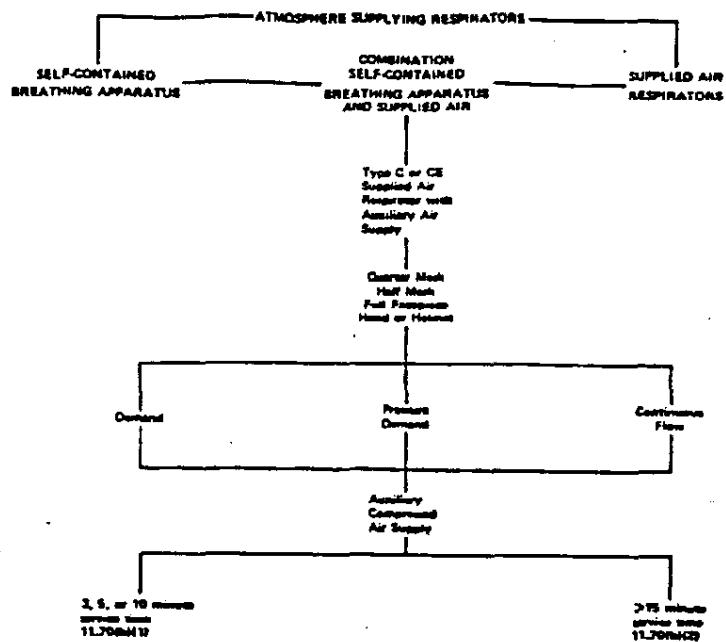
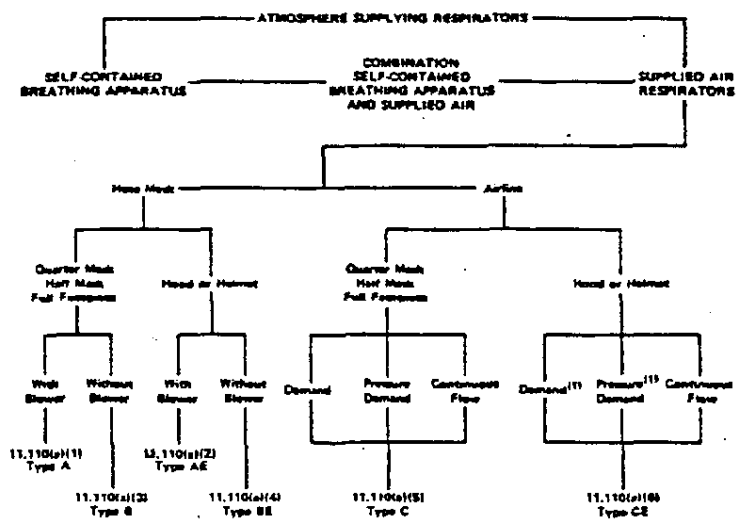


Figure 3(b).  
Combination SCBA and supplied air respirators.



(1) No devices with this configuration presently approved (October 1975), although the general specs for the design, manufacture, and approval in the future.

Figure 3(c).  
Supplied air respirators.

Table 3  
Classification and Description of Respirators by Mode of Operation

| Atmosphere-Supplying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Air-Purifying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| <p>A respirable atmosphere independent of the ambient air is supplied to the wearer.</p> <p><b>Self-Contained Breathing Apparatus (SCBA)</b></p> <p>A supply of air, oxygen, or oxygen-generating material is carried by the wearer. Normally equipped with full facepiece, but may be equipped with a quarter-mask facepiece, half-mask facepiece, helmet, hood, or mouthpiece and nose clamp.</p> <p>(1) Closed Circuit SCBA (oxygen only, negative pressure<sup>a</sup> or positive pressure<sup>b</sup>).</p> <p>(a) <i>Compressed or liquid oxygen type.</i> Equipped with a facepiece or mouthpiece and nose clamp. High-pressure oxygen from a gas cylinder passes through a high-pressure reducing valve and, in some designs, through a low-pressure admission valve to a breathing bag or container. Liquid oxygen is converted to low-pressure gaseous oxygen and delivered to the breathing bag. The wearer inhales from the bag, through a corrugated tube connected to a mouthpiece or facepiece and a one-way check valve. Exhaled air passes through another check valve and tube into a container of carbon-dioxide removing chemical and reenters the breathing bag. Make-up oxygen enters the bag continuously or as the bag deflates sufficiently to actuate an admission valve. A pressure-relief system is provided, and a manual bypass system and saliva trap may be provided depending upon the design.</p> <p><b>Supplied-Air Respirators</b></p> <p>(1) <i>Hose Mask</i><br/>Equipped with a facepiece, breathing tube, rugged safety harness, and large-diameter heavy-duty nonkinking air-supply hose. The breathing tube and air-supply hose are securely attached to the harness. The facepiece is equipped with an exhalation valve. The harness has provision for attaching a safety line.</p> <p>(a) <i>Hose mask with blower.</i> Air is supplied by a motor-driven or hand-operated blower. The wearer can continue to inhale through the hose if the blower fails. Up to 300 feet (91 meters) of hose length is permissible.</p> <p>(b) <i>Hose mask without blower.</i> The wearer provides motivating force to pull air through the hose. The hose inlet is anchored and fitted with a funnel or like object covered with a fine mesh screen to prevent entrance of coarse particulate matter. Up to 75 feet (23 meters) of hose length is permissible.</p> <p>(2) <i>Air-Line Respirator</i><br/>Respirable air is supplied through a small-diameter hose from a compressor or compressed-air cylinder(s). The hose is attached to the wearer by a belt or other suitable means and can be detached rapidly in an emergency. A flow-control valve</p> | <p>Ambient air, prior to being inhaled, is passed through a filter, cartridge, or canister which removes particles, vapors, gases, or a combination of these contaminants. The breathing action of the wearer operates the nonpowered type of respirator. The powered type contains a blower — stationary or carried by the wearer — which passes ambient air through an air-purifying component and then supplies purified air to the respirator-inlet covering. The nonpowered type is equipped with a facepiece or mouthpiece and nose clamp. The powered type is equipped with a facepiece, helmet, hood, or suit.</p> <p><b>Vapor- and Gas-Removing Respirators</b><br/>Equipped with cartridge(s) or canister(s) to remove a single vapor or gas (for example: chlorine gas), a single class of vapors or gases (for example: organic vapors), or a combination of two or more classes of vapors or gases (for example: organic vapors and acidic gases) from air.</p> <p><b>Particulate-Removing Respirators</b><br/>Equipped with filter(s) to remove a single type of particulate matter (for example: dust) or a combination of two or more types of particulate matter (for example: dust and fume) from air. Filter may be a replaceable part or a permanent part of the respirator. Filter may be of the single-use or the reusable type.</p> <p><b>Combination Particulate- and Vapor- and Gas-Removing Respirators</b><br/>Equipped with cartridge(s) or canister(s) to remove particulate matter, vapors, and gases from air. The filter may be a permanent part or a replaceable part of a cartridge or canister.</p> |

(b) *Oxygen generating type.* Equipped with a facepiece or mouthpiece and nose clamp. Water vapor in the exhaled breath reacts with chemical in the canister to release oxygen to the breathing bag. The wearer inhales from the bag through a corrugated tube and one-way check valve at the facepiece. Exhaled air passes through a second check valve/breathing tube assembly into the canister. The oxygen release rate is governed by the volume of exhaled air. Carbon dioxide in the exhaled breath is removed by the canister fill.

(2) *Open Circuit SCBA (compressed air, compressed oxygen, liquid air, liquid oxygen).* A bypass system is provided in case of regulator failure except on escape-type units.

(a) *Demand type.* Equipped with a facepiece or mouthpiece and nose clamp. The demand valve permits oxygen or air flow only during inhalation. Exhaled breath passes to ambient atmosphere through a valve(s) in the facepiece.

(b) *Pressure-demand type.* Equipped with a facepiece only. Positive pressure is maintained in the facepiece. The apparatus may have provision for the wearer to select the demand or pressure-demand mode of operation, in which case the demand mode should be used only when donning or removing the apparatus.

#### Combination Air-Line Respirators with Auxiliary Self-Contained Air Supply

Include an air-line respirator with an auxiliary self-contained air supply. To escape from a hazardous atmosphere in the event the primary air supply fails to operate, the wearer switches to the auxiliary self-contained air supply. Devices approved for both entry into and escape from dangerous atmospheres have a low-pressure warning alarm and contain at least a 15-minute self-contained air supply.

#### Combination Atmosphere-Supplying and Air-Purifying Respirators

Provide the wearer with the option of using either of two different modes of operation: (1) an atmosphere-supplying respirator with an auxiliary air-purifying attachment which provides protection in the event the air supply fails or (2) an air-purifying respirator with an auxiliary self-contained air supply which is used when the atmosphere may exceed safe conditions for use of an air-purifying respirator.

or orifice is provided to govern the rate of air flow to the wearer. Exhaled air passes to the ambient atmosphere through a valve(s) or opening(s) in the enclosure (facepiece, helmet, hood, or suit). Up to 300 feet (91 meters) of hose length is permissible.

(a) *Continuous-flow class.* Equipped with a facepiece, hood, helmet, or suit. At least 115 liters (four cubic feet) of air per minute to tight-fitting facepieces and 170 liters (six cubic feet) of air per minute to loose-fitting helmets, hoods, and suits is required. Air is supplied to a suit through a system of internal tubes to the head, trunk, and extremities through valves located in appropriate parts of the suit.

(b) *Demand type.* Equipped with a facepiece only. The demand valve permits flow of air only during inhalation.

(c) *Pressure-demand type.* Equipped with a facepiece only. A positive pressure is maintained in the facepiece.

<sup>a</sup>Device produces negative pressure in respiratory inlet covering during inhalation.

<sup>b</sup>Device produces positive pressure in respiratory inlet covering during both inhalation and exhalation.

<sup>c</sup>Equipped with a demand valve that is activated on initiation of inhalation and permits the flow of breathing atmosphere to the facepiece. On exhalation, pressure in the facepiece becomes positive and the demand valve is deactivated.

<sup>d</sup>A positive pressure is maintained in the facepiece by a spring loaded or balanced regulator and exhalation valve.

Table 4  
Capabilities and Limitations of Respirators

| Atmosphere-Supplying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Air-Purifying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| <p>(Sec 5.2 for specifications on respirators against oxygen-deficient atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions.</p> <p><b>General limitation:</b> Except for some air-line suits, no protection is provided against skin irritation by materials such as ammonia and hydrogen chloride, or against sorption of materials such as hydrogen cyanide, trichloroethylene, or organic phosphates through the skin.</p> <p>Use of atmosphere-supplying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions (see Table 5 and 9.3 and 9.4).</p>                                                                                                                                                                                                                                      | <p><b>General limitation:</b> Air-purifying respirators do not protect against oxygen-deficient atmospheres nor against skin irritation by, or sorption through the skin of, airborne contaminants.</p> <p>The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the design efficiency and capacity of the cartridge, canister, or filter and the facepiece-to-face seal on the user. For gases and vapors, the maximum concentration for which the air-purifying element is designed is specified by the manufacturer or is listed on labels of cartridges and canisters.</p> <p>Nonpowered air-purifying respirators will not provide the maximum design protection specified unless the facepiece or mouthpiece/nose clamp is carefully fitted to the wearer's face to prevent inward leakage (see 7.4). The time period over which protection is provided is dependent on canister, cartridge, or filter type; concentration of contaminant; humidity level in the ambient atmosphere; and the wearer's respiratory rate.</p> <p>The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. Nonpowered air-purifying respirators may cause discomfort due to a noticeable resistance to inhalation. This problem is minimized in powered respirators. Respirator facepieces present special problems to individuals required to wear prescription lenses (see 9.1). These devices do have the advantage of being small, light, and simple in operation.</p> <p>Use of air-purifying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions (see Table 5 and 9.3 and 9.4).</p> |
| <p><b>Supplied-Air Respirators</b></p> <p>The respirable air supply is not limited to the quantity the individual can carry, and the devices are lightweight and simple.</p> <p><b>Limitation:</b> Limited to use in atmospheres from which the wearer can escape unharmful without the aid of the respirator.</p> <p>The wearer is restricted in movement by the hose and must return to a respirable atmosphere by retracing his route of entry. The hose is subject to being severed or pinched off.</p> <p>(1) <b>Flow mask.</b><br/>The hose inlet or blower must be located and secured in a respirable atmosphere. If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation. Maximum hose length may restrict application of device.</p>                                                                               | <p><b>Vapor- and Gas-Removing Respirators</b></p> <p><b>Limitation:</b> No protection is provided against particulate contaminants. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air.</p> <p>An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.</p> <p>Use should be avoided in atmospheres</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p><b>Self-Contained Breathing Apparatus (SCBA)</b></p> <p>The wearer carries his own breathing atmosphere.</p> <p><b>Limitation:</b> The period over which the device will provide protection is limited by the amount of air or oxygen in the apparatus, the ambient atmospheric pressure (service life of open-circuit devices is cut in half by a doubling of the atmospheric pressure), and the type of work being performed. Some SCBA devices have a short service life (less than 15 minutes) and are suitable only for escape (self-rescue) from an irrespirable atmosphere.</p> <p>(1) <b>Flow mask.</b><br/>The hose inlet or blower must be located and secured in a respirable atmosphere. If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation. Maximum hose length may restrict application of device.</p> | <p><b>Particulate-Removing Respirators</b></p> <p><b>Limitations:</b> Protection against non-volatile particles only. No protection against gases and vapors.</p> <p>Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions (see Table 5).</p> <p>(1) <b>Full facepiece Respirator.</b><br/>Provides protection against eye irritation in addition to respiratory protection.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

Table 4  
Capabilities and Limitations of Respirators

| Atmosphere-Supplying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Air-Purifying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <p>(See 5.2 for specifications on respirable atmospheres.)</p> <p>Atmosphere-supplying respirators provide protection against oxygen deficiency and toxic atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions.</p> <p><b>General limitations:</b> Except for some air-line suits, no protection is provided against skin irritation by materials such as ammonia and hydrogen chloride, or against sorption of materials such as hydrogen cyanide, tritium, or organic phosphate pesticides through the skin. Facepieces present special problems to individuals required to wear prescription lenses (see 9.1). Use of atmosphere-supplying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions (see Table 5 and 9.3 and 9.4).</p>                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p><b>General limitations:</b> Air-purifying respirators do not protect against oxygen-deficient atmospheres nor against skin irritations by, or sorption through the skin of, airborne contaminants.</p> <p>The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the design efficiency and capacity of the cartridge, canister, or filter and the facepiece-to-face seal on the user. For gases and vapors, the maximum concentration for which the air-purifying element is designed is specified by the manufacturer or is listed on labels of cartridges and canisters.</p> <p>Nonpowered air-purifying respirators will not provide the maximum design protection specified unless the facepiece or mouthpiece/nose clamp is carefully fitted to the wearer's face to prevent inward leakage (see 7.4). The time period over which protection is provided is dependent on canister, cartridge, or filter type; concentration of contaminant; humidity levels in the ambient atmosphere; and the wearer's respiratory rate.</p> <p>The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. Nonpowered air-purifying respirators may cause discomfort due to a noticeable resistance to inhalation. This problem is minimized in powered respirators. Respirator facepieces present special problems to individuals required to wear prescription lenses (see 9.1). Those devices do have the advantage of being small, light, and simple in operation.</p> <p>Use of air-purifying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions (see Table 5 and 9.3 and 9.4).</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p><b>Self-Contained Breathing Apparatus (SCBA)</b></p> <p>The wearer carries his own breathing atmosphere.</p> <p><b>Limitations:</b> The period over which the device will provide protection is limited by the amount of air or oxygen in the apparatus, the ambient atmospheric pressure (service life of open-circuit devices is cut in half by a doubling of the atmospheric pressure), and the type of work being performed. Some SCBA devices have a short service life (less than 15 minutes) and are suitable only for escape (self-rescue) from an irrespirable atmosphere.</p> <p>Chief limitations of SCBA devices are their weight or bulk, or both, limited service life, and the training required for their maintenance and safe use.</p> <p><b>(1) Closed-Circuit SCBA.</b><br/>The closed-circuit operation conserves oxygen and permits longer service life at reduced weight. The negative-pressure type produces a negative pressure in the</p> | <p><b>Supplied-Air Respirators</b></p> <p>The respirable air supply is not limited to the quantity the individual can carry, and the devices are lightweight and simple.</p> <p><b>Limitations:</b> Limited to use in atmospheres from which the wearer can escape unharmed without the aid of the respirator.</p> <p>The wearer is restricted in movement by the hose and must return to a respirable atmosphere by retracing his route of entry. The hose is subject to being severed or pinched off.</p> <p><b>(1) Hose Mask.</b><br/>The hose inlet or blower must be located and secured in a respirable atmosphere.</p> <p><b>(a) Hose mask with blower.</b><br/>If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation.</p> <p><b>(b) Hose mask without blower.</b><br/>Maximum hose length may restrict application of device.</p> | <p><b>Vapor- and Gas-Removing Respirators</b></p> <p><b>Limitations:</b> No protection is provided against particulate contaminants. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air.</p> <p>An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.</p> <p>Use should be avoided in atmospheres</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p><b>Particulate-Removing Respirators</b></p> <p><b>Limitations:</b> Protection against non-volatile particles only. No protection against gases and vapors.</p> <p>Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions (see Table 5).</p> <p><b>(1) Full Facepiece Respirator.</b><br/>Provides protection against eye irritation in addition to respiratory protection.</p> |



- (c) combination self-contained and supplied-air
- (2) Air-purifying respirators
  - (a) gas and vapor
  - (b) particulate (aerosols including dust, fog, fume, mist, smoke, and sprays)
  - (c) combination gas, vapor, and particulate
- (3) Combination atmosphere-supplying and air-purifying respirators

c. Respirator Selection

OSHA 1910.134 states that respirators shall be selected on the basis of the hazards to which workers are exposed and that ANSI Z88.2-1969 shall be used for guidance in their selection. OSHA also requires that approved or accepted respirators be used when available. For certain respiratory hazards, specific instructions about respirator use are given in other OSHA regulations. The trend seems to be toward regulations that specify the conditions of respirator use for each task. OSHA 1910.134 is then consulted for general instructions. Regardless of the regulations, respirators must be selected with the environment in which they will be used in mind. To do so requires certain basic information, so one should always ask the following questions before selecting a respirator.

(I) Decision Considerations

- A. WHAT IS THE ESTIMATED CONTAMINANT CONCENTRATION WHERE THE RESPIRATOR WILL BE USED, as determined by industrial hygiene monitoring information and/or reference to previous plant or DMEH surveys?

- B. WHAT ARE THE PERMISSIBLE LIMITS OF EXPOSURE TO THE CONTAMINANT(S) - threshold limit value (TLV) and short-term exposure limit (STEL)?

This information is available from the most current listing of ACGIH TLV's, the OSHA standards (1910.1000 - Tables Z1, Z2, Z3) or from the industrial hygiene section of DMEH.

- C. IS THE CONTAMINANT A GAS, VAPOR, MIST, DUST OR FUME?

This information can be determined by studying the manufacturing or maintenance process - raw materials, intermediate products, by-products and the wastes. See Material Safety Data Sheets when available.

- D. COULD THE CONTAMINANT CONCENTRATION BE TERMED IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)?

This knowledge is derived from the manufacturer of raw materials, the industrial hygiene section of DMEH, the plant industrial hygienist, and Material Safety Data Sheets, when available. In addition, consideration should be given to the potential for contamination of atmospheres under abnormal or emergency considerations.

- E. IF THE CONTAMINANT IS FLAMMABLE, DOES THE ESTIMATED CONCENTRATION APPROACH THE LOWER EXPLOSIVE LIMIT (LEL), OR DO DUST CONCENTRATIONS CREATE A POTENTIAL EXPLOSION PROBLEM?

Besides creating a potential fire and explosion condition, in most situations flammable vapor or gas concentrations exceeding the LEL are immediately dangerous to life and health. The LEL is specified on Material Safety Data Sheets. Gas or vapor levels can be determined with an explosion meter. Here, too, consideration should be given to emergency (such as spill) conditions.

F. DOES THE CONTAMINANT HAVE ADEQUATE WARNING PROPERTIES?

Manufacturers can supply such information, directly or through Material Safety Data Sheets. Warning properties such as odor, irritation or taste should ideally be present at concentrations at or below the TLV.

G. WILL THE CONTAMINANT IRRITATE THE EYES AT THE ESTIMATED CONCENTRATION?

Frequently, this will be self-evident if the operation is in progress. This information, too, is available from the Material Safety Data Sheets of raw materials. For irritating materials, a full facepiece respirator should be used.

H. IF THE CONTAMINANT IS A GAS OR VAPOR, IS THERE ANY AVAILABLE SORBENT THAT TRAPS IT EFFICIENTLY?

Respirator manufacturers, the industrial hygiene section of DMEH and plant industrial hygienists can provide this information.

- I. CAN THE CONTAMINANT BE ABSORBED THROUGH THE SKIN AS A VAPOR OR LIQUID? IF SO, WILL IT SIGNIFICANTLY ADD TO THE EMPLOYEE'S EXPOSURE AND CAUSE INJURY?

Skin absorption is indicated in the OSHA Standard 1910.1000, Table Z1 by the notation "skin" after the material name. Material Safety Data Sheets will also indicate skin absorption potential.

#### REMINDER

In all cases where OSHA has specified that a specific respirator be used for a specific task or exposure (such as in the asbestos, acrylonitrile, and carcinogen standards 1910.1001-1910.1045 or in future additions), that respirator or one providing equal or better protection must be used. This can be determined by reference to the specific health standard for the substance of concern.

The answers to these questions can provide enough information for choosing a respirator for routine use. There is nothing strange or unique about these questions. They represent the factors that a good industrial hygiene/safety program would incorporate for respirator selection or any other type of control and form the basis for the Respirator Decision Logic used in the Joint NIOSH and OSHA Standards Completion Program.

You should review the Decision Logic when considering respirator selection because it incorporates the

above questions in an orderly sequence. By following this logic, you will be able to choose a respirator that is satisfactory for the situation at hand and be assured that you have not overlooked any important factor (see Appendix C, Joint NIOSH/OSHA Respirator Decision Logic).

(II) Additional Decision Criteria

In addition, the following criteria are of particular interest:

When respirators are used for protection against gases and vapor, it is commonly recommended that cartridges be changed when the wearer senses the vapor by either odor, taste or irritation. Section IV B of the Decision Logic states that A SUBSTANCE SHOULD BE CONSIDERED TO HAVE WARNING PROPERTIES IF THE ODOR OR IRRITATION THRESHOLD IS NOT MORE THAN THREE TIMES THE EXPOSURE LIMIT, and there is no ceiling limit. Consideration is given to whether undetected exposure in this concentration range could cause serious or irreversible health effects. If not, the substance is considered to have adequate warning properties.

Section IV C of the Decision Logic states that WHERE THERE IS SUPPORTING EVIDENCE OF VAPOR BREAKTHROUGH IN LESS THAN THREE MINUTES AT CONCENTRATIONS IMMEDIATELY DANGEROUS TO LIFE OR HEALTH OR BELOW, A CARTRIDGE OR CANISTER SORBENT AIR-PURIFYING DEVICE SHOULD NOT BE ALLOWED FOR ANY USE. The principal sources of information on sorbent efficiencies are Lawrence Livermore Laboratory and 30 CFR-11 on certain specific materials on which cartridge tests are run. Users should be alert to any future information

on sorbent efficiency as it will definitely affect choice of air-purifying respirators (see Appendix D).

Section IV E concerns atmospheres immediately dangerous to life or health (IDLH). Opinions on the correct definition of IDLH differ, but this section gives several guidelines to assist you in defining it. Although not everyone will agree with all the guidelines given, this is the best information available for assessing IDLH problems.

#### SELECTION OF RESPIRATORS FOR ROUTINE USE

"Routine" use of a respirator is daily or frequent use on a regular basis. In such cases, a respirator of simple maintenance, minimal wearing discomfort, low resistance to breathing, light weight, and compact construction should be considered.

DMEH and S&PP recommend that locations DISCONTINUE THE USE OF GAS MASKS within Monsanto. Many injuries and fatalities have been reported over the years through improper use of gas mask equipment. Where relatively high concentrations of organic vapors, alkaline or acid gases, etc. exist fullface supplied-air equipment is recommended.

#### SELECTION OF RESPIRATORS FOR NONROUTINE AND EMERGENCY USE

A respirator used "nonroutinely" is designed for hazardous situations that occur only occasionally. For such applications, initial costs and maintenance costs are less important than that for routine applications. The degree of protection and the useful service time provided are important.

Any respirator that protects adequately against a hazardous atmosphere which occurs suddenly, may be used for escape purposes. If the hazardous atmosphere causes eye irritation, the respirator should have a full facepiece, or hood. Chemical goggles may also be used for escape purposes to protect against extreme eye irritation.

Mouthbit/nose clip respirators are NOT recommended, even for use as a means of escape from emergency situations. A slip or fall could cause the wearer to lose a secure mouth seal and gasp a potentially lethal atmosphere. In addition, such a respirator provides no eye protection against potentially high concentrations of materials which are irritating to the eye.

IF AN AREA CONTAINING AN UNKNOWN AIR CONTAMINANT CONCENTRATION MUST BE ENTERED, A PRESSURE DEMAND SCBA OR A COMBINATION SCBA AND AIR SUPPLIED AIRLINE RESPIRATOR, EITHER OF WHICH IS SPECIFICALLY DESIGNED TO MAINTAIN POSITIVE AIR PRESSURE INSIDE THE FACEPIECE SHOULD BE USED.

Plant fire situations routinely encountered by firefighters, require entry into unknown concentrations of air contaminants. These atmospheres would reasonably be classified as Immediately Dangerous to Life and Health (IDLH) (see Appendix J). For this reason, A PRESSURE-DEMAND SCBA SHOULD BE USED IN FIRE-FIGHTING.

All the questions that should be answered in selecting respirators for routine use should also be answered in selecting respirators for emergency use.

## RESPIRATOR PROTECTION FACTORS

### DEFINITION

The respirator protection factor indicates how much protection a respirator provides. It is the ratio of the contaminant concentrations outside and inside the respirator. Determination of the protection factor requires quantitative performance tests of the respirator worn in a test atmosphere during exercise simulating motions made by workers, or worn by workers carrying out tasks in contaminated work areas.

### ASSIGNMENT

Much research has been done recently on assigning protection factors in various types of respirators. Table 5 reproduced verbatim from the ANSI Z88.2 - 1980, "Practices for Respiratory Protection document, lists assigned respirator protection factors resulting from this research. When using Table 5 pay strict attention to its footnotes as they are essential in interpreting the table and assist in application of protection factors.

### APPLICATION

To apply an assigned protection factor for a particular type of respirator, one must know both the actual contaminant concentration in the work area and the established time-weighted average concentration for the material. Multiplying the time-weighted average concentration by the respirator protection factor gives the maximum concentration of the contaminant against which the particular type of respirator may be used. If the actual concentration is less than the calculated maximum use concentration, the respirator may be used.

Table 5  
Respirator Protection Factors<sup>a</sup>

| Type of Respirator                                                                                                 | Permitted for Use in Deficient Atmosphere | Permitted for Use in Immediately-Dangerous-to-Life-or-Health Atmosphere <sup>f</sup> | Respirator Protection Factor                                                            |                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                    |                                           |                                                                                      | Qualitative Test                                                                        | Quantitative Test                                                                                                                                                                                                                              |
| Particulate filter, quarter-mask or half-mask facepiece <sup>b,c</sup>                                             | No                                        | No                                                                                   | 10                                                                                      | As measured on each person with maximum of 100.                                                                                                                                                                                                |
| Vapor- or gas-removing, quarter-mask or half-mask facepiece <sup>b</sup>                                           | No                                        | No                                                                                   | 10, or maximum use limit of cartridge or canister for vapor or gas, whichever is less.  | As measured on each person with maximum of 100, or maximum use limit of cartridge or canister for vapor or gas <sup>d</sup> , whichever is less.                                                                                               |
| Combination particulate-filter and vapor- or gas-removing, quarter-mask or half-mask facepiece <sup>b,c</sup>      | No                                        | No                                                                                   | 10, or maximum use limit of cartridge or canister for vapor or gas, whichever is less.  | As measured on each person with maximum of 100, or maximum use limit of cartridge or canister for vapor or gas <sup>d</sup> , whichever is less.                                                                                               |
| Particulate filter, full facepiece <sup>b</sup>                                                                    | No                                        | No                                                                                   | 100                                                                                     | As measured on each person with maximum of 100 if dust, fume, or mist filter is used, or maximum of 1000 if high-efficiency filter is used.                                                                                                    |
| Vapor- or gas-removing, full facepiece                                                                             | No                                        | No                                                                                   | 100, or maximum use limit of cartridge or canister for vapor or gas, whichever is less. | As measured on each person with maximum of 1000, or maximum use limit of cartridge or canister for vapor or gas <sup>d</sup> , whichever is less.                                                                                              |
| Combination particulate-filter and vapor- or gas-removing, full facepiece <sup>b</sup>                             | No                                        | No                                                                                   | 100, or maximum use limit of cartridge or canister for vapor or gas, whichever is less. | As measured on each person with maximum of 1000 if dust, fume, or mist filter is used and maximum of 10000 if high-efficiency filter is used, or maximum use limit of cartridge or canister for vapor or gas <sup>d</sup> , whichever is less. |
| Powered particulate-filter, any respiratory inlet covering <sup>b,c,d</sup>                                        | No                                        | No (yes, if escape provisions are provided <sup>d</sup> )                            | N/A                                                                                     | N/A                                                                                                                                                                                                                                            |
| Powered vapor- or gas-removing, any respiratory inlet covering <sup>b,c,d</sup>                                    | No                                        | No (yes, if escape provisions are provided <sup>d</sup> )                            | N/A                                                                                     | N/A                                                                                                                                                                                                                                            |
| Powered combination particulate filter and vapor- or gas-removing, any respiratory inlet covering <sup>b,c,d</sup> | No                                        | No (yes, if escape provisions are provided <sup>d</sup> )                            | N/A                                                                                     | N/A                                                                                                                                                                                                                                            |

Table 5 (Continued)  
Respirator Protection Factors<sup>a</sup>

| Type of Respirator                                                                                                                                      | Permitted for the in Oxygen-Deficient Atmosphere                                                             | Permitted for the in Immediately Dangerous-to-Life-or-Health Atmosphere <sup>f</sup> | Respirator Protection Factor |                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                         |                                                                                                              |                                                                                      | Qualitative Test             | Quantitative Test                                                                                                                                                                                                                                                          |
| Air-line, demand, quarter-mask or half-mask facepiece, with or without escape provisions <sup>e,g</sup>                                                 | Yes <sup>f</sup>                                                                                             | No                                                                                   | 10                           | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                                    |
| Air-line, demand, full facepiece, with or without escape provisions <sup>e</sup>                                                                        | Yes <sup>f</sup>                                                                                             | No                                                                                   | 100                          | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                                    |
| Air-line, continuous-flow or pressure-demand type, any facepiece, without escape provisions <sup>e</sup>                                                | Yes <sup>f</sup>                                                                                             | No                                                                                   | N/A                          | N/A<br>No tests are required due to positive-pressure operation of respirator. The protection factor provided by the respirator is limited to use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.     |
| Air-line, continuous-flow or pressure-demand type, any facepiece, with escape provisions <sup>e,g</sup>                                                 | Yes <sup>g</sup>                                                                                             | Yes                                                                                  | N/A                          | N/A<br>No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus. <sup>h</sup>                                                                                                                                  |
| Air line, continuous flow, helmet, hood, or suit, without escape provisions                                                                             | Yes <sup>f</sup>                                                                                             | No                                                                                   | N/A                          | N/A<br>No tests are required due to positive-pressure operation of respirator. The protection factor provided by the respirator is limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values. |
| Air-line, continuous flow, helmet, hood, or suit, with escape provisions <sup>g</sup>                                                                   | Yes <sup>g</sup>                                                                                             | Yes                                                                                  | N/A                          | N/A<br>No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus. <sup>h</sup>                                                                                                                                  |
| Hose mask, with or without blower, full facepiece                                                                                                       | Yes <sup>f</sup>                                                                                             | No                                                                                   | 10                           | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                                    |
| Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, quarter-mask or half-mask facepiece <sup>e</sup> | Yes <sup>f</sup>                                                                                             | No                                                                                   | 10                           | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                                    |
| Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, full facepiece or manifold <sup>e</sup>          | Yes <sup>f</sup><br>(Yes <sup>g</sup> , if respirator is used for mine rescue and mine recovery operations.) | No (Yes, if respirator is used for mine rescue and mine recovery operations.)        | 100                          | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values, except when the respirator is used for mine rescue and mine recovery operations.                   |

Table 5 (Continued)  
Respirator Protection Factors<sup>a</sup>

| Type of Respirator                                                                                                                                          | Permitted for Use in Oxygen-Deficient Atmosphere | Permitted for Use in Immediately-Dangerous-to-Life-or-Health Atmosphere <sup>f</sup> | Respirator Protection Factor |                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                             |                                                  |                                                                                      | Qualitative Test             | Quantitative Test                                                                                                                                                                                                                                               |
| Air-line, demand, quarter-mask or half-mask facepiece, with or without escape provisions <sup>c,e</sup>                                                     | Yes <sup>f</sup>                                 | No                                                                                   | 10                           | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                         |
| Air-line, demand, full facepiece, with or without escape provisions <sup>c</sup>                                                                            | Yes <sup>f</sup>                                 | No                                                                                   | 100                          | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                         |
| Air-line, continuous-flow or pressure-demand type, any facepiece, without escape provisions <sup>c</sup>                                                    | Yes <sup>f</sup>                                 | No                                                                                   | N/A                          | N/A                                                                                                                                                                                                                                                             |
| Air-line, continuous-flow or pressure-demand type, any facepiece, with escape provisions <sup>c,e</sup>                                                     | Yes <sup>f</sup>                                 | Yes                                                                                  | N/A                          | No tests are required due to positive-pressure operation of respirator. The protection factor provided by the respirator is limited to use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values. |
| Air-line, continuous flow, helmet, hood, or suit, without escape provisions                                                                                 | Yes <sup>f</sup>                                 | No                                                                                   | N/A                          | No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus. <sup>h</sup>                                                                                                                              |
| Air-line, continuous-flow, helmet, hood, or suit, with escape provisions <sup>c</sup>                                                                       | Yes <sup>f</sup>                                 | Yes                                                                                  | N/A                          | N/A                                                                                                                                                                                                                                                             |
| Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, quarter-mask or half-mask facepiece <sup>c</sup>     | Yes <sup>f</sup>                                 | No                                                                                   | 10                           | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                         |
| Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, full facepiece or mouthpiece/nose clamp <sup>c</sup> | Yes <sup>f</sup>                                 | No                                                                                   | 10                           | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                         |
| Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, full facepiece or mouthpiece/nose clamp <sup>c</sup> | Yes <sup>f</sup>                                 | No                                                                                   | 100                          | As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.                                                                                         |

No (yes, if respirator is used for mine rescue and mine recovery operations.)

(Yes<sup>f</sup>, if respirator is used for mine rescue and mine recovery operations.)

| Self contained breathing apparatus, pressure-demand-type open-circuit or positive-pressure-type closed circuit, quarter-mask or half-mask facepiece, full facepiece, or mouthpiece/nose clamp <sup>c</sup> | Yes <sup>d</sup> | N/A | No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus, <sup>h</sup> | N/A |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----|------------------------------------------------------------------------------------------------------------------------------------|-----|
| Combination respirators not listed.                                                                                                                                                                        |                  |     | The type and mode of operation having the lowest respirator protection factor shall be applied to the combination respirator.      |     |

N/A means not applicable since a respirator-fitting test is not carried out.

<sup>a</sup> A respirator protection factor is a measure of the degree of protection provided by a respirator to a respirator wearer. Multiplying the permissible time-weighted average concentration or the permissible ceiling concentration, whichever is applicable, for a toxic substance, or the maximum permissible airborne concentration for a radionuclide, by a protection factor assigned to a respirator gives the maximum concentration of the hazardous substance for which the respirator can be used. Limitations of filters, cartridges, and canisters used in air-purifying respirators shall be considered in determining protection factors.

<sup>b</sup> When the respirator is used for protection against airborne particulate matter having a permissible time-weighted average concentration less than 0.05 milligram particulate matter per cubic meter of air or less than 2 million particles per cubic foot of air, or for protection against airborne radionuclide particulate matter, the respirator shall be equipped with a high-efficiency filter(s).

<sup>c</sup> If the air contaminant causes eye irritation, the wearer of a respirator equipped with a quarter-mask or half-mask facepiece or mouthpiece and nose clamp shall be permitted to use a protective goggle or to use a respirator equipped with a full facepiece.

<sup>d</sup> If the powered air-purifying respirator is equipped with a facepiece, the escape provision means that the wearer is able to breathe through the filter, cartridge, or canister and through the pump. If the powered air-purifying respirator is equipped with a helmet, hood, or suit, the escape provision shall be an auxiliary self-contained supply of respirable air.

<sup>e</sup> The escape provision shall be an auxiliary self-contained supply of respirable air.

<sup>f</sup> For definition of "oxygen deficiency - not immediately dangerous to life or health" see Section 2.

<sup>g</sup> For definition of "oxygen deficiency - immediately dangerous to life or health" see Section 2 and A10.

<sup>h</sup> The protection factor measurement exceeds the limit of sensitivity of the test apparatus. Therefore, the respirator has been classified for use in atmospheres having unknown concentrations of contaminants.

<sup>i</sup> The service life of a vapor- or gas-removing cartridge or canister depends on the specific vapor or gas, the concentration of the vapor or gas in air, the temperature and humidity of the air, the type and quantity of the ambient in the cartridge or canister, and the activity of the respirator wearer. Cartridges and canisters may provide only very short service lives for certain vapors and gases. Vapor/gas service life testing is recommended to ensure that cartridges and canisters provide adequate service lives. Reference should be made to published reports which give vapor/gas life data for cartridges and canisters.

<sup>j</sup> Vapor- and gas-removing respirators are not approved for contaminants that lack adequate warning properties of odor, irritation, or taste at concentrations in air at or above the permissible exposure limits.

NOTE: Respirator protection factors for air-purifying-type respirators equipped with a mouthpiece/nose clamp form of respiratory inlet covering are not given, since such respirators are approved only for escape purposes.

agent, it shall be acceptable procedure to equip an air-purifying respirator with a high-efficiency filter.

(2) When carrying out a qualitative or quantitative respirator-fitting test which uses a vapor or gas as the test agent, it shall be acceptable procedure to equip an air-purifying respirator with an appropriate cartridge or canister which removes the vapor or gas from air.

(3) When carrying out a quantitative respirator-fitting test, it shall be acceptable procedure to attach a sampling probe to the respirator which is connected by flexible tubing to an instrument which measures the penetration of the test agent into the respirator.

When carrying out quantitative respirator-fitting tests, it shall be an acceptable procedure to carry out a single test for each available make and model of respirator in order to select a respirator for use by a person. However, three additional quantitative respirator-fitting tests involving the wearing of the selected make and model of respirator by the person shall be carried out to determine a protection factor for that particular respirator and person. The lowest protection factor determined by these three tests shall be assigned to a particular person wearing a specific make and model of respirator.

If a qualitative respirator-fitting test has been used in respirator selection, a person shall be allowed to use only the specific make(s) and model(s) of respirator(s) for which the person obtained a satisfactory fit, and the respirator protection factor listed under "qualitative test" in Table 5 shall apply. Under no circumstances shall a person be allowed to use any respirator if the results of the qualitative respirator-fitting test indicates that the person is unable to obtain a satisfactory fit.

If a quantitative respirator-fitting test has been used in selecting a respirator, the test results shall be used to assign a respirator protection factor to each person for each specific make and model of respirator tested. The assigned respirator protection factor shall be applied when the person wears the specific respirator in a hazardous atmosphere, but it shall not exceed the respirator protection factor listed under "quantitative test" in Table 5 for the particular type of respirator.

**6.12 Respirator-Fitting-Test Records.** Records of respirator-fitting tests shall be kept for at least the duration of employment. These records shall include the following information:

- (1) Type of respirator-fitting test used
- (2) Specific make and model of respirator tested
- (3) Name of person tested
- (4) Name of test operator
- (5) Date of test
- (6) Results of respirator-fitting tests

(a) Success or failure of person to obtain satisfactory fit if a qualitative respirator-fitting test was carried out

(b) Respirator protection factor based upon test results if a quantitative respirator-fitting test was carried out

**6.13 Respirator Protection Factor Assignment.** When a group of persons wear respirators in a given work area, a single respirator protection factor shall be assigned to all respirator wearers in the group. When negative-pressure respirators are being used, this respirator protection factor shall correspond to the lowest value established by qualitative or quantitative respirator-fitting tests for any person of the group with the specific make and model of respirator which that person will wear in the given work area.

**6.14 Face Dimensions and Facepiece Sizes.** The wide range of face dimensions requires more than a single size of respirator facepiece to provide a proper fit to all respirator users. Therefore, respirator facepieces of more than one size shall be available in any respirator-selection program involving respirators equipped with facepieces.

**6.15 Employee Acceptance.** Employee acceptance of a particular respirator model within a class shall be considered in selecting a respirator since this may determine whether or not he wears the respirator properly. Acceptance factors to be considered include discomfort, breathing resistance, weight, and interference with vision or the work to be performed. If the results of respirator-fitting tests show that the person can obtain an acceptable fit with two or more respirator models of the selected class of respirator, then the person should be permitted to use the respirator model which he or she prefers.

## 7. Use of Respirators

**7.1 Standard Operating Procedures.** Written standard operating procedures shall cover a complete respirator program (see 3.5.1) and shall include information necessary for the proper use of respirators, including training of respirator wearers, respirator sealing tests, issuance of respirators, inspection of respirators prior to use, monitoring respirator use, monitoring respiratory hazard, and planning for routine, nonroutine, emergency, and rescue uses of respirators.

The written standard operating procedures shall include plans necessary to ensure the safe routine use and nonroutine use of respirators. Emergency and rescue uses of respirators shall be anticipated, and the writ-

In describing use of protection factors in respirator selection, it is assumed that a complete respirator program is in force. A PROTECTION FACTOR IS NOT APPLICABLE IF THE WEARER CANNOT SATISFACTORILY SEAL THE RESPIRATOR TO HIS FACE OR HEAD. ANYTHING SUCH AS FACIAL HAIR OR SPECTACLES THAT PREVENTS SATISFACTORY SEALING OR FUNCTIONING OF A RESPIRATOR NULLIFIES APPLICATION OF A RESPIRATOR PROTECTION FACTOR. A protection factor can be used only if the respirator is in good operating condition, so the respirator must be properly maintained. Other limitations of various types of respirators discussed in Table 4, must also be considered in applying protection factors.

### 3. TRAINING AND FITTING

#### a. Elements of an Adequate Training Program

Selecting the respirator appropriate to a given hazard is important but equally important is using the selected device properly. Proper use can be ensured by carefully training both supervisors and workers in selection, use, and maintenance of respirators.

Like the overall respirator program, the content of the training program can vary widely, depending on circumstances. However, OSHA 1910.134 requires that training on both workers and supervisors include the following, no matter what the circumstances:

1. An opportunity to handle the respirator,
2. Proper fitting,
3. Test of facepiece-to-face seal;
4. A familiarizing period of wear in normal air.

Furthermore, OSHA requires that the wearer receive fitting instructions including demonstrations and practice in wearing, adjusting, and determining the fit of the respirator. These requirements originated in ANSI Standard Z88.2-1969. Section 7.4 of that Standard gives more details.

DMEH recommends that the training of supervisors and workers also include:

1. Discussion of the engineering and administrative controls in use and why respirators also are needed,
2. Explanation of the nature of the respiratory hazard and what happens if the respirator is not used properly,
3. Explanation of why a particular type of respirator has been selected,
4. Discussion of how to recognize and handle emergencies.

The training requirements apply to large and small plants with no differentiation to meet individual needs. The training content the supervisor needs may differ however, from that for the individual worker, and both may differ markedly from that needed by members of emergency response teams.

The exact format of the training program will vary widely, depending upon the organization. It should be emphasized however, that these training and fitting requirements apply to large and small locations alike.

#### (I) Supervisor Training

Supervisors, those who oversee the daily activities of one or more workers who wear respirators frequently, should have a reasonably comprehensive knowledge

of respirators and respiratory protection practices. Their training should include, but not necessarily be limited to, knowledge of the following:

- (a) Basic respiratory protection practices.
- (b) Selection and use of respirators to protect each worker against every respiratory hazard to which he may be exposed.
- (c) The nature and extent of the respiratory hazards to which the workers may be exposed.
- (d) The structure and operation of the entire respirator program. The supervisor should understand his responsibility to facilitate functioning of the program, including maintenance that the worker may be expected to do himself, issuance of respirators, control of their use and evaluation of the program's effectiveness.
- (e) The legal requirements pertinent to use of respirators in his situation.

(II) Worker Instruction and Training

The extent and frequency of the workers' training depends primarily on the nature and extent of the hazard. If the hazard is a nuisance particulate, for example, the danger from misuse of the respirator is not likely to be serious. However, with highly toxic particulates, a single misuse may have serious consequences. The same holds true, of course, for gases and vapors. If the respirator is to be used in an emergency, training in its use

should be very thorough and complete. In any case, the worker should be given some instruction and training in respiratory protection practices.

DMEH recommends as a minimum, both worker and supervisor should be trained in basic respiratory protection practices. Also each should be trained in use of the respirator selected for his particular situation. Because proper respirator use depends especially upon the wearer's motivation, it is important that the need for the respirator be explained fully. ANSI Standard Z88.2, Sec. 7.4 lists the following points to be included in a minimal acceptable respirator program.

- (A) Instruction in the nature of the hazard, whether acute, chronic, or both, and an honest appraisal of what may happen if the respirator is not used.
- (B) Explanation of why more positive control is not immediately feasible. This should include recognition that every reasonable effort is being made to reduce or eliminate the need for respirators.
- (C) Discussion of why this is the proper type of respirator for the particular purpose.
- (D) Discussion of the respirator's capabilities and limitations.
- (E) Instruction and training in actual use of the respirator (especially one for emergency use) and CLOSE, FREQUENT SUPERVISION to ensure that it continues to be used properly.

(F) Classroom and field training in recognizing and coping with emergencies.

(G) Other special training as needed.

A major thrust is toward explaining as much as possible about the reasons for wearing a respirator. This, of course, is to motivate the user to accept the fact that protection is necessary, and to instill in him/her the desire to wear and maintain the respirator properly. Pitching a respirator at a worker with orders that he/she wear it because OSHA says so is one of the easiest ways to ensure its misuse.

At best, a respirator may cause discomfort and inconvenience, so there is a natural resistance toward wearing it conscientiously. Recent field studies have pointed this out. Much of this natural resistance can be overcome by taking the time and effort to inform the wearer as thoroughly as possible why he needs the respirator. This effort will create easier acceptance of respirators and contribute to subsequent correct use.

b. Respirator Fitting

All the care that went into design and manufacture of a respirator to give maximum efficiency will not protect the wearer if there is an improper match between face-piece and wearer or improper wearing practices. The problem is twofold. ASSUMING THAT MORE THAN ONE BRAND OF A PARTICULAR TYPE OF FACEPIECE IS AVAILABLE, the first problem is to determine which fits best. The second problem is to

ensure that the user knows when the respirator fits properly. Both problems can be solved by the use of fitting tests, which is an OSHA requirement.

The following are fitting procedures which are currently recommended by DMEH. These procedures should be used in the selection of the BEST fitting respirator for each employee and also in the determination that the respirator is being worn correctly EACH TIME it is donned (i.e., that it is consistently providing the user adequate protection relative to the hazard).

NOTE: Just as every employee does not wear the same size safety shoe, employees DO NOT all wear the same standard size respirator (facial size, like foot size, varies with each individual, although like shoe sizes, most (approximately 95%) facial sizes can be fit properly utilizing a range of respirator sizes (small, medium, large). All the major respirator manufacturers now produce a given model respirator in two or three sizes permitting proper fit of most employees with one or two brands of respirators.

(I) Respirator Fitting Procedures

One point must be kept in mind throughout the following procedures. The OSHA regulations require that workers be allowed to test the face-piece-to-face seal of the respirator and wear it in a test atmosphere. Note: During any fitting test, the respirator head straps must be as comfortable as possible. Tightening the straps will sometimes increase or reduce the face-piece leakage, but the wearer may be unable to tolerate the respirator for any length of time.

(A) Fitting Tests for Initial Respirator Selection  
(i.e., Selecting "Best Fit")

(1) Qualitative fitting - Irritant smoke test

As a qualitative means of determining respirator fit, this test has a distinct advantage in that the wearer usually reacts involuntarily to leakage by coughing or sneezing. The likelihood of his giving a false indication of proper fit is reduced. On the other hand, the aerosol is irritating and must be used carefully. Also, it is advisable to have exhaust ventilation behind the subject to protect the person doing the testing.

This test can be used for both air-purifying and atmosphere-supplying respirators, but AN AIR-PURIFYING RESPIRATOR MUST HAVE A HIGH-EFFICIENCY FILTER(S). AFTER THE TEST, IT MAY BE NECESSARY TO REPLACE THE HIGH-EFFICIENCY FILTER(S) ON THE AIR-PURIFYING ELEMENT(S), DEPENDING UPON THE HAZARD TO WHICH THE RESPIRATOR WEARER IS TO BE EXPOSED. This test can be used for worker training or respirator selection.

The irritant smoke test must be performed with proper safeguards because the aerosol is irritating. A suggested procedure is as follows.

- (a) The wearer puts on the respirator normally, taking care not to tighten the headstraps uncomfortably. He stands with his back to a source of exhaust ventilation, such as a chemical exhaust hood.



qualitative respirator fit test using irritant smoke generated from a ventilation smoke tube using 2-way rubber squeeze bulb



Ideal qualitative respirator fit test employing large plastic bag inside which is dispersed test aerosol (organic vapor, irritant smoke, etc.)

- (b) The tester tells the wearer to CLOSE HIS EYES, even if he is wearing a full facepiece respirator, and to keep them closed until told to open them.
- (c) The tester lightly puffs smoke over the respirator, holding the smoke tube at least 2 feet from it. At this time, he should keep the amount of smoke minimal and pause between puffs to note the wearer's reaction. (NOTE: If the wearer detects no leakage, the tester may increase the smoke density and move the smoke tube progressively closer to the subject, still remaining alert to his reactions.)
- (d) When the smoke tube has been brought to within about 6 inches of the respirator with no leakage detected, the tester may start to direct smoke specifically at the potential sources of leakage, around the sealing surface and exhalation valve, while the subject holds his head still.
- (e) At this point, if no leakage has been detected, the wearer may cautiously begin the head movements outlined below. The tester should remain especially alert and be prepared to stop producing smoke immediately. During the test, the subject should make movements that approximate a normal working situation. These may include but not necessarily be limited to the following:

1. Normal breathing.
2. Deep breathing, as during heavy exertion. This should not be done long enough to cause hyperventilation.
3. Side-to-side and up-and-down head movements. These movements should be exaggerated, but should approximate those that take place on the job.
4. Other exercises may be added depending upon the situation. For example, if an employee spends a significant part of his time bent over at some task, it may be desirable to include an exercise approximating this bending.

Since this test will be used to both train the employee and select the respirator that fits him/her the best, the employee should perform the complete set of exercises.

If leakage is detected at any time, the tester should stop the smoke and let the wearer readjust the face-piece or headstrap tension. The tester should then start the test at the second step.

In all fairness, this test is not so time-consuming as it sounds. Also, because of its greater sensitivity and lesser reliance on subjective response, it is considered more reliable than other qualitative fitting tests (i.e., "banana oil" isoamyl acetate, talcum powder). If the wearer

keeps his eyes closed and the smoke is increased gradually there is little chance of discomfort (Appendix E contains a SOP for respirator fit testing using irritant smoke).

(2) Quantitative fitting tests.

All quantitative respirator performance tests involve placing the wearer in an atmosphere containing an easily detectable, relatively nontoxic gas, vapor, or aerosol. The atmosphere inside the respirator is sampled continuously through a probe in the respiratory-inlet covering. The leakage is expressed as a percentage of the challenge atmosphere outside the respirator, called "per cent of penetration," or simply "penetration".

Currently DMEH is not recommending that plants employ this type fitting, unless required by specific OSHA regulation (1910.1045 acrylonitrile standard requires quantitative fitting). Those plants and labs covered by OSHA regulations requiring quantitative fitting have received appropriate information and training in the proper quantitative fitting procedures.

(B) Fitting Tests for Field Testing of Respirator Seal.

The seal of a respirator to a wearer can be tested in the field by procedures recommended

by respirator manufacturers or by any of the following tests:

(1) Irritant smoke test

The person wearing a respirator is exposed to an irritant smoke. (AN AIR-PURIFYING RESPIRATOR MUST BE EQUIPPED WITH THE APPROPRIATE HIGH EFFICIENCY AIR-PURIFYING ELEMENT.) If the respirator wearer is unable to detect the penetration of the test agent into the respirator, it can be reasonably assured that the seal of the respirator to the wearer is satisfactory.

(2) Isoamyl acetate test

The person wearing a respirator is exposed to isoamyl acetate (Banana Oil). (An air-purifying respirator must be equipped with the appropriate organic vapor air-purifying element.) If the respirator wearer is unable to detect the penetration of the test agent into the respirator, it can be reasonably assured that the seal of the respirator to the wearer is satisfactory.

(3) Negative pressure sealing test

A negative air pressure respirator sealing test can be used on air-purifying respirators equipped with tight-fitting respiratory-inlet coverings and breathing tubes which can be squeezed or blocked at the inlet to prevent the passage of air.



Field, qualitative respirator fit test using stencil brush filled with organic solvent:



Figure 8-1.  
Negative pressure test.

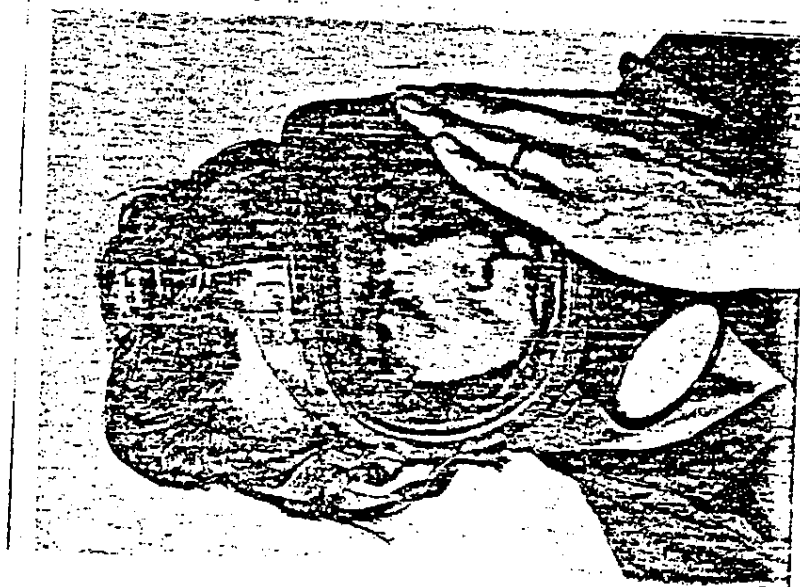


Figure 8-2.  
Positive pressure test.

This test may be difficult or impossible to carry out on valveless respirators. The test consists of closing off the inlet opening of the respirator's canister(s), cartridge(s), or filter(s) by covering with the palm of the hand(s), by replacing the inlet opening of the respirator's canister(s), cartridge(s), or filter(s) by covering with the palm of the hand(s), by replacing the inlet seal on a canister(s), or by squeezing a breathing tube or blocking its inlet so that it will not allow the passage of air, inhaling gently, and holding the breath for at least 10 seconds. If a facepiece collapses slightly and no inward leakage of air into the facepiece is detected, it can be reasonably assured that the fit of the respirator to the wearer is satisfactory.

(4) Positive pressure sealing test

A positive air pressure test can be used on respirators equipped with tight-fitting respiratory-inlet coverings which contain both inhalation and exhalation valves. This test may be difficult or impossible to carry out on valveless respirators. The test is conducted by closing off the exhalation valve and/or breathing tube and exhaling gently. The fit of a respirator equipped with a facepiece is considered to be satisfactory if a slight positive pressure can be built up inside the facepiece without detection of any outward leakage of air between the sealing surface

of the facepiece and the respirator wearer's face. For some respirators, this test method requires that the respirator wearer first remove an exhalation cover from the respirator and then replace it after completion of the test and these tasks often are difficult to carry out without disturbing the fit of the respirator to the wearer.

c. Special Fitting Problems

In addition to the normal problems associated with properly fitting a group of workers with respiratory protection, there are a few specific problems which can be avoided by following a few basic guidelines. Among these are facial hair, dentures, prescription glasses, and the wearing of other types of protective headgear such as surgeons' caps, bumpcaps, hardhats, goggles, and faceshields.

(I) Facial Hair

An employee cannot consistently obtain an acceptable level of protection from a respirator if he has facial hair in the area where the respirator seals to the face. Any intrusion of facial hair into the sealing surface of the respirator results in an increase in leakage. Problem areas, other than full facial hair, are beards and moustaches with half-mask facepieces and long, wide sideburns on full facepieces. Due to the wide variability of the facepiece-to-face seal (protection factor) for such an individual, adequate respiratory protection cannot be assured.

In order to protect the health of Monsanto employees and comply with the provisions of the OSHA Standard

29CFR1910.134(e)(5), it is the position of the environmental health specialists within the Department of Medicine and Environmental Health (DMEH) that:

"ANY EMPLOYEE WHO HAS POTENTIAL NEED TO WEAR A TIGHT-FITTING RESPIRATOR IN THE PERFORMANCE OF JOB DUTIES MUST BE CLEAN SHAVEN IN THE AREA BETWEEN THE SEALING SURFACE OF THE RESPIRATOR AND THE FACE."

This guideline is applicable to persons having facial hair which affects the safe and proper functioning of tight-fitting respirators; it does not prohibit facial hair in general. The Facial Hair Guideline also covers contractor employees working in Monsanto facilities.

The guideline DOES NOT APPLY to loose fitting continuous flow respirators such as hoods, blouses or air suits since this class of respirators, seal not to the face, but loosely to the shoulders or waist. Due to their design, facepiece-to-face seal is not a critical factor with regard to the protection afforded by this class of equipment.

Individuals who have facial hair styles which might interfere with the sealing surface of a respirator must be closely supervised. Over a short period of time (even days), the facial hair could extend into the critical seal area. The above requirement does not mean that all facial hair must be forbidden when respirators are worn, as a modest moustache or sideburns may be permitted if they do not interfere with the sealing surface of the respirator. Each case must be considered individually. It is incumbent upon the supervisor to ensure that the respirator is sealing properly.

(II) Dentures

Dentures, either partial or full, can be worn with respirators subject to certain restrictions. Full dentures generally present few problems other than some possible discomfort to the individual when wearing half-mask or full facepiece respirator. In fact, it is recommended that full dentures not be removed because of the distortion of the jaw without them. This can cause leakage in the chin area.

(III) Prescription Glasses

Prescription or safety glasses may be worn with half-mask respirators, although there is likely to be some interference with the mask at the bridge of the nose. This interference can be minimized by careful choice of mask and proper fitting and training.

GLASSES WITH STANDARD TEMPLE BARS SHALL NOT BE WORN WITH FULL FACEPIECE RESPIRATORS, AS THE EXTENSION OF THE TEMPLE BARS THROUGH THE SEALING SURFACE OF THE FACEPIECE WILL CAUSE LEAKAGE. If perscription glasses must be worn, all NIOSH approved full facepieces are required to provide for optional use of corrective spectacles or lenses without temple bars which break the facepiece-to-face seal or which shall not reduce the respiratory protection qualities of the facepiece.

CONTACT LENSES SHALL NOT BE WORN WITH FULL FACEPIECE RESPIRATORS. These devices present a distinct hazard to the individual because of the possibility of the lenses slipping due to pressure on the outside corners of the eyes from a full-face mask or a speck of dirt getting under them while the

respirator is being worn. Corrective action would entail removing the respirator, which means the individual would either have to leave the contaminated atmosphere or run the risk of exposure by removing the respirator in the contaminated area.

(IV) Protective Headgear

Use of other types of protective headgear is permitted with respirators but certain precautions shall be observed. THE ADDITIONAL HEADGEAR SHALL NOT INTERFERE WITH THE NORMAL METHOD OF WEARING THE RESPIRATOR. This means that the respirator head straps or head-harness will lie next to the head in their normal position, and other protective headgear will go over them.

Goggles may be worn with half-masks only if they do not interfere with the normal sealing of the mask in the nasal bridge area. Goggles shall never be worn with full facepiece respirators. The strap holding the goggles to the face, out of necessity, will pass under the sealing edge in the temple area and cause leakage. A full-face-piece granted a NIOSH approval, must have an impact resistant, shatterproof lens or eyepieces.

Faceshields can be worn with half-mask or full face-piece respirators depending on the individual design. The shield must not interfere with the normal position of the respirator on the face.

4. ASSIGNMENT OF RESPIRATORS

Issuance of respirators seems simple, but issue of an incorrect respirator may injure or even kill a worker, so the matter cannot

be treated lightly. The person responsible for issuing respirators must be adequately trained to make sure that he/she issues the correct respirator for each job. Plants may develop a system wherein each wearer is issued a card that specifies what type of respirator he/she can be issued for protection against a particular hazard. They are required to show this card to the issuer who can issue only the type of respirator listed. Such a card would list the particular brand and size (model number) of respirator based on the results of initial fitting tests.

When practical, a respirator should be assigned to each worker for their exclusive use, and should be permanently marked to indicate to whom it is assigned. Care must be taken to ensure that the marking does not hurt the respirator performance. If possible, records should be kept on the issuance and use of each respirator. To do so, each must be permanently identified.

## 5. CLEANING AND DISINFECTION

### a. Introduction

Where respirators are used routinely (daily), they should be cleaned and inspected daily. In a small program involving only occasional respirator use, respirators should be cleaned and inspected after each use. If each worker is to maintain his own respirator, he should be thoroughly briefed on its cleaning and disinfecting. Although a worker may not be required to maintain his/her own respirator, briefings on the cleaning procedure will encourage his/her acceptance of the respirator by providing assurance that they always received a clean, disinfected, properly maintained device. This is particularly important where respirators are not individually assigned. Where respirators are individually assigned (a practice to be encouraged) they should be durably identified to ensure that the worker always receives the same device. Identification markers must not penetrate

the facepiece or block filter or cartridge ports or exhalation valves.

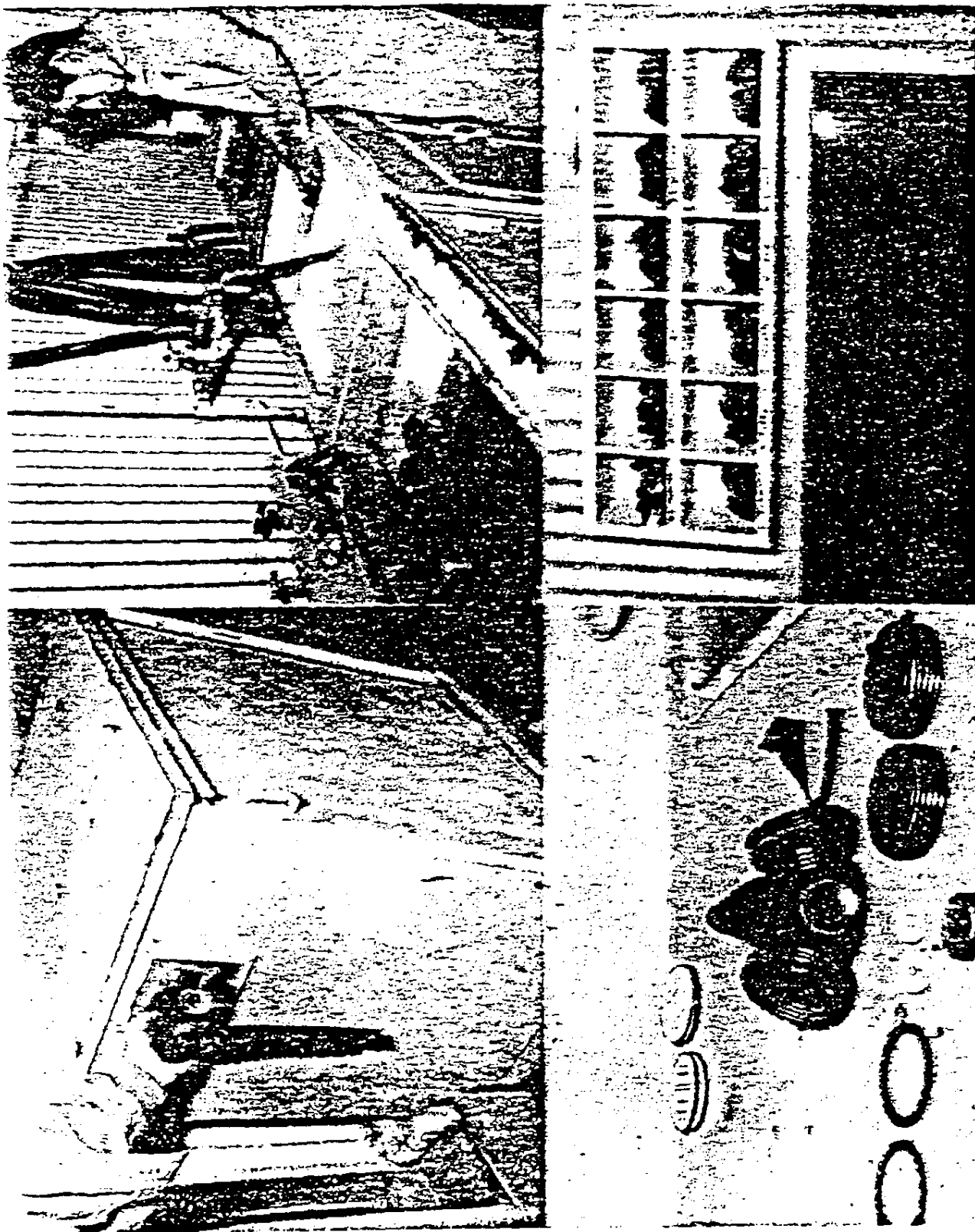
In a small respirator program, or where each worker cleans his/her own respirator, washing with detergent in warm water using a brush, thorough rinsing in a clean place is generally accepted as sound procedure. Precautions should be taken to prevent damage from rough handling during this procedure.

In a large program, there may be a centralized cleaning and maintenance facility with specialized equipment and personnel trained in respirator maintenance. A typical, hypothetical, large respirator maintenance facility should include features such as separate areas for disassembly of used respirators and assembly of freshly cleaned and maintained devices which ensure that the clean respirators do not become contaminated. Also, there should be ample storage space for the clean respirators, and spare parts (filters, exhalation valves, headbands, etc.) should be readily available. There should also be a test bench for checking the operation of SCBA regulators as well as a leak test system. A facility of this type would take about 500 sq. ft.

b. Cleaning and Disinfection

It is generally accepted that washing with a good detergent in warm water (by hand brushing or use of a specially adapted washing machine), rinsing and air-drying in a clean place is a sound cleaning procedure. Care should be taken not to damage the respirator by excessive heating or agitation in the washing solution. The general procedure that may be followed in cleaning air-purifying respirators is described below:

- (1) Remove, when necessary, the following components of respirator facepiece assemblies before cleaning and sanitizing:



Typical respirator hand washing facility, dirty respirator repository, respirator storage cabinet, and respirator maintenance bench

- (a) filters, cartridges, canisters
  - (b) speaking diaphragms
  - (c) demand and pressure-demand valve assemblies
  - (d) any components recommended by the respirator manufacturers
- (2) Wash respirator facepiece assemblies in warm (49°C or 120°F maximum temperature) cleaner-sanitizer solution. A stiff bristle (not wire) brush may be used to facilitate removal of dirt or other foreign material.
  - (3) Rinse respirator facepiece assemblies in clean, warm (49°C or 120°F maximum temperature) water.
  - (4) Drain all water and air dry respirator facepiece assemblies.
  - (5) Clean and sanitize all parts removed from respirator facepiece as recommended by the manufacturers.
  - (6) Hand wipe respirator facepiece assemblies, all parts, all gasket and valve sealing surfaces with damp, lint-free cloth as necessary to remove water residues and all foreign materials.
  - (7) Inspect parts and replace any which are defective.
  - (8) Reassemble parts on respirator facepiece assemblies.
  - (9) Attach new filters, cartridges, and canisters to respirator facepiece.
  - (10) Visually inspect, and where possible, test parts and respirator assemblies for proper function.

- (11) Place assembled respirators in appropriate containers for storage.

Machines may be used to expedite the cleaning, sanitizing, rinsing, and drying of large numbers of respirators. Extreme care must be taken to insure against tumbling, agitation, or exposure to temperatures above those recommended by the manufacturer (normally 49°C or 120°F maximum) as these conditions are likely to result in damage to the respirators. Ultra-sonic cleaners, clothes washing machines, dishwashers, and clothes dryers have been specially adapted and successfully used for cleaning and drying respirators.

Cleaner-sanitizers that effectively clean the respirator and contain a bactericidal agent are commercially available. The bactericidal agent frequently used is a quaternary ammonium compound.

Strong cleaning and sanitizing agents and many solvents can damage rubber or elastomeric respirator parts. These materials must be used with caution.

Alternatively, respirators may be washed in a detergent solution and then sanitized by immersion in a sanitizing solution. Some sanitizing solutions which have proven effective are: 1) a hypochlorite solution (50 parts per million chlorine), 2-minute immersion; 2) an aqueous iodine solution (50 parts per million of iodine), 2-minute immersion; or 3) a quaternary ammonium solution (200 parts per million of quaternary ammonium compounds in water with less than 500 parts per million total hardness), 2-minute immersion. Different concentrations of quaternary ammonium salts are required to achieve a sanitizing solution with waters of varying hardness. Inflammation of the skin, dermatitis, may occur on the respirator user if the quaternary ammonium compounds are not completely rinsed from the respirator.

The hypochlorite and iodine solutions are unstable and break down as time progresses, they may cause deterioration of rubber or other elastomeric parts and may be corrosive to metallic parts. Immersion times should not be extended beyond the mentioned time periods and the sanitizers must be thoroughly rinsed from the respirator parts.

Respirators may be contaminated with toxic materials. If the contamination is light, normal cleaning procedures should provide satisfactory decontamination; otherwise separate decontamination step(s) may be required before cleaning.

An example of a written standard operation procedure for disassembly, cleaning, and maintenance of respirators is found in Appendix F.

## 6. INSPECTION FOR DEFECTS

Probably the most important part of a respirator maintenance program is continual inspection of the devices. If conscientiously performed, inspections will identify damaged or malfunctioning respirators before they can be used. The OSHA requirements outline two primary types of inspection, that while the respirator is in use and that while it is being cleaned. In a small operation where the worker probably maintains his own respirator, the two types of inspection become essentially one and the same. In a large organization with a central respirator maintenance facility, the inspections differ.

### a. Inspection Schedules

All respiratory protective equipment must be inspected:

1. before and after each use; and
2. during cleaning.

Equipment designated for emergency use must be inspected:

1. after each use;
2. during cleaning; and
3. at least monthly.

Self-contained breathing apparatus must be inspected

1. at least monthly;
2. a record must be kept of inspection dates and findings for RESPIRATORS MAINTAINED FOR EMERGENCY USE.

b. Inspection Procedures

Inspection procedures can be divided into those for "field" inspection and those for use during cleaning.

(I) Field Inspection

(A) Air-Purifying Respirators

Routinely used air-purifying respirators should be checked as follows before and after each use.

- (1) Examine the facepiece for:
  - (a) Excessive dirt;
  - (b) Cracks, tears, holes, or distortion from improper storage;
  - (c) Inflexibility (stretch and massage to restore flexibility);
  - (d) Cracked or badly scratched lenses in full facepieces;
  - (e) Cracked or broken air-purifying element holder(s), badly worn threads, or missing gasket(s) (if required).

(2) Examine the headstraps or head harness for:

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

(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, cracks, tears, or distortion in the valve material, improper insertion of the valve body in the facepiece;
- (b) Cracks, breaks, or chips in the valve body, particularly in the sealing surface;
- (c) Missing or defective valve cover,
- (d) Improper installation of the valve in the valve body.

(4) Examine the air-purifying elements for:

- (a) Incorrect cartridge, canister, or filter for the hazard;
- (b) Incorrect installation, loose connections, missing or worn gaskets or cross-threading in holder;
- (c) Expired shelf-life date on cartridge or canister;
- (d) Cracks or dents in outside case of filter, cartridge, or canister;

- (e) Evidence of prior use of sorbent cartridge or canister, indicated by absence of sealing material, tape, foil, etc., over inlet.
- (5) 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.
- (6) Examine the harness of a front- and back-mounted gas mask for:
  - (a) Damage or wear to the canister holder which may prevent its being held securely in place;
  - (b) Broken harness straps or fastenings.

(B) Atmosphere Supplying Respirators

For a routinely used atmosphere-supplying device, use the following procedures:

- (1) If the device has tight-fitting facepiece, use the procedures outlined above for air-purifying respirators, except those pertaining to the air-purifying elements.
- (2) If the device is a hood, helmet, blouse, or full suit, use the following procedures:
  - (a) Examine the hood, blouse, or full suit for rips and tears, seam integrity, etc.;

(b) Examine the protective headgear, if required, for general condition, with emphasis on the suspension inside the headgear;

(c) Examine the protective faceshield, if any, for cracks or breaks or impaired vision due to rebounding abrasive particles;

(d) Make sure that the protective screen is intact and secured correctly over the faceshield of abrasive blasting hoods and blouses.

(3) Examine the air supply system for:

(a) Integrity and good condition of air supply lines and hoses, including attachments and end fittings;

(b) Correct operation and condition of all regulators, valves, or other air-flow regulators.

#### (C) Self-Contained Breathing Apparatus (SCBA)

SCBA, the most complicated of respiratory protective devices, require more extensive inspection and testing than other devices. Owing to the intricacy of the parts of the SCBA, visual inspection is not sufficient to find defective units. Inspection and testing of SCBA must be done by individuals familiar with the particular device.

#### FACEPIECE ASSEMBLIES

Facepiece assemblies shall be inspected as outlined in Section 6(b)(1)(B) "Field Inspection",

with the addition of inspection of the breathing tube and the facepiece to regulator connector. Attention shall be given to the exhalation valves of those devices having a pressure demand mode of operation.

#### REGULATORS AND ALARMS

Regulators and alarms of SCBA shall be visually inspected and a simple test performed to check proper regulator function and integrity of the regulatory diaphragm. The alarm should be activated to test proper function. A method for testing regulator function and diaphragm integrity is described in a recent S&PP/DMEH Bulletin (#79-3), issued June 7, 1979, titled "SCBA Alert and Inspection Request".

#### OTHER ASSOCIATED EQUIPMENT

Other parts of SCBA which must be checked are:

1. Cylinder-check pressure, check cylinder valve for leaks, inspect cylinder valve lock for presence and function. (If not fully charged, then recharge.)
2. Back-pack and harness assembly - inspect integrity of straps, buckles and fasteners, check back-pack cylinder lock assembly for function.

While complete test and inspection procedures for each device available cannot be given in this guide, such tests and inspections should be made. Complete inspection procedures are

packed with most devices or are available from the manufacturer.

(II) Inspection After Cleaning and Maintenance

The procedures for inspection after cleaning and maintenance are the same as outlined in the preceding "field inspection" section.

(III) Maintenance and Repair

The OSHA standards state that "replacement or repairs 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 their limitations and never try to replace components or make repairs and adjustments beyond manufacturer's recommendations, unless they have been specially trained by the manufacturer.

These restrictions apply primarily to maintenance of the more complicated devices, especially open-circuit SCBA's, and even more specifically their reducing or admission valves (regulators) which "...shall be returned to the manufacturer or to a trained technician for adjustment or repair." The words "trained technician" permit on-site repair if the maintenance personnel are trained by the manufacturer. There should be no problems in repairing and maintaining most other respirators, particularly the most commonly used air-purifying types.

An important aspect of any maintenance program is having enough spare parts on hand. Only continual surveillance of replacement rate will determine what parts in what quantities must be kept in stock. It is desirable to have some sort of recordkeeping system to indicate spare parts usage and the inventory on hand.

## 7. STORAGE

All the care that has gone into cleaning and maintenance of a respirator can be negated by improper storage. Respiratory protective equipment must be stored so as to protect it from dust, sunlight, heat, extreme cold, excessive moisture, and damaging chemicals. Leaving a respirator unprotected, as on a workbench or in a tool cabinet or tool box among heavy wrenches, can lead to damage of the working parts or permanent distortion of the facepiece, thus making it ineffective.

AFTER CLEANING AND DISINFECTING THE RESPIRATORS, THEY SHOULD BE PLACED INDIVIDUALLY IN HEAT-SEALED OR RE-SEALABLE PLASTIC BAGS UNTIL REISSUE. They should be stored in a single layer with the facepiece and exhalation valve in a more or less normal position to prevent the rubber or plastic from taking a permanent distorted "set".

### a. Air-purifying Respirators

Air-purifying respirators kept ready for nonroutine or emergency use should be stored in a cabinet in individual compartments. A steel wall-mounted cabinet can be used for this purpose. Each compartment should be clearly labeled with the user's name.

A standard steel storage cabinet may also be used. Respirators should be stored in a single layer only to prevent possible distortion.

b. Air-supplying Respiratory Protective Equipment

A storage chest for self-contained breathing apparatus (SCBA) may be purchased from the respirator manufacturer.

Storage cabinets should be located in noncontaminated, but readily accessible, areas.

8. SURVEILLANCE OF USE

a. Random Inspection

Respirators in use shall be randomly inspected frequently to ensure that those selected for the job are being used and that they are in good condition. Respiratory protection is no better than the respirator in use. Periodic monitoring of respirator use should include:

- (I) Determination that the proper respirators are being used.
- (II) Determination that respirators are being worn properly.
- (III) Consultation with wearers about:
  - Discomfort
  - Resistance to breathing
  - Interference with vision
  - Restriction of movement
  - Interference with job performance

Problems discovered during the random inspections must be rectified.

b. Employee Responsibility

Proper supervision of respirator use should ensure that each worker understands that he has the following responsibilities:

- (I) He shall use the respirator as instructed;
- (II) He shall guard against damaging the respirator;
- (III) He shall go immediately to an area having respirable air if the respirator fails to provide proper protection;
- (IV) He shall report any respirator malfunction to a person responsible for the respirator program.

c. Determination of Wearer's Exposure to Hazards

Appropriate surveillance of work area conditions and of worker exposure to respiratory hazards shall be carried out. This means that the concentration of the respiratory hazard to which workers are exposed shall be determined periodically and records shall be kept. The monitoring must cover conditions throughout a full work shift as activities in the work may vary during the shift and change the hazard concentration. The time-weighted average concentration and ceiling (peak) concentration of the hazard during the workshift must be determined. Preferably, the air in the work area should be sampled in the workers' breathing zones.

9. PROGRAM EVALUATION

OSHA 1910.134 and Sec. 3.5.9 of ANSI Z88.2 state that respirator program effectiveness shall be inspected and evaluated regularly. Periodic monitoring is necessary to ensure that workers are adequately protected. THE PROGRAM SHOULD BE EVALUATED AT LEAST ANNUALLY, and the written operating procedures should be modified to reflect the evaluation results if necessary.

Frequent inspection of respirator use will determine whether the correct respirators are being used and worn properly. Examination of respirators in use and in storage will indicate how well they are maintained. Wearers should be consulted periodically about their acceptance of respirators, including the discomfort, resistance to breathing, fatigue, interference with vision and communication, restriction of movement, and interference with job performance, and their confidence in the respirator's effectiveness.

The results of periodic inspections of respirator use, consultations with wearers, measurements of hazard levels in work areas, and medical surveillance of wearers should be reviewed, studied, and analyzed to determine the effectiveness of the respirator program. Evidence of excessive exposure to hazards should be followed up to determine why inadequate protection was provided, and action should be taken to remedy the problem. The results of the program evaluation should be presented in a written report that should list plans to correct faults and the target dates for their implementation.

A questionnaire for evaluating the effectiveness of your respirator program is found in Appendix H. It can be used, along with the OSHA Field Operations Manual Chapter III to give the respirator program administrator and plant management the status of the program.

#### 10. MEDICAL SURVEILLANCE

OSHA 1910.134 and Sec. 3.7 of ANSI Z88.2 state that no one should be assigned to tasks requiring use of respirators unless he has been found physically able to do the work while wearing the respirator. Both standards declare that a PHYSICIAN shall determine what health and physical conditions are pertinent, and that respirator wearers' medical status should be reviewed periodically. If the plant physician has questions

relating to the appropriate medical surveillance for general or a specific respirator application, your respective DMEH Occupational Physician should be contacted.

Pre-employment medical examinations should identify those who are physically or psychologically unfit to wear respirators. As another part of this examination, medical tests pertinent to the respiratory hazards that workers may encounter should be made to get baseline data against which to assess physiological changes in respirator wearers.

Periodic medical examinations shall be made to determine if the employee has suffered any degradation in their respiratory status. Examination frequency should be tailored to particular situations.

The results of the periodic examinations should be compared with those of the pre-employment examinations and previous periodic examinations to help determine whether the respirators used are adequate.

a. Medical Limitations

Workers must be evaluated by competent medical personnel to assure that they are physically and mentally able to wear the respirators. These evaluations should be an important part of the employee's periodic physical examinations routinely given in most industrial medical facilities.

Adequate medical supervision of respirator users is indispensable in determining the extent of individual stress tolerance, and preventing potential physiological difficulties.

b. Physiological Factors

The AIHA/ACGIH Respiratory Protective Devices Manual devotes an entire chapter to the physiology of respiration

and the effects of respiratory protection on respiration. Much additional research is needed to correlate the effects of stress caused by breathing against some resistance while performing various types of work, including studies of energy expenditure, pulmonary ventilation, cardiovascular physiology, and potential for precipitating pulmonary dysfunctions.

Because of the additional stress placed on the cardio-pulmonary system, some pathological conditions, especially those associated with hypoxemia, should preclude the use of respiratory protective devices. Other cardiovascular or systemic diseases may be aggravated or these diseases may limit the use of respiratory devices.

The following clinical conditions are among those which are most likely to be investigated by the examining physician:

1. Chronic obstructive and restrictive lung disease; chronic bronchitis, emphysema, pneumoconioses, pulmonary fibrosis, asthma, cystic fibrosis, etc.
2. Ischemic heart disease; coronary insufficiency and myocardial infarction.
3. Benign and accelerated hypertension.
4. Hemorrhagic disorders; hemophilia, hypersplenism, thrombocytopenia, purpura, etc.
5. Thyroid enlargement
6. Epilepsy; grand mal, focal, etc.
7. Diabetes mellitus.

8. Cerebrovascular accidents.
9. Facial abnormalities.
10. Serious defects in visual acuity.
11. Ruptured ear drum.
12. Other disabilities.

c. Psychological Factors

It is generally very difficult to evaluate a wearer's psychological limitations through a routine medical examination. The examining medical doctor should investigate any mental illness thoroughly to ascertain that the wearing of respiratory protective equipment will not aggravate the existing condition. Under the best conditions, a degree of anxiety is often encountered when wearing a respirator which may become exaggerated in emergency situations. Experienced personnel who fit and train respirator users should note unusual behavior patterns.

d. Wearer Acceptance

Wearer acceptance of a respirator can best be accomplished through proper training. Knowing the reason for using a device, the possible consequences of not wearing it, its capabilities, explaining why engineering controls are not used, relieving "fears of the unknown" or "only sissies use them" concepts, and any other preconceived notions, will greatly improve wearer acceptance.

e. Claustrophobia

Some people experience claustrophobia when wearing respirators. Claustrophobic reactions may not be detected when a

device is first tried on or during the fitting phase. It usually does not appear until the wearer goes into an atmosphere that is either hazardous or irritating. Use of a room, chamber, or "smoke house" filled with an irritating smoke, such as from burning wet straw, assists greatly in identifying those individuals who tend to develop claustrophobia.

f. Stress

Stress conditions generated in an emergency may completely incapacitate an individual, not only endangering himself, but others around him. Emergency personnel such as standby men who are observing workers in a tank or rescue team, should be trained using simulated conditions. Because there is no way to predict how an individual might react under actual stress conditions, every effort should be made to condition him physically, mentally and psychologically. This can only be accomplished by repeated and sufficient training.

g. Periodic Medical Examinations

Physical examinations are required FOR EACH USER BEFORE THEY WEAR ANY DEVICE AND PERIODICALLY THEREAFTER. The periodicity will be determined by the physician in conjunction with the industrial hygienist.

h. Medical Approval Forms

It is recommended that each location utilize medical approval forms for every individual who might use respirators. These forms are to be completed by the examining physician for the person in charge of the respirator program. The assessment of medical restrictions will facilitate the planning of training activities and the type of job assignments.

## 11. APPROVED RESPIRATORS

When purchasing respiratory protective equipment, be sure to purchase APPROVED equipment for the particular contaminant. An approved respirator is one that has been found to meet minimum performance standards by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH). OSHA requires that approved respirators be used if they are available. If only one brand of respirator is approved for a particular hazard, then that brand is considered to be "available" and must be used.

### a. NIOSH/MSHA Approval

A NIOSH approved respirator contains the following:

- (I) An assigned identification number placed on each unit, e.g., TC-21C-101.
- (II) A label identifying the type of hazard the respirator is approved to protect against.
- (III) Additional information on the label which indicates limitations and identified the component parts approved for use with the basic unit.

### b. BOM Approval

In the past, the Bureau of Mines (BOM) approved respirators. The BOM no longer grants approval; however, approvals may be valid for some older BOM respirators.

Pressure-demand (+ pressure) SCBA Equipment has been demonstrated to provide significantly greater protection to the user than demand (- pressure) units. As SCBA equipment is often used in known or potentially hazardous situations, the maximum protection should be afforded the user. For

this reason, DMEH strongly recommends that the older BOM approved demand SCBA units be modified, if possible, to NIOSH/MSHA approved pressure demand units. Some older BOM approved SCBA equipment cannot be modified to a NIOSH approval due to design changes which have taken place over the past 15 years. If the BOM equipment cannot be modified to pressure-demand (+ pressure) then it should be placed on a retirement schedule and replaced with pressure-demand equipment. The SCBA manufacturer should be contacted as to the possibility of modification for each specific model.

DMEH and S&PP have previously recommended that BOM approved gas mask use within Monsanto be discontinued, whenever feasible, and be replaced with either full-face chemical cartridge air-purifying or air supplied respiratory protection.

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- (ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles.
- (iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.
- (4) Every protector shall be distinctly marked to facilitate identification only of the manufacturer.
- (5) When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and care taken to see that such limitations and precautions are strictly observed.
- (6) Design, construction, testing, and use of devices for eye and face protection shall be in accordance with American National Standard for Occupational and Educational Eye and Face Protection, Z87.1-1968.

## 1910.134—RESPIRATORY PROTECTION

## (a) Permissible practice.

(1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include the requirements outlined in paragraph (b) of this section.

(3) The employee shall use the provided respiratory protection in accordance with instructions and training received.

## (b) Requirements for a minimal acceptable program.

(1) Written standard operating procedures

governing the selection and use of respirators shall be established.

(2) Respirators shall be selected on the basis of hazards to which the worker is exposed.

(3) The user shall be instructed and trained in the proper use of respirators and their limitations.

(4) Where practicable, the respirators should be assigned to individual workers for their exclusive use.

(5) Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

(6) Respirators shall be stored in a convenient, clean, and sanitary location.

(7) Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

(8) Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

1910.134(b)(8)

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(9) There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

(10) Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

(11) Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by competent authorities. The U.S. Department of Interior, Bureau of Mines, and the U.S. Department of Agriculture are recognized as such authorities. Although respirators listed by the U.S. Department of Agriculture continue to be acceptable for protection against specified pesticides, the U.S. Department of the Interior, Bureau of Mines, is the agency now responsible for testing and approving pesticide respirators.

(c) Selection of respirators.

Proper selection of respirators shall be made according to the guidance of American National Standard Practices for Respiratory Protection Z88.2-1969.

(d) Air quality.

(1) Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity. Oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Compressed oxygen shall not be used in supplied-air respirators or in open circuit self-contained breathing apparatus that have previously used compressed air. Oxygen must never be used with air line respirators.

(2) Breathing air may be supplied to respirators from cylinders or air compressors.

(i) Cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178).

(ii) The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications in subparagraph (1) of this paragraph.

(3) Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

(4) Breathing gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B-00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

(e) Use of respirators.

(1) Standard procedures shall be developed for respirator use. These should include all

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information and guidance necessary for their proper selection, use, and care. Possible emergency and routine uses of respirators should be anticipated and planned for.

(2) The correct respirator shall be specified for each job. The respirator type is usually specified in the work procedures by a qualified individual supervising the respiratory protective program. The individual issuing them shall be adequately instructed to insure that the correct respirator is issued. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark shall not affect the respirator performance in any way. The date of issuance should be recorded.

(3) Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.

(i) In areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere, at least one additional man shall be present. Communications (visual, voice, or signal line) shall be maintained between both or all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist the other(s) in case of emergency.

(ii) When self-contained breathing apparatus or hose masks with blowers are used in atmospheres immediately dangerous to life or health, standby men must be present with suitable rescue equipment.

(iii) Persons using air line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres or other and equivalent provisions for the rescue of persons from hazardous atmospheres shall be used. A standby man or men with suitable self-

contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

(4) Respiratory protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

(5) For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Training shall provide the men an opportunity to handle the respirator, have it fitted properly, test its face-piece-to-face seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

(i) Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly. Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also, the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic check. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece fitting instructions.

(ii) Providing respiratory protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. As a temporary measure, glasses with short temple bars or without temple bars may be taped to the wearer's head. Wearing of contact lenses in contaminated atmospheres with a respirator shall not be allowed. Systems have been developed for mounting correc-

## STANDARDS AND INTERPRETATIONS

tive lenses inside full facepieces. When a workman must wear corrective lenses as part of the facepiece, the facepiece and lenses shall be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal.

(iii) If corrective spectacles or goggles are required, they shall be worn so as not to affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

**(f) Maintenance and care of respirators.**

(1) A program for maintenance and care of respirators shall be adjusted to the type of plant, working conditions, and hazards involved, and shall include the following basic services:

- (i) Inspection for defects (including a leak check),
- (ii) Cleaning and disinfecting,
- (iii) Repair,
- (iv) Storage

Equipment shall be properly maintained to retain its original effectiveness.

(2)

(i) All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used but is kept ready for emergency use shall be inspected after each use and, at least monthly to assure that it is in satisfactory working condition.

(ii) Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

(iii) Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, head-

bands, valves, connecting tube, and canisters. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration. Stretching and manipulating rubber or elastomer parts with a massaging action will keep them pliable and flexible and prevent them from taking a set during storage.

(iv) A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

(3) Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure that proper protection is provided for the wearer. Each worker should be briefed on the cleaning procedure and be assured that he will always receive a clean and disinfected respirator. Such assurances are of greatest significance when respirators are not individually assigned to workers. Respirators maintained for emergency use shall be cleaned and disinfected after each use.

(4) Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or to make adjustment or repairs beyond the manufacturer's recommendations. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

(5)

(i) After inspection, cleaning, and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for the purpose. The compartments should be clearly marked. Routinely used respirators, such as dust respirators, may be placed in plastic bags. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

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(ii) Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position and function will not be impaired by the elastomer setting in an abnormal position.

(iii) Instructions for proper storage of emergency respirators, such as gas masks and self-contained breathing apparatus, are found in "use and care" instructions usually mounted inside the carrying case lid.

**(g) Identification of gas mask canisters.**

(1) The primary means of identifying a gas mask canister shall be by means of properly worded labels. The secondary means of identifying a gas mask canister shall be by a color code.

(2) All who issue or use gas masks falling within the scope of this section shall see that all gas mask canisters purchased or used by them are properly labeled and colored in accordance with these requirements before they are placed in service and that the labels and colors are properly maintained at all times thereafter until the canisters have completely served their purpose.

(3) On each canister shall appear in bold letters the following:

(i)

Canister for .....  
(Name for atmospheric contaminant)  
or  
Type N Gas Mask Canister

(ii) In addition, essentially the following wording shall appear beneath the appropriate phase on the canister label: "For

respiratory protection in atmospheres containing not more than ..... percent by volume of ....."

(iii) All of the markings specified above should be placed on the most conspicuous surface or surfaces of the canister.

(4) Canisters having a special high-efficiency filter for protection against radionuclides and other highly toxic particulates shall be labeled with a statement of the type and degree of protection afforded by the filter. The label shall be affixed to the neck end of, or to the gray stripe which is around and near the top of, the canister. The degree of protection shall be marked as the percent of penetration of the canister by a 0.3-micron-diameter dioctyl phthalate (DOP) smoke at a flow rate of 85 liters per minute.

(5) Each canister shall have a label warning that gas masks should be used only in atmospheres containing sufficient oxygen to support life (at least 16 percent by volume), since gas mask canisters are only designed to neutralize or remove contaminants from the air.

(6) Each gas mask canister shall be painted a distinctive color or combination of colors indicated in Table I-1. All colors used shall be such that they are clearly identifiable by the user and clearly distinguishable from one another. The color coating used shall offer a high degree of resistance to chipping, scaling, peeling, blistering, fading, and the effects of the ordinary atmospheres to which they may be exposed under normal conditions of storage and use. Appropriately colored pressure sensitive tape may be used for the stripes.

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TABLE I-1

| <i>Atmospheric contaminants to be protected against</i>                                                       | <i>Colors assigned*</i>                                                                                                   |
|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Acid gases.....                                                                                               | White.                                                                                                                    |
| Hydrocyanic acid gas.....                                                                                     | White with ½-inch green stripe completely around the canister near the bottom.                                            |
| Chlorine gas.....                                                                                             | White with ½-inch yellow stripe completely around the canister near the bottom.                                           |
| Organic vapors.....                                                                                           | Black.                                                                                                                    |
| Ammonia gas.....                                                                                              | Green.                                                                                                                    |
| Acid gases and ammonia gas.....                                                                               | Green with ½-inch white stripe completely around the canister near the bottom.                                            |
| Carbon monoxide.....                                                                                          | Blue.                                                                                                                     |
| Acid gases and organic vapors.....                                                                            | Yellow.                                                                                                                   |
| Hydrocyanic acid gas and chloropicrin vapor.....                                                              | Yellow with ½-inch blue stripe completely around the canister near the bottom.                                            |
| Acid gases, organic vapors, and ammonia gases.....                                                            | Brown.                                                                                                                    |
| Radioactive materials, excepting tritium and noble gases.....                                                 | Purple (Magenta).                                                                                                         |
| Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors..... | Canister color for contaminant, as designated above, with ½-inch gray stripe completely around the canister near the top. |
| All of the above atmospheric contaminants.....                                                                | Red with ½-inch gray stripe completely around the canister near the top.                                                  |

\*Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

## 1910.135—OCCUPATIONAL HEAD PROTECTION

Helmets for the protection of heads of occupational workers from impact and penetration from falling and flying objects and from limited electric shock and burn shall meet the

requirements and specifications established in American National Standard Safety Requirements for Industrial Head Protection, Z89.1-1969.



## 1910.136—OCCUPATIONAL FOOT PROTECTION

Safety-toe footwear for employees shall meet the requirements and specifications in

American National Standard for Men's Safety-Toe Footwear, Z41.1-1967.

## APPENDIX B

OSHA Instruction CPL 2-2.20  
April 2, 1979  
Office of Field Coordination

### CHAPTER III

#### OSHA STANDARD METHOD FOR DETERMINATION OF RESPIRATORY PROTECTION PROGRAM ACCEPTABILITY

##### A. General.

1. Introduction. The OSHA General Industry standard on Respiratory protection, 29 CFR 1910.134, requires that a respiratory protection program be established by the employer and that respirators be provided and be effective when such equipment is necessary to protect the health of the employee.
  - a. An acceptable respiratory protective program will lower the probability that an employee will suffer ill health from performing duties in contaminated or oxygen deficient atmospheres.
  - b. However, OSHA health standards place primary emphasis on engineering, administrative and work practice controls in light of the inherent deficiencies of respirators and respirator programs.
2. Exposure. Exposure to a contaminant is determined by measuring the airborne concentrations of contaminants in the breathing zone of the employee. Procedures in Chapter I, General Industrial Hygiene Policy and Chapter II, Determination of Compliance and Classification of Violations for Air Contaminants, establish the criteria to be used for determining whether an exposure occurs.
3. Definitions. For purposes of this chapter, the terms "exposure" and "overexposure" refer to concentrations in the breathing zone of the employee, outside of the respirator (i.e. the exposure of the employee if no respirator were being worn).
4. Citations. Citations shall be issued under 29 CFR 1910.134 as established in this chapter, and as otherwise specified in the Field Operations Manual (FOM) and this manual.

5. Situations Where Overexposure Does Not Occur.

a. Where an overexposure has not been established but where an improper respirator is being used (e.g., a dust respirator being used to reduce exposure to organic vapors), a citation under 29 CFR 1910.134(b)(2) shall be issued as other than serious, provided the Industrial Hygienist documents that an overexposure is possible.

DUST RESPIRATOR  
b. Where employee overexposure has not been established, and one or more of the other requirements of 29 CFR 1910.134 is not being met; e.g., an unapproved, nuisance is being used to reduce exposure to toxic dusts, a de minimis violation(s) shall be recorded in accordance with OSHA procedures. (Note that this policy does not include emergency use respirators.) The Industrial Hygienist shall advise the employer of the elements of a good respirator program as required under 29 CFR 1910.134.

6. Respirator Standards. An acceptable respiratory protective program includes all of the elements of 29 CFR 1910.134; however, the standard is structured such that essentially the same requirement is often specified in more than one section. In these cases, the section which most adequately describes the violation shall be cited. Sections which are at least, in part, duplicative are:

- Written operating procedures - 29 CFR 1910.134(b)(1), (e)(1) and (e)(3).
- Proper selection - 29 CFR 1910.134(b)(2), (c), and (e)(2).
- Training and fitting - 29 CFR 1910.134(b)(3), (e)(5) and (e)(5)(i-iii).
- Exclusive employee use - 29 CFR 1910.134(b)(4) (not specifically citable - see comments below) and (e)(2).
- Cleaning and disinfecting - 29 CFR 1910.134(b)(5) and (f)(3).
- Storage - 29 CFR 1910.134(b)(6) and (f)(5)(i-iii).

- Inspection and maintenance - 29 CFR 1910.134(b)(7), (e)(4), (f)(2)(i-iv), and (f)(4).
- Work area surveillance - 29 CFR 1910.134(b)(8) only.
- Inspection and evaluation of the program - 29 CFR 1910.134(b)(9) only.
- Medical examinations - 29 CFR 1910.134(b)(10) only.
- Approved respirators - 29 CFR 1910.134(b)(11) only.

7. General Respirator Provision Standard.

29 CFR 1910.134(a)(2) is the general section requiring employers to provide respirators "... when such equipment is necessary to protect the health of the employee" and requiring the establishment and maintenance of a respiratory protective program which meets the requirements outlined in 29 CFR 1910.134(b). Thus, if no respiratory program has been established or if some, but not all of the requirements of 1910.134(b) are being met, paragraph 1910.134(a)(2) and the specific paragraphs under 1910.134(b) (or if preferred, alternative paragraphs as previously discussed) that are applicable will be cited and grouped as one item.

8. ANSI Standards. A cross-reference between the OSHA and the American National Standards Institute (ANSI) standards on respiratory protection (from which the standard was adopted) is given in Figure III-1.

B. Interpretations and Guidelines. The following are specific comments regarding selected provisions of the standard where explanations beyond the wording of the standard are necessary:

1. Written Operating Procedures.

- a. The employer must have written standard operating procedures governing the selection and use of respirators. The procedures must include a discussion or explanation of all of the items specified in 29 CFR 1910.134(b).

- (1) The Industrial Hygienist shall inspect the written procedures for completeness and accuracy and shall record the details of the employer's program.

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- (2) If possible, the Industrial Hygienist shall obtain a copy of the written procedures for the case file.
- b. The determination of the adequacy of the written procedures is a professional judgment made by the Industrial Hygienist.
  - (1) Complete lack of written procedures indicates a major flaw in the respiratory protective program; such a program is not acceptable and appropriate citations shall be issued.
  - (2) Deficiencies in the written program which do not detract from the overall effectiveness of the program should be brought to the attention of the employer in the closing conference.
- c. If written procedures are established but not implemented, the citation should generally be based upon 29 CFR 1910.134(e)(1). However, if written procedures are established but do not cover the safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies, the citations should generally be based upon 29 CFR 1910.134(e)(3).

2. Proper Selection.

- a. A classification of respiratory hazards which relate to respirator selection may be found in Figure III-2. A guide for respirator selection is presented in Figure III-3. Respirator selection according to the type of hazard and appropriate approval schedules may be found in Figure III-4.
- b. In assessing whether an employer's procedures for the selection of respirators are adequate, the Industrial Hygienist shall:
  - (1) Determine the physical state(s) of the substance as it is encountered and listed in Figure III-3 and place it into one of the following general categories:

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- (a) Gas or vapor.
  - (b) Particulate (dust, mist, fume, smoke or fog).
  - (c) Combination of (a) and (b).
- (2) If it is available, assemble and record toxicological and other pertinent information for the particular contaminant including:
- (a) Permissible exposure limits.
  - (b) Exposure measurements.
  - (c) Oxygen deficiency.
- (3) Selectively examine a representative number of respirators being used to verify that proper selection of respirators has been made. If there is evidence of improper selection, the Industrial Hygienist shall record the type of respirator, manufacturer, model, contaminant and concentration, job description, name of employee, time, date, location and other information required in this chapter.
- (4) Compare air contaminant exposure measurements collected during the inspection to the protection factor for the respirator device. Protection factors (PFs) should be considered as an element in determining compliance with 29 CFR 1910.134(c).
- (a) A protection factor is the ratio of the ambient airborne concentration of the contaminant to the concentration of that contaminant inside the facepiece. It is a measure of the facepiece fit of a respirator based on quantitative respirator fit tests. The product of the PF and the permissible exposure limit (PEL) is the maximum use concentration (MUC).
  - (b) Figures III-5 and III-6 list the PFs for particulate filter respirators, chemical car-

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tridge respirators, gas masks, supplied-air respirators, and self-contained breathing apparatus.

- (c) For specific requirements of vinyl chloride, see 29 CFR 1910.1017; for asbestos, see 29 CFR 1910.1001; and for any substance regulated after the promulgation of vinyl chloride, see the specific standard or program directive.
- c. Figure III-7, adapted from ANSI Z88.2-1969, lists the restrictions and limitations of respirators. The following information should be considered when evaluating respirator use:
  - (1) Warning Properties.
    - (a) It is important to realize that 30 CFR 11, NIOSH/MSHA approvals for respirators generally do not apply to gases or vapors with poor warning properties except where the device is equipped with an end-of-service life indicator (e.g., carbon monoxide). However, OSHA standards may permit such a use for a specific gas or vapor.
    - (b) Warning properties dependant upon human senses are not foolproof. However, they do provide some indication to the employee of possible sorbent exhaustion, or of poor facepiece fit, or of other respirator malfunction.
      - 1 Warning properties include odor, eye irritation and respiratory irritation.
      - 2 Adequate warning properties can be assumed when the odor, taste, or irritation effects of the substance are detectable and persistent at concentrations at or below the PEL. (However, it must be realized that many substances cause olfactory fatigue and, therefore, cannot be considered to have adequate warning properties.)

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- (c) If the odor or irritation threshold of a substance occurs at concentrations many times greater than the PEL, this substance should be considered to have poor warning properties.
  - (d) If the odor or irritation threshold is somewhat above the PEL (but not in excess of three times the limit) and there is no ceiling limit, a determination should be made as to whether an undetected exposure in this concentration range could cause serious or irreversible health effects. (Refer to the Substance Toxicity Table of Chapter II.) If not, the substance is considered to have adequate warning properties. In such a situation, it is expected that environmental concentrations will vary considerably and; therefore, warning of respirator failure would soon be perceived at contaminant concentrations somewhat above the PEL.
- (2) Toxicity. Contaminants may also have too great a toxicity to allow the use of chemical cartridge respirators or gas masks (e.g., carcinogens without a specific OSHA standard allowing their use, hydrogen sulfide or nickel carbonyl).
- (a) These situations must be evaluated on a case-by-case basis and if, in the professional judgment of the Industrial Hygienist, a health hazard exists due to the high toxicity of the substance, the respirator shall be deemed to not "provide adequate respiratory protection against the particular hazard".
  - (b) Consultation shall be sought from the ARA for Technical Support and this consultation shall be documented in the case file.
- (3) Unapproved Respirators. Chemical cartridge respirators or gas masks shall be considered

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unacceptable or "unapproved" (i.e. a violation of 29 CFR 1910.134(b)(11)) for gaseous contaminants which have either inadequate warning properties or such a toxicity as described in the preceding paragraph (unless they have an end-of-service life indicator and are approved by NIOSH, or are specified by an OSHA standard).

- (4) Supplied-Air Respirators. If there are no chemical cartridge respirators or gas masks available which satisfy the requirements specified in paragraphs B.2.c.(1) and (2) supplied air respirators shall be required unless impractical (e.g., due to employee mobility).

(a) When supplied-air respirators are impractical an effective fit testing program must be ensured. (See paragraph B.3.)

(b) The Industrial Hygienist shall also determine the required frequency of cartridge or canister replacement which is dependent upon the breakthrough of the air contaminant. Consultation with the ARA for Technical Support may be necessary.

- (5) Quarter or half-mask chemical cartridge respirators should not be used to protect against any material present at concentrations which may be highly irritating to the eyes.

d. A violation involving proper selection shall include in the citation wording a description of the particular deficiency (e.g., the contaminant concentration was not evaluated during respirator selection, resulting in an insufficient protection factor).

3. Training and Fitting for the Employees.

- a. 29 CFR 1910.134(b)(3) requires that "the user be instructed and trained in the proper use of respirators and their limitations" and 1910.134(e)(5) requires that "the user be properly instructed in its selection, use and maintenance". According to ANSI this requires

training in the nature of the hazard (i.e. the resulting health effect from overexposure). If it is determined that the employee has not been trained in the nature of the hazard, the employer is not in compliance with this section.

- b. The training requirements of 29 CFR 1910.134(e)(5) and (e)(5)(i) include demonstrations on "... how the respirator should be worn, how to adjust it, and how to determine if it fits properly." 1910.134(e)(5) further requires that the respirator be worn in a "test atmosphere"; e.g., isoamyl acetate, or irritant smoke as part of the training. Quantitative fit testing would also meet this requirement.
- c. The Industrial Hygienist shall ask the employer and/or employee to demonstrate familiarity with the fitting technique and shall determine that the fitting has been performed properly.
- d. In evaluating whether an employer has taken precautions to ensure proper respirator fit, the Industrial Hygienist shall consider the following:
  - (1) Whether the employee wears the respirator as it was originally intended. All of the following shall be considered:
    - (a) The respirator and all functional parts including straps must be in place and worn in the appropriate positions.
    - (b) All straps shall be secure.
    - (c) Modification to the respirator or straps shall not be made; for example, replacing the straps with string or rubber bands indicates an ineffective respirator.
    - (d) Use of a facelet or a knitted covering over the rubber face seal voids the approval of the respirator.
  - (2) Whether the employee wearing the respirator tests it for fit each time it is worn.

- (a) In general, the manufacturer's instructions for fit test should be followed. These may include:

- 1 A Positive Pressure Test. Close the exhalation valve and exhale gently into the facepiece. The facepiece fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires that the wearer first remove the exhalation valve cover and then carefully replace it after the test.
- 2 A Negative Pressure Test. Close off the inlet opening of the canister or cartridge(s) by covering it with the palm of the hand(s) or by replacing the seal(s). Inhale gently so that the facepiece collapses slightly, and hold the breath for approximately 10 seconds. If the facepiece remains slightly collapsed, the fit of the respirator is considered satisfactory.

- (b) The Industrial Hygienist may use any established testing procedures to determine if the employee's respirator fits properly.

CAUTION: IRRITANT SMOKE TUBES MAY ONLY BE USED TO EVALUATE FACE SEAL WHEN HIGH-EFFICIENCY PARTICULATE CARTRIDGES ARE IN USE.

- (3) The Industrial Hygienist shall examine during the inspection, selected employees wearing the respirators to determine proper fitting.

4. Exclusive Employee Use. 29 CFR 1910.134(b)(4) states "Where practicable, the respirators should be assigned to individual workers for their exclusive use". Due to the general wording of this requirement, 29 CFR 1910.134(b) (4) will not be cited.

5. Cleaning and Disinfecting. 29 CFR 1910.134(b)(5) states "Respirators ... issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary." This is interpreted to apply only to those respirators that are "routinely used" throughout the day. Cleaning at a frequency less than each day is acceptable, if proper protection is still afforded to the employee.
6. Storage. The requirements of 29 CFR 1910.134(b)(6) are self-explanatory.
7. Inspection and Maintenance. The requirements of 29 CFR 1910.134(b)(7) are self-explanatory.
8. Work Area Surveillance. Although not specifically discussed in 29 CFR 1910.134(b)(8), the standard requires surveillance. This is interpreted to include identification of the contaminant, nature of the hazard, concentration at the breathing zone, and if appropriate, biological monitoring. (See ANSI Z38.2.) The Industrial Hygienist must carefully and fully document this hazard. Citations shall not be issued under this paragraph for minor deficiencies in a monitoring program, but they shall be brought to the attention of the employer and not cited.
9. Inspection and Evaluation of the Program.
  - a. Numerous factors affect the employee's acceptance of respirators including comfort, ability to breathe without objectionable effort, adequate visibility under all conditions, provisions for wearing prescription glasses, if necessary, ability to communicate, ability to perform all tasks without undue interference and confidence in the facepiece fit.
  - b. Failure to consider these factors is likely to reduce co-operation of the users in promoting a satisfactory program. How well these problems are resolved can be determined by employer observation of respirator users during normal activities and employer solicitation of employee comments.
  - c. In addition, under 29 CFR 1910.134(b)(9), regular inspections are required to ensure that respirators are

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properly selected, used, cleaned and maintained. If the employer is not making any effort to ensure that the respirator program is effective, by observing respirator use, soliciting user comments or conducting regular inspections, a citation shall be issued.

10. Medical Examination. 29 CFR 1910.134(b)(10) is an enforceable requirement of the standard. A citation may be issued under this paragraph if appropriate medical determinations have not been provided.

11. Approved Respirators.

- a. 29 CFR 1910.134(b)(11) states "Approved or accepted respirators shall be used when they are available." A respirator is approved as the whole unit with specific components.
- (1) Mixing of components between different types or makes of respirators nullifies the approval.
  - (2) The use of nonapproved components nullifies the approval.
  - (3) The use of an approved respirator in atmospheric concentrations for which it is not approved constitutes a violation.
  - (4) Observation by the Industrial Hygienist that one or more employees are working in the contaminated area above the PEL without approved respiratory protection establishes a violation.
  - (5) Use of nonapproved components such as incorrect hoses or regulators on self-contained breathing apparatus or air-line respirators may result in serious harm to the user due to possible malfunction of the system.
- b. In general, for air contaminants listed in 29 CFR 1910.1000, Tables Z-1 to Z-3, either joint Mine Safety and Health Administration (MSHA) and NIOSH, MSHA alone, or Bureau of Mines approved respirators are recognized by OSHA to be adequate.

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- (1) The Bureau of Mines approval schedule specifies that the following types of respirators are approved until the dates specified, if the respirator was purchased on or before June 30, 1975:

| <u>Expiration Date</u>                                                       | <u>Respirator Type</u>                                                                 |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Until March 31, 1979<br><del>NOTE: EXTENDING LABEL FURTHER<br/>PENDING</del> | For self-contained breathing apparatus approved under Bureau of Mines Schedule 13-13E. |
| Until March 31, 1980                                                         | For supplied-air respirators approved under Bureau of Mines Schedule 19B.              |

- (2) In addition, gas masks approved in accordance with Bureau of Mines Schedule 14F are approved until further notice. The approval for all other Bureau of Mines respirators has expired and shall not be considered approved.
- (3) Specific standards for particular compounds may specify MSHA/NIOSH approval.
- c. The approval schedules for Bureau of Mines approved respirators and the subparts of 30 CFR 11 for MSHA/NIOSH approved respirators are listed in Figure III-8. A description of labels and markings of approved respirators is given in the same figure and examples are given in Figures III-9 and III-10.
- d. To determine if a respirator is approved, identify the type of respirator by brand name and model number. An approval label is usually on the box or container or on the canister, or the approval can be found in "NIOSH Certified Equipment (NCE) List". An updated copy should be available in each Area Office.
- e. MSHA/NIOSH will provide a test schedule for any respirator against any specific contaminant. The use of unapproved respirators, even in special use situations, is unacceptable unless approval is pending before NIOSH.

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12. Special Procedures For Supplied-Air Respirators.

- a. The Industrial Hygienist shall inspect the sources of the supplied-air as follows:

- (1) Compressed breathing air shall meet the quality specification for grade D breathing air as described in "Compressed Gas Association Commodity Specification G-7.1-1966".

Oxygen Content (v/v) 19 - 23%  
(atmosphere air)

Balance predominately nitrogen

Hydrocarbon (Condensed) 5 mg/M<sup>3</sup>

Carbon monoxide 20 ppm

Carbon dioxide 1,000 ppm

- (2) Where the Industrial Hygienist feels it is necessary to check the quality of air, appropriate methods shall be used to check for carbon monoxide, carbon dioxide, hydrocarbons and oxygen. The results shall be recorded.

- b. The Industrial Hygienist must use professional judgment when evaluating the location of an air supply compressor. If the compressor is located in a contaminated atmosphere where the contaminants may enter the compressor, and there are no adequate filtering devices on the compressor, an ineffective supplied-air respirator program is indicated.

Figure III-1 -- Cross Reference Between 29 CFR 1910.134 -  
ANSI Standard Z88.2-1969

| 1910.134<br>Section |          | Z88.2-1969<br>Chapter and Section |
|---------------------|----------|-----------------------------------|
| (a)                 | (1)      | 3.2                               |
|                     | (2)      | 3.3                               |
|                     | (3)      | 3.4.1                             |
| (b)                 | (1)      | 3.5.1                             |
|                     | (2)      | 3.5.2                             |
|                     | (3)      | 3.5.3                             |
|                     | (4)      | 3.5.4                             |
|                     | (5)      | 3.5.5                             |
|                     | (6)      | 3.5.6                             |
|                     | (7)      | 3.5.7                             |
|                     | (8)      | 3.5.8                             |
|                     | (9)      | 3.5.9                             |
|                     | (10)     | 3.7                               |
|                     | (11)     | 3.8                               |
| (c)                 |          | 6                                 |
| (d)                 | (1)      | 5.3 and 6.3.2.2                   |
|                     | (2) (i)  | 5.3                               |
|                     | (3) (ii) | 5.3 and 6.3.2.2                   |
|                     | (4)      | 5.3                               |
| (e)                 | (1)      | 7.1                               |
|                     | (2)      | 7.2                               |
|                     | (3)      | 7.3                               |
|                     | (3) (i)  | 7.3                               |
|                     | (ii)     | 6.3.2.1                           |
|                     | (iii)    | 6.3.2.2                           |
|                     | (4)      | 10.3                              |
|                     | (5)      | 7.4                               |
|                     | (5) (i)  | 7.5                               |
|                     | (ii)     | 9.1                               |
|                     | (iii)    | 9.2                               |
| (f)                 | (1)      | 8.1                               |
|                     | (2) (i)  | 8.2                               |
|                     | (ii)     | 8.2                               |
|                     | (iii)    | 8.2                               |
|                     | (iv)     | 8.2                               |
|                     | (3)      | 8.3                               |
|                     | (4)      | 8.4                               |
|                     | (5) (i)  | 8.5                               |
|                     | (ii)     | 8.5                               |
|                     | (iii)    | 8.5                               |

Source: ANSI Standard K13.1-1967 "American National Standard  
Identification of Gas Mask Canisters."

Figure III-2 -- Classification Of Respiratory Hazards According To  
Their Properties Which Influence Respirator Selection

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Gas Or Vapor Contaminants

**Inert:** They do not react with other substances under most conditions and create a respiratory hazard by displacing air and producing oxygen deficiency (for example, helium, neon, argon).

**Acidic:** Substances that are acids or that react with water to produce an acid. In water they produce positively charged hydrogen ions. They taste sour and many are corrosive to tissues (for example, hydrogen chloride, sulfur dioxide, fluorine, nitrogen dioxide, acetic acid, carbon dioxide, hydrogen sulfide, and hydrogen cyanide).

**Alkaline:** Substances that are alkalis or that react with water to produce an alkali. When in water solutions, they result in the production of negatively charged hydroxyl ion (OH<sup>-</sup>). They taste bitter, and many are corrosive to tissues (for example, ammonia, amines, phosphine, arsine, and stibine).

**Organic:** These are the compounds of carbon. Examples are saturated hydrocarbons (methane, ethane, butane), unsaturated hydrocarbons (ethylene, acetylene), alcohols (methyl alcohol,

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Particulate Contaminants

Particles are produced by mechanical means by the disintegration processes of grinding, crushing, drilling, blasting and spraying; or by the physiochemical reactions such as combustion, vaporization, distillation, sublimation, calcination, and condensation. Particles are classified as follows:

**Dust:** A solid mechanically produced particle with sizes varying from sub-microscopic to visible or macroscopic.

**Spray:** A liquid mechanically produced particle with size generally in the visible or macroscopic range.

**Fume:** A solid condensation particle of extremely small particle size, generally less than one micron in diameter.

**Mist:** A liquid condensation particle with sizes ranging from submicroscopic to visible or macroscopic.

**Fog:** A mist of sufficient concentrate to perceptibly obscure vision.

**Smoke:** A system which includes the products of incomplete combustion of

Figure III-2 --Classification Of Respiratory Hazards According To  
Their Properties Which Influence Respirator Selection--Continued

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Gas Or Vapor Contaminants

---

Particulate Contaminants

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propyl alcohol), ethers (methyl ether, ethyl ether), aldehydes (formaldehyde), ketones (dimethyl ketone), organic acids (formic acid, acetic acid), halides (chloroform, carbon tetrachloride), amides (formamide, acetamide), nitriles (acetonitrile), isocyanates (toluene diisocyanate), amines (methylamine), epoxies (epoxyethane, propylene oxide), and aromatics (benzene, toluene, xylene).

Organometallic: Compounds in which metals are chemically bonded to organic groups (for example, ethyl silicate, tetraethyl lead, and organic phosphates).

Hydrides: Compounds in which hydrogen is chemically bonded to metals and certain other elements (for example, diborane and lithium hydride).

organic substances in the form of solid and liquid particles and gaseous products in air. Smoke is usually of sufficient concentration to perceptibly obscure vision.

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Source:

ANSI Z89.2-1969, "Practices for Respiratory Protection".

Figure III-3 -- Guide For The Selection Of Respirators

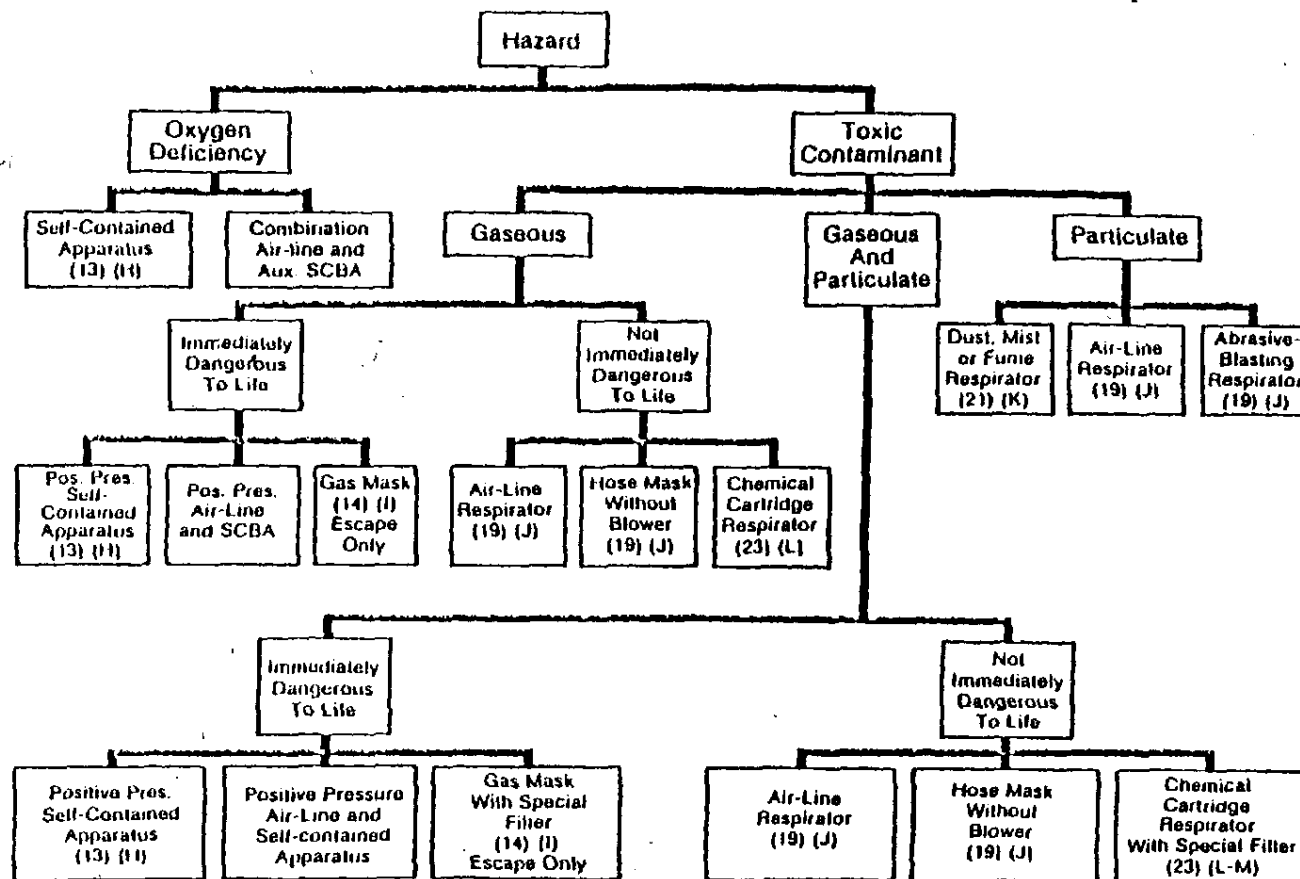
| Hazard                                       | Respirator                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>GAS OR VAPOR CONTAMINANTS</b>             |                                                                                                                                                                                                                                                                                                                      |
| Oxygen Deficiency                            | Self-contained breathing apparatus.<br>Combination air-line respirator with auxiliary positive pressure self-contained air supply.                                                                                                                                                                                   |
| Immediately dangerous to life or health      | Self-contained breathing apparatus in positive pressure mode.<br>Air-purifying, full facepiece respirator with chemical canister (gas mask) for escape only.<br>Self-rescue mouth piece respirator (for escape only).<br>Combination air-line respirator with auxiliary positive pressure self-contained air supply. |
| Not immediately dangerous of life or health  | Air-line respirator<br>Air-purifying, half-mask or full facepiece respirator with chemical cartridge(s) or canister.                                                                                                                                                                                                 |
| <b>PARTICULATE CONTAMINANTS</b>              |                                                                                                                                                                                                                                                                                                                      |
| Immediately dangerous to life or health      | Self-contained breathing apparatus in positive pressure mode.<br>Air-purifying, full facepiece respirator with appropriate filter (for escape only).<br>Self-rescue mouthpiece respirator (for escape only).<br>Combination air-line respirator with auxiliary positive pressure self-contained air supply.          |
| Not immediately dangerous to life or health. | Air-purifying, half-mask or full facepiece respirator with filter pad or cartridge(s).<br>Air-line respirator.<br>Air-line abrasive-blasting respirator.                                                                                                                                                             |

Figure III-3 --Guide For The Selection Of Respirators--Continued

| Hazard                                               | Respirator                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| COMBINATION GAS, VAPOR, AND PARTICULATE CONTAMINANTS |                                                                                                                                                                                                                                                                                                                                                       |
| Immediately dangerous to life or health              | Self-contained breathing apparatus in positive pressure mode.<br>Air-purifying full facepiece respirator with chemical canister and appropriate filter (gas mask with filter for escape only).<br>Self-rescue mouthpiece respirator (for escape only).<br>Combination air-line respirator with auxiliary positive pressure self-contained air supply. |
| Not immediately dangerous to life or health.         | Air-line respirator.<br>Air-purifying, half-mask or full facepiece respirator with chemical cartridge or canister and appropriate filter.                                                                                                                                                                                                             |

Source: ANSI Z88.2-1969 "Practices for Respiratory Protection".

Figure III - 4 Outline for selecting respiratory protective devices.



\* Based on Bureau of Mines Information Circular 7792

Numbers in parentheses refer to Bureau of Mines Schedules, letters in parentheses refer to Subpart of NIOSH/MESA 30 CFR Part 11.

Figure III-5 -- Protection Factors For Particulate Filter Respirators

| Concentrations in multiples of permissible exposure limits   | Facepiece Pressure | Permissible respirators                                                                       |
|--------------------------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------|
| 5 X                                                          | -                  | Single use dust                                                                               |
|                                                              | -                  | Quarter-mask dust                                                                             |
| 10 X                                                         | -                  | Half mask dust                                                                                |
|                                                              | -                  | Half- or quarter mask, fume                                                                   |
|                                                              | -                  | Half- or quarter mask, high-efficiency                                                        |
|                                                              | -                  | Half-mask supplied air                                                                        |
| 50 X                                                         | -                  | Full facepiece, high-efficiency                                                               |
|                                                              | -                  | Full facepiece, supplied air                                                                  |
|                                                              | -                  | Self-contained breathing apparatus (SCBA)                                                     |
| 1,000 X                                                      | +                  | Powered, high-efficiency, all enclosures                                                      |
|                                                              | +                  | Half-mask, supplied air, Type C positive pressure, demand mode                                |
| 2,000 X                                                      | +                  | Supplied air with full facepiece, hood, helmet or suit, Type C positive pressure, demand mode |
| 10,000 X                                                     | +                  | Full facepiece, SCBA                                                                          |
|                                                              | +                  | Full facepiece supplied air and auxiliary self-contained air supply                           |
| Emergency entry into unknown concentrations or firefighting. | +                  | Full facepiece SCBA                                                                           |
| Escape only <u>1/</u>                                        | +                  | Any SCBA                                                                                      |
|                                                              | -                  | Any self rescuer                                                                              |

1/ In an atmosphere which is immediately dangerous to life or health.

NOTES: 1. Half-mask and quarter-mask respirators should not be used if the particulate matter causes eye irritation at the use concentrations.

2. Full facepiece supplied-air respirators should not be used in any atmosphere which is immediately dangerous to life or health unless it is equipped with an auxiliary air supply which can be operated in the positive pressure.

Source: "Respirator Protection Factors," E. Hyatt. Los Alamos Scientific Laboratory Publication LA - 6084-MS, January, 1976.

Figure III-6 -- Protection Factors For Gases Or Vapors Respirators

| Concentrations in multiples of permissible exposure limits   | Facepiece Pressure | Permissible respirators                                                                                                                 |
|--------------------------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 10 X                                                         | -                  | Quarter or half-mask chemical cartridge respirator with "Name" cartridges or canister half mask, supplied-air                           |
| 50 X                                                         | -                  | Full facepiece gas mask or chemical cartridge with "Name" cartridges or canister.<br>Full facepiece SCBA<br>Full facepiece supplied-air |
| 1,000 X                                                      | +                  | Half-mask supplied-air                                                                                                                  |
| 2,000 X                                                      | +                  | Supplied-air with full facepiece, hood, helmet or suit                                                                                  |
| 10,000 X                                                     | +                  | Full facepiece, SCBA<br>Full facepiece supplied air with auxiliary self-contained air supply                                            |
| Emergency entry into unknown concentrations or firefighting. | +                  | Full facepiece SCBA                                                                                                                     |
| Escape only <u>1/</u>                                        | +                  | Any full facepiece SCBA                                                                                                                 |
|                                                              | -                  | Gasmask with a "Name" canister                                                                                                          |
|                                                              | -                  | Any self-rescuer                                                                                                                        |

1/ In an atmosphere which is immediately dangerous to life or health.

NOTES: 1. The "Name" means approved chemical canisters or cartridges against a specific contaminant or a combination of contaminants such as organic vapor, acid gases, organic vapor plus particulates or acid gases plus organic vapor.

2. Quarter or half-mask respirators should not be used if eye irritation occurs at the use concentration.

3. Full facepiece supplied air respirators should not be used in any atmosphere which is immediately dangerous to life or health unless it is equipped with an auxiliary air tank which can be operated in the positive pressure mode.

Source: "Respirator Protection Factors," E. Haytt, Los Alamos Scientific Laboratory Publication LA-6084-MS, January, 1976.

Figure III-7 -- Capabilities And Limitations Of Respirators

Atmosphere-Supplying Respirators

Air-Purifying Respirators

(See 5.3 for specifications on respirable atmospheres.)

Atmosphere-supplying respirators provide protection against oxygen deficiency and most toxic atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions.

General Limitations: Except for the supplied-air suit, no protection is provided against skin irritation by materials such as ammonia and HCl, or against sorption of materials such as HCN, tritium, or organic phosphate pesticides through the skin. See 6.3.5.1. Facepieces present special problems to individuals required to wear prescription lenses (see 9.1 and 9.2).

Self-Contained Breathing Apparatus (SCBA)

The wearer carries his own breathing atmosphere. Use is permissible in atmospheres immediately dangerous to life or health.

Limitations: The period over which the device will provide protection is limited by the amount of air or oxygen in the apparatus, the ambient atmospheric pressure (service life is cut in half by a doubling of the atmospheric pressure), and work load. A warning device shall be provided to indicate to the wearer when the service life has been reduced to a low level. Some SCBA devices have a short service life (few minutes) and are suitable only for

Hose Mask or Air-Line Respirator

The respirable air supply is not limited to the quantity the individual can carry, and the devices are light weight and simple.

Limitations: The wearer is restricted in movement by the hose or air-line and must return to a respirable atmosphere by retracing his route of entry. The hose or air-line is subject to being severed or pinched off.

(1) Hose Mask

(a) Hose mask with blower. If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation. Use is permissible in atmospheres immediately dangerous to life or health.

General limitations: Air-purifying respirators do not protect against oxygen-deficient atmospheres nor against skin irritation by, or sorption through the skin of, airborne contaminants. See 6.3.1. and 6.3.5.1.

The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the designed efficiency and capacity of the cartridge, canister, or filter. For gases and vapors and for particles having a TLV of less than 0.1 mg/M<sup>3</sup>, the maximum concentration for which the air-purifying unit is designed is specified on the label. Respirators without a blower to maintain a constant positive pressure within the facepiece will not provide the maximum design protection specified unless the facepiece is carefully fitted to the wearer's face to prevent inward leakage. See 7.5. The time period over which protection is provided is dependent on canister, cartridge, or filter type, concentration of contaminant, and the wearer's respiratory rate.

The proper type of canister, cartridge, or filter shall be selected for the particular atmosphere and conditions. Air-purifying respirators generally cause discomfort and objectionable resistance to breathing although these problems are minimized in blower-operated units. Respirator facepieces present special problems to individuals required to wear prescription lenses. (See 9.1 and 9.2.) These devices do have the advantage of being small, light, and simple in operation. Gas- and Vapor-Removing Respirators Particulate-Removing Respirators

Additional Limitations: No protection is provided against particulate contaminants, specified on the canister or cartridge label. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air. This is not a reliable indi-

Additional Limitations: Protect against non-volatile particles only. No protection against gases or vapors. The filter shall be replaced or cleaned when breathing becomes difficult due to plugging by retained particles.

Floure III-7 -- Capabilities And Limitations Or Respirators--Continued

- Atmosphere-Supplying Respirators

Air-Purifying Respirators

escape (self-rescue) from an irrespirable atmosphere. Chief limitations of SCBA devices are their weight or bulk or both, limited service life, and the training required for their maintenance and safe use.

(1) Closed-circuit SCBA

The closed circuit operation conserves oxygen and permits longer service life.

(2) Open-circuit SCBA -demand and pressure-demand.

The demand type produces a negative pressure in the facepiece on inhalation whereas the pressure-demand type maintains a positive pressure in the facepiece and is less apt to permit inward leakage of contaminants.

(b) Hose mask without blower. Limited to use in atmospheres from which the wearer can escape unharmed without aid of the respirator.

(2) Air-Line Respirators (Continuous-Flow, Demand and Pressure-Demand Types)

The demand type produces a negative pressure in the facepiece on inhalation whereas continuous flow and pressure-demand types maintain a positive pressure in the facepiece at all times and are less apt to permit inward leakage of contaminants.

Limitations: Air-line respirators are limited to use in atmospheres not immediately dangerous to life or health except under conditions specified in 6.3.2 and 7.3. Air-line respirators provide no protection if the air supply fails.

(3) Supplied Air-Suit

These suits protect against atmospheres that affect the skin or mucous membranes or that may be absorbed through the unbroken skin.

Limitations: Some contaminants, such as tritium, may penetrate the suit material and limit its effectiveness. Other conta-

cator of canister performance. An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

(1) Full Facepiece Respirator (Gas Mask)  
 Should avoid use in atmospheres immediately dangerous to life or health if the contaminant(s) lacks sufficient warning properties (that is, odor or irritation).

(2) Half-mask Respirator (Chemical Cartridge Respirator)

Shall not use in atmospheres immediately dangerous to life or health and should be limited to low concentrations of gases and vapors. A fabric covering shall not be worn on the facepiece since it will permit gases and vapors to pass.

No protection is provided for the eyes.

(3) Mouthpiece Respirator (Chemical Cartridge)

Shall not be used in atmospheres immediately dangerous to life or health. Mouth breathing prevents detection of contaminants by odor. The nose clip shall be securely in place to prevent nasal breathing.

No protection is provided to the eyes.

These respirators shall not be used during shot and sand blasting operations. Abrasive-blasting respirators shall be used.

(1) Full Facepiece Respirator

Should avoid use in atmospheres immediately dangerous to life or health if the contaminant(s) lacks sufficient warning properties (that is, odor or irritation).

(2) Half-Mask Respirator

Shall not be used in atmospheres immediately dangerous to life or health. A fabric covering on the facepiece is permissible only in atmospheres of coarse dusts and mists of low toxicity.

No protection is provided for the eyes.

(3) Mouthpiece Respirator (Filter)

Shall not be used in atmospheres immediately dangerous to life or health. Mouth breathing prevents detection of contaminants by odor. The nose clip shall be securely in place to prevent nasal breathing.

No protection is provided to the eyes from irritating aerosols.

Figure III-7 -- Capabilities And Limitations Of Respirators--Continued

| Atmosphere-Supplying Respirators                                                                                                                                                                                                                                                                                                                                                   | Air-Purifying Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>minants, such as fluorine, may react chemically with the suit material and damage it. See 6.3.5.1.</p> <p>These suits are limited in use to atmospheres not immediately dangerous to life or health except under the conditions specified in 6.3.2 and 7.3.</p>                                                                                                                 | <p>(4) Self-Rescue Mouthpiece Respirator (Filter)<br/>       Designed for self-rescue from immediately dangerous atmospheres of gases and vapors. Mouth breathing prevents detection of contaminants by odor. The nose clip shall be securely in place to prevent nasal breathing. No protection is provided to the eyes.</p> <p>(4) Self-Rescue Mouthpiece Respirator (Filter)<br/>       Designed for self-rescue from atmospheres having immediately dangerous concentrations of toxic particles. Mouth breathing prevents detection of contaminants by odor. The nose clip shall be securely in place to prevent nasal breathing. No protection is provided to the eyes from irritating aerosols.</p> |
| <p>Combination Self-Contained and Air-Line Respirators</p>                                                                                                                                                                                                                                                                                                                         | <p>Combination Particulate and Vapor- and Gas-Removing Respirators</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p>The equipping of an air-line respirator with a small cylinder of compressed air to provide an emergency air supply qualifies the respirator for use in immediately dangerous atmospheres. See 6.3.2.</p>                                                                                                                                                                        | <p>The advantages and disadvantages of the component parts of the combination respirator as described above will apply.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <p>Combination Atmosphere-Supplying and Air-Purifying Respirators</p>                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>The advantages and disadvantages, expressed above, of the mode of operation being used will govern. The mode with the greater limitations (air-purifying mode) will mainly determine the overall capabilities and limitations of the respirator since the wearer may for some reason fail to change the mode of operation even though conditions would require such change.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

NOTE: Only positive pressure atmosphere-supplying respirators (SCBA or supplied-air plus SCBA) can be used in an atmosphere which is immediately dangerous to life or health.

Source: ANSI Z88.2-1969, "Practices for Respiratory Protection".

Figure III-8 --The Approved Respirator

| Type Device                                  | Bureau of Mines Approval |                        | 30 CFR Part 11 Approval |                        |
|----------------------------------------------|--------------------------|------------------------|-------------------------|------------------------|
|                                              | Schedule No.             | Markings <sup>1/</sup> | Subpart                 | Markings <sup>2/</sup> |
| Self-contained breathing apparatus           | 13, Mar. 5, 1919         | BM-13-XXX              | H                       | TC-13F-XX              |
|                                              | 13A, Jan. 21, 1930       | BM-13A-XXX             |                         |                        |
|                                              | 13B, Aug. 12, 1935       | BM-13B-XXX             |                         |                        |
|                                              | 13C, Jul. 9, 1946        | BM-13C-XXX             |                         |                        |
|                                              | 13D, Sept. 22, 1956      | BM-13D-XXX             |                         |                        |
|                                              | 13E, Jul. 19, 1968       | BM-13E-XXX             |                         |                        |
| Gas masks                                    | 14F, Apr. 23, 1955       | BM-14F-XXX             | I                       | TC-14G-XX              |
| Supplied-air respirators                     | 19B, Apr. 19, 1955       | BM-19B-XXX             | J                       | TC-19C-XX              |
| Filter type dust, fume, and mist respirators | 21B, Jan. 19, 1965       | BM-21B-XXX             | K                       | TC-21C-XX              |
| Chemical cartridge respirators               | 23B, Aug. 4, 1959        | BM-23B-XXX             | L                       | TC-23C-XX              |
| Pesticide respirators                        | (No previous schedules)  |                        | M                       | TC-23C-XX              |
| Special use respirators                      | (No previous schedules)  |                        | N                       | TC-14G-XX<br>TC-23C-XX |

<sup>1/</sup> Usually found on the facepiece and on the approval label.

<sup>2/</sup> Found on the approval label only.

NOTE: See attachment.

Figure III-8 --Continued

Description of Labels and Markings of Approved Respirators

30 CFR 11.33 1/

(b) Approval labels shall bear the emblem of the Mine Safety and Health Administration (MSHA and/or the Mining Enforcement and Safety Administration and/or U.S. Bureau of Mines) and the seal of the Department of Health, Education and Welfare, the applicant's name and address, an approval number assigned by the Institute, and, where appropriate, restrictions or limitations placed upon the use of the respirator by the MSHA and the Institute (NIOSH). The approval number assigned by the Institute shall be designated by the prefix TC and a serial number.

(c) MSHA and the Institute shall, where necessary, notify the applicant when additional labels, markings, or instructions will be required.

(d) Approval labels and markings shall only be used by the applicant to whom they were issued.

(e) Legible reproductions or abbreviated forms of the label approved by MSHA and the Institute for use on each respirator shall be attached to or printed at the following locations:

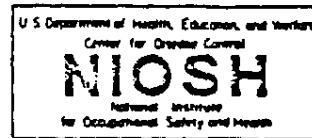
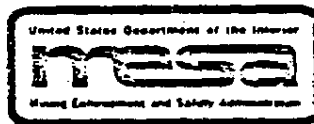
| <u>Respirator Type</u>                                          | <u>Label Type</u>         | <u>Location</u>                                                                                                                           |
|-----------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Self-contained breathing apparatus                              | Entire                    | Harness assembly and canister (where applicable).                                                                                         |
| Gas Mask                                                        | Entire                    | Mask container and canister.                                                                                                              |
| Supplied-air respirator                                         | Entire                    | Respirator container or instruction card.                                                                                                 |
| Dust, fume and mist respirator                                  | Entire<br>Abbreviated.    | Respirator container and filter container.<br>Filters.                                                                                    |
| Chemical-cartridge respirator, including paint spray respirator | Entire<br><br>Abbreviated | Respirator container, cartridge container, and filter containers (where applicable).<br><br>Cartridges and filters and filter containers. |
| Pesticide respirator                                            | Entire<br><br>Abbreviated | Respirator container, and cartridge and filter containers.<br><br>Cartridges and filters.                                                 |

(f) The use of any MSHA and NIOSH approval label obligates the applicant to whom it is issued to maintain or cause to be maintained the approved quality control sampling schedule and the acceptable level for each characteristic tested, and to assure that it is manufactured according to the drawings and specifications upon which the certificate of approval is based.

Source: 1/ Federal Register, March 25, 1972.

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**PERMISSIBLE  
SUPPLIED-AIR RESPIRATOR  
TYPE CE  
CONTINUOUS-FLOW CLASS**



**MINING ENFORCEMENT AND SAFETY ADMINISTRATION  
NATIONAL INSTITUTE FOR OCCUPATIONAL  
SAFETY AND HEALTH**

**APPROVAL NO. TC-19C-108**

**ISSUED TO  
MINE SAFETY APPLIANCES COMPANY  
Pittsburgh, Pennsylvania, U.S.A.**

**LIMITATIONS**

Approved for respiratory protection in any atmosphere not immediately dangerous to life or health and from which the wearer can escape without the aid of the respirator. This approval applies only when the respirator is supplied with respirable air through 15 to 50 feet of hose within the pressure range of 16 to 20 pounds per square inch as specified by the manufacturer.

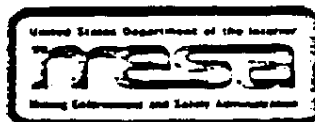
**CAUTION**

This respirator must not be worn in any atmosphere immediately dangerous to life or health. Follow the manufacturer's instructions for providing a supply of respirable air.

In making renewals or repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained.

This respirator shall be selected, fitted, used, and maintained in accordance with Mining Enforcement and Safety Administration, Occupational Safety and Health Administration, and other applicable regulations.

**PERMISSIBLE  
CHEMICAL-CARTRIDGE RESPIRATOR  
FOR  
ORGANIC VAPORS AND PAINT, LACQUER, AND ENAMEL MISTS**



**MINING ENFORCEMENT AND SAFETY ADMINISTRATION  
NATIONAL INSTITUTE FOR OCCUPATIONAL  
SAFETY AND HEALTH**

**APPROVAL NO. TC-23C-201**

**ISSUED TO  
MINE SAFETY APPLIANCES COMPANY  
Pittsburgh, Pennsylvania, U.S.A.**

**LIMITATIONS**

Approved for respiratory protection against (1) mists of paints, lacquers, and enamels, (2) not more than 1,000 parts per million organic vapors by volume, or (3) any combination thereof.

Not for use in atmospheres containing less than 19.5 percent oxygen. Do not wear for protection against organic vapors with poor warning properties or those which generate high heats of reaction with sorbent material in the cartridge. Maximum use concentrations will be lower than 1,000 parts per million where that concentration of organic vapors produces atmospheres immediately dangerous to life or health.

**CAUTION**

In making renewals or repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained.

This respirator shall be selected, fitted, used, and maintained in accordance with Mining Enforcement and Safety Administration, Occupational Safety and Health Administration, and other applicable regulations.

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## APPENDIX C

### JOINT NIOSH/OSHA STANDARDS COMPLETION PROGRAM

#### RESPIRATOR DECISION LOGIC

18 AUGUST 1975

##### I. INTRODUCTION

THE PURPOSE OF THE RESPIRATOR DECISION LOGIC IS TO ASSURE TECHNICAL ACCURACY AND UNIFORMITY BETWEEN SUBSTANCES IN THE SELECTION OF RESPIRATORS AND TO PROVIDE NECESSARY CRITERIA TO SUPPORT THIS SELECTION. THE DECISION LOGIC IS A STEP-BY-STEP ELIMINATION OF INAPPROPRIATE RESPIRATORS UNTIL ONLY THOSE WHICH ARE ACCEPTABLE REMAIN. JUDGEMENT BY PERSONS KNOWLEDGEABLE OF INHALATION HAZARDS AND RESPIRATORY PROTECTION EQUIPMENT IS ESSENTIAL TO ENSURE APPROPRIATE SELECTION OF RESPIRATORS.

THE PRIMARY TECHNICAL CRITERIA FOR WHAT CONSTITUTES A PERMISSIBLE RESPIRATOR IS BASED ON THE TECHNICAL REQUIREMENTS OF 30 CFR PART 11 (DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, RESPIRATORY PROTECTIVE DEVICES AND TESTS FOR PERMISSIBILITY). THE PROPOSED SUBSTANCE HEALTH STANDARDS WILL ALLOW ONLY RESPIRATORS APPROVED BY THE BUREAU OF MINES (OR MINING ENFORCEMENT AND SAFETY ADMINISTRATION (MESA)) AND NIOSH UNDER 30 CFR 11.

PROTECTION FACTORS ARE CRITERIA USED IN DETERMINING WHAT LIMITING CONCENTRATIONS ARE TO BE PERMITTED FOR EACH RESPIRATOR TYPE THAT WILL AFFORD ADEQUATE PROTECTION TO THE WEAKER. THE REFERENCED SUBPARTS OF 30 CFR 11 GIVE TECHNICAL DESCRIPTIONS CONCERNING EACH TYPE OR CLASS OF RESPIRATORS REFERENCED IN THE DECISION LOGIC. 30 CFR 11 SHOULD BE USED WITH THE DECISION LOGIC IN ORDER TO PROPERLY UNDERSTAND THE CRITERIA FOR THE SPECIFICATION OF ALLOWABLE RESPIRATORS.

##### II. GENERAL DECISION LOGIC FLOWCHART

###### STEP 1 - ASSEMBLE INFORMATION ON SUBSTANCE

ASSEMBLE NECESSARY TOXICOLOGICAL SAFETY, AND RESEARCH INFORMATION FOR THE PARTICULAR CONTAMINANT. TYPICALLY THE FOLLOWING ARE REQUIRED:

- 1) PERMISSIBLE EXPOSURE LIMITS SPECIFIED IN 29 CFR 1910.1000 (TABLES Z-1, Z-2, AND Z-3). THESE ARE THE FORMER 29 CFR 1910.93 TABLES.
- 2) WARNING PROPERTIES IF THE SUBSTANCE IS A GAS OR A VAPOR. REFER TO PART IV(B) OF THIS LOGIC.
- 3) EYE IRRITATION POTENTIAL OF THE SUBSTANCE. REFER TO PART IV(D) OF THIS LOGIC.
- 4) LFL (LOWER FLAMMABLE LIMIT) FOR THE SUBSTANCE. REFER TO PART IV(F) OF THIS LOGIC.
- 5) IDLM CONCENTRATION FOR THE SUBSTANCE. REFER TO PART IV(E) OF THIS LOGIC.
- 6) POSSIBILITY OF POOR CURRENT EFFICIENCY AT IDLM CONCENTRATION AND BELOW. REFER TO PART IV(C) OF THIS LOGIC.

7) ANY EVIDENCE OF POSSIBLE SYSTEMIC INJURY OR DEATH RESULTING FROM ABSORPTION OF THE SUBSTANCE (AS A GAS OR VAPOR) THROUGH THE SKIN. REFER TO PART IV(A) OF THIS LOGIC.

8) THE VAPOR PRESSURE OF THE SUBSTANCE (AND EQUIVALENT PPM).

STEP 2 - DETERMINE PHYSICAL STATE OF SUBSTANCE.

DETERMINE THE PHYSICAL STATE(S) OF THE SUBSTANCE AS IT IS LIKELY TO BE ENCOUNTERED IN THE OCCUPATIONAL ENVIRONMENT. IT WILL BE EITHER:

- A) GAS OR VAPOR,
- B) PARTICULATE (DUST, FUME OR MIST), OR
- C) COMBINATION OF (A) AND (B).

STEP 3 - ASSEMBLE A TABLE OF PERMISSIBLE RESPIRATORY PROTECTION FOR SUBSTANCE

THIS IS DONE USING THE MATERIAL FROM STEP 1 AND THE APPROPRIATE SPECIFIC DECISION LOGIC CHART FROM PART III OF THIS LOGIC AND THE RESPIRATOR PROTECTION FACTORS IN APPENDIX I.

III.A. SPECIFIC DECISION LOGIC CHART FOR RESPIRATORY PROTECTION AGAINST GASES OR VAPORS

| <u>CONDITION</u>                             | <u>SELECTION SEQUENCE</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ROUTINE USE                                  | <ul style="list-style-type: none"> <li>A) CONSIDER SKIN ABSORPTION - (SEE IV A),</li> <li>B) PPM WARNING PROPERTIES - ELIMINATE ALL AIR PURIFYING RESPIRATORS (SEE IV B),</li> <li>C) EYE IRRITATION - ELIMINATE OR RESTRICT USE OF HALF MASK RESPIRATOR (SEE IV D),</li> <li>D) IDLH OR LFL - ABOVE THIS CONCENTRATION ELIMINATE ALL BUT POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS AND COMBINATION POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SEE IV E AND F),</li> <li>E) LIST ALL ALLOWED RESPIRATORS BY CONDITION OF USE AND TYPE.</li> </ul> |
| ENTRY AND ESCAPE FROM UNKNOWN CONCENTRATIONS | USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS OR COMBINATION POSITIVE PRESSURE SUPPLIED AIR RESPIRATOR WITH POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS.                                                                                                                                                                                                                                                                                                                                                                                            |
| FIREFIGHTING                                 | USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| ESCAPE                                       | GAS MASK OR ESCAPE SELF-CONTAINED BREATHING APPARATUS (SEE IV C).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

III.B. SPECIFIC DECISION LOGIC CHART FOR RESPIRATORY PROTECTION AGAINST PARTICULATES

| <u>CONDITION</u> | <u>SELECTION SEQUENCE</u>                                                                                                                                                              |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ROUTINE USE      | <ul style="list-style-type: none"> <li>A) CONSIDER SKIN ABSORPTION - (SEE IV A),</li> <li>B) EYE IRRITATION - ELIMINATE OR RESTRICT USE OF HALF MASK RESPIRATOR (SEE IV D),</li> </ul> |

- C) SYSTEMIC POISON - ELIMINATE SINGLE-USE RESPIRATOR.
- D) FOR PERMISSIBLE EXPOSURE LESS THAN 0.05 MG/CU.M. - ELIMINATE OPM RESPIRATORS EXCEPT WITH HIGH EFFICIENCY PARTICULATE FILTER.
- E) IDLM OR LFL - ABOVE THIS CONCENTRATION ELIMINATE ALL BUT POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS AND COMBINATION POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SEE IV E).
- F) LIST ALL ALLOWED RESPIRATORS BY CONDITION OF USE AND TYPE.

ENTRY AND ESCAPE FROM  
UNKNOWN CONCENTRATION

USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS OR COMBINATION POSITIVE PRESSURE SUPPLIED AIR RESPIRATOR WITH POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS.

FIREFIGHTING

USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SEE IV F).

### III.C. SPECIFIC DECISION LOGIC CHART FOR RESPIRATORY PROTECTION AGAINST COMBINATION OF GAS OR VAPOR AND PARTICULATES

| <u>CONDITION</u>                               | <u>SELECTION SEQUENCE</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ROUTINE USE                                    | <ul style="list-style-type: none"> <li>A) CONSIDER SKIN SORPTION - (SEE IV A).</li> <li>B) POOR WARNING PROPERTIES OR INADEQUATE SORBENT EFFICIENCY - ELIMINATE ALL AIR PURIFYING RESPIRATORS (SEE IV B &amp; C).</li> <li>C) ELIMINATE ALL RESPIRATORS EXCEPT WITH COMBINATION SORBENT/PARTICULATE FILTER.</li> <li>D) EYE IRRITATION - ELIMINATE OR RESTRICT USE OF HALF MASK RESPIRATOR (SEE IV D).</li> <li>E) FOR PERMISSIBLE EXPOSURES LESS THAN 0.05 MG/CU.M. - ELIMINATE ALL RESPIRATORS EXCEPT WITH SORBENT/HIGH EFFICIENCY PARTICULATE FILTER.</li> <li>F) IDLM OR LFL - ABOVE THIS CONCENTRATION ELIMINATE ALL BUT POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS AND COMBINATION POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SEE IV E).</li> <li>G) LIST ALL ALLOWED RESPIRATORS BY CONDITION OF USE AND TYPE.</li> </ul> |
| ENTRY AND ESCAPE FROM<br>UNKNOWN CONCENTRATION | USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS OR COMBINATION POSITIVE PRESSURE SUPPLIED AIR RESPIRATOR WITH POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| FIREFIGHTING                                   | USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SEE IV F).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| ESCAPE                                         | GAS MASK OR ESCAPE SELF-CONTAINED BREATHING APPARATUS (SEE IV C).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

#### IV. 1. SKIN ABSORPTION

PERSONAL PROTECTION REQUIREMENTS FOR PROTECTION AGAINST EXPOSURE TO SUBSTANCES WHICH MAY CAUSE INJURY BY ABSORPTION THROUGH THE SKIN FROM MATERIALS SPLASHED OR SPILLED ON THE SKIN ARE COVERED IN SECTION (F) OF EACH SUBSTANCE STANDARD. RESPIRATOR SELECTION CRITERIA ARE BASED PRIMARILY ON THE INHALATION HAZARD OF THE SUBSTANCE. A SUPPLIED-AIR SUIT MAY PROVIDE BOTH SKIN AND RESPIRATORY PROTECTION FOR EXTREMELY TOXIC SUBSTANCES WHICH MAY BE ABSORBED THROUGH THE SKIN.

SUPPLIED-AIR SUITS ARE NOT COVERED IN 30 CFR 11. DATA ARE NOT AVAILABLE UPON WHICH TO MAKE RECOMMENDATIONS FOR SUPPLIED-AIR-SUITS FOR ALL TYPES OF EXPOSURES.

WHERE INFORMATION IS AVAILABLE INDICATING SYSTEMIC INJURY OR DEATH RESULTING FROM ABSORPTION OF A GAS OR VAPOR THROUGH THE SKIN, THE FOLLOWING STATEMENT IS INCLUDED IN APPENDIX B, SECTION (V) OF THE SUBSTANCE STANDARD:

"USE OF SUPPLIED-AIR SUITS OR OTHER IMPERVIOUS COVERINGS MAY BE NECESSARY TO PREVENT SKIN CONTACT WITH \* WHEN THE CONCENTRATION OF \* IS UNKNOWN OR GREATER THAN \*\* (IDLH). SUPPLIED-AIR SUITS SHOULD BE SELECTED, USED, AND MAINTAINED UNDER THE IMMEDIATE SUPERVISION OF PERSONS KNOWLEDGEABLE IN THE LIMITATIONS AND POTENTIAL LIFE ENDANGERING CHARACTERISTICS OF SUPPLIED-AIR SUITS."

A SENTENCE IS ADDED TO THE RESPIRATOR TABLE IN THE ENTRY AND ESCAPE FROM UNKNOWN CONCENTRATIONS SECTION AS SHOWN BELOW:

SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE, A COMBINATION RESPIRATOR WHICH INCLUDES A TYPE C SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE OR CONTINUOUS FLOW MODE AND AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND MODE OR OTHER POSITIVE PRESSURE MODE. (SUPPLIED-AIR SUITS MAY BE NECESSARY.)

#### IV. 2. POOR WARNING PROPERTIES

IT IS IMPORTANT TO REALIZE THAT 30 CFR 11 NIOSH/MSHA APPROVALS FOR AIR-PURIFYING (ORGANIC VAPOR) DEVICES PROHIBIT USE AGAINST ORGANIC VAPORS WITH POOR WARNING PROPERTIES. SPECIFICALLY, 30 CFR 11.90(A) (NOTE 4) COVERS GAS MASKS (CANISTER RESPIRATORS) AND 30 CFR 11.150 (NOTE 7) COVERS CHEMICAL CARTRIDGE RESPIRATORS. THUS THESE APPROVALS ARE ONLY FOR THOSE ORGANIC VAPORS WITH ADEQUATE WARNING PROPERTIES AND NOT ALL ORGANIC VAPORS.

WARNING PROPERTIES RELYING UPON HUMAN SENSES ARE NOT FOOLPROOF. HOWEVER, THEY PROVIDE SOME INDICATION TO THE EMPLOYEE OF POSSIBLE SORENT EXHAUSTION OR OF POOR FACEPIECE FIT OR OTHER RESPIRATOR MALFUNCTION. WARNING PROPERTIES INCLUDE ODOR, EYE IRRITATION, AND RESPIRATORY IRRITATION.

ADEQUATE WARNING PROPERTIES CAN BE ASSUMED WHEN THE SUBSTANCE ODOR, TASTE, OR IRRITATION EFFECTS ARE DETECTABLE AND PERSISTENT AT CONCENTRATIONS "AT" OR "BELOW" THE PERMISSIBLE EXPOSURE LIMIT.

IF THE ODOR OR IRRITATION THRESHOLD OF A SUBSTANCE IS MANY TIMES GREATER THAN THE PERMISSIBLE EXPOSURE LIMIT, THIS SUBSTANCE SHOULD BE CONSIDERED TO HAVE POOR WARNING PROPERTIES. IF THE SUBSTANCE ODOR OR IRRITATION THRESHOLD IS SOMEWHAT ABOVE THE PERMISSIBLE EXPOSURE LIMIT (NOT IN EXCESS OF THREE TIMES THE LIMIT) AND THERE IS NO CEILING LIMIT, CONSIDERATION IS GIVEN AS TO WHETHER OR NOT UNDETECTED EXPOSURE IN THIS CONCENTRATION RANGE COULD CAUSE SERIOUS OR IRREVERSIBLE HEALTH EFFECTS. IF NOT, THE SUBSTANCE IS CONSIDERED TO HAVE ADEQUATE WARNING PROPERTIES.

IT IS EXPECTED THAT ENVIRONMENTAL CONCENTRATIONS WILL VARY CONSIDERABLY AND, THEREFORE, WARNING OF A RESPIRATOR FAILURE WOULD SOON BE PERCEIVED AT CONTAMINANT CONCENTRATIONS SOMEWHAT ABOVE THE PERMISSIBLE EXPOSURE LIMIT.

#### IV. C. SORBENT EFFICIENCIES

WHERE SUPPORTING EVIDENCE EXISTS ON IMMEDIATE (LESS THAN THREE MINUTES) BREAKTHROUGH TIME AT THE IDLM CONCENTRATION AND BELOW FOR A CARTRIDGE OR CANISTER SORBENT, AIR-PURIFYING DEVICES SHALL NOT BE ALLOWED FOR ANY USE, ESCAPE OR OTHERWISE.

#### IV. D. EYE IRRITATION

FOR ROUTINE WORK OPERATIONS, ANY PERCEPTIBLE EYE IRRITATION IS CONSIDERED UNACCEPTABLE. THEREFORE, ONLY FULL FACEPIECE RESPIRATORS ARE PERMISSIBLE IN CONTAMINANT CONCENTRATIONS WHICH PRODUCE EYE IRRITATION. NOTE THAT 30 CFR 11.40(R)(NOTE 6) SPECIFIES THAT EYE PROTECTION MAY BE REQUIRED IN CERTAIN CONCENTRATIONS OF ACID GASES AND ORGANIC VAPORS. FOR ESCAPE, SOME EYE IRRITATION IS PERMISSIBLE IF IT IS DETERMINED THAT SUCH IRRITATION WOULD NOT INHIBIT ESCAPE AND SUCH IRRITATION IS REVERSIBLE.

WHERE QUANTITATIVE EYE IRRITATION DATA CANNOT BE FOUND IN LITERATURE REFERENCES, AND THEORETICAL CONSIDERATIONS INDICATE THE SUBSTANCE SHOULD NOT BE AN EYE IRRITANT, HALF FACEPIECE RESPIRATORS ARE ALLOWED.

#### IV. E. IDLM

THE DEFINITION OF IDLM PROVIDED IN 30 CFR 11.3(T) IS AS FOLLOWS:

"IMMEDIATELY DANGEROUS TO LIFE OR HEALTH" MEANS CONDITIONS THAT POSE AN IMMEDIATE THREAT TO LIFE OR HEALTH OR CONDITIONS THAT POSE AN IMMEDIATE THREAT OF SEVERE EXPOSURE TO CONTAMINANTS, SUCH AS RADIOACTIVE MATERIALS, WHICH ARE LIKELY TO HAVE ADVERSE CUMULATIVE OR DELAYED EFFECTS ON HEALTH.

THE PURPOSE OF ESTABLISHING AN IDLM EXPOSURE CONCENTRATION IS TO INSURE THAT THE WORKER CAN ESCAPE WITHOUT INJURY OR IRREVERSIBLE HEALTH EFFECTS FROM AN IDLM CONCENTRATION IN THE EVENT OF FAILURE OF THE RESPIRATORY PROTECTIVE EQUIPMENT. THE IDLM IS CONSIDERED A MAXIMUM CONCENTRATION ABOVE WHICH ONLY HIGHLY RELIABLE BREATHING APPARATUS PROVIDING MAXIMUM WORKER PROTECTION IS PERMITTED. SINCE IDLM VALUES ARE CONSERVATIVELY SET, ANY APPROVED RESPIRATOR MAY BE USED UP TO ITS MAXIMUM USE CONCENTRATION BELOW THE IDLM.

IN ESTABLISHING THE IDLM CONCENTRATION THE FOLLOWING FACTORS ARE CONSIDERED:

1. ESCAPE WITHOUT LOSS OF LIFE OR IRREVERSIBLE HEALTH EFFECTS. THIRTY MINUTES IS CONSIDERED THE MAXIMUM PERMISSIBLE EXPOSURE TIME FOR ESCAPE.
2. SEVERE EYE OR RESPIRATORY IRRITATION OR OTHER REACTIONS WHICH WOULD INHIBIT ESCAPE WITHOUT INJURY.

IDLM SHOULD BE DETERMINED FROM THE FOLLOWING SOURCES:

1. SPECIFIC IDLM PROVIDED IN THE LITERATURE SUCH AS THE AHA HYGIENIC GUIDES.
2. HUMAN EXPOSURE DATA.

3. ACUTE ANIMAL EXPOSURE DATA.

4. WHERE SUCH DATA ARE LACKING TOXICOLOGICAL DATA FROM ANALOGOUS SUBSTANCES, AND CHRONIC ANIMAL EXPOSURE DATA MAY BE CONSIDERED.

THE FOLLOWING GUIDELINES SHOULD BE USED TO INTERPRET TOXICOLOGICAL DATA REPORTED IN THE LITERATURE FOR ANIMAL SPECIES:

1. WHERE ACUTE EXPOSURE ANIMAL DATA ARE AVAILABLE (30 MINUTES TO 4-HOUR EXPOSURES), THE LOWEST EXPOSURE CONCENTRATION CAUSING DEATH OR IRREVERSIBLE HEALTH EFFECTS IN ANY SPECIES IS DETERMINED TO BE THE IOLH CONCENTRATION.
2. WHERE ONLY CHRONIC EXPOSURE DATA ARE AVAILABLE AND THESE DATA DO NOT REVEAL ANY EXPOSURE CONCENTRATION WHICH WOULD RESULT IN IRREVERSIBLE HEALTH EFFECTS, THEN THESE DATA HAVE NO RELEVANCE AND SHOULD NOT BE USED IN DETERMINING THE IOLH CONCENTRATION.

WHERE THERE IS EVIDENCE OF AN IOLH CONCENTRATION ABOVE THAT ALLOWED ON THE BASIS OF A PROTECTION FACTOR, RESPIRATORS SHOULD BE SELECTED ON THE BASIS OF THE PROTECTION FACTOR AFFORDED BY EACH DEVICE WITHIN THE LIMITATIONS OF THE DEVICE.

IV. F. LOWER FLAMMABLE LIMIT AND FIREFIGHTING

CONTAMINANT CONCENTRATIONS IN EXCESS OF THE LFL ARE CONSIDERED TO BE IMMEDIATELY DANGEROUS TO LIFE OR HEALTH, AT OR ABOVE THE LFL, THE USE OF RESPIRATORS IS LIMITED TO THOSE DEVICES WHICH PROVIDE THE MAXIMUM PROTECTION, I.E., POSITIVE-PRESSURE SCBA, AND COMBINATION POSITIVE-PRESSURE SUPPLIED-AIR RESPIRATOR WITH POSITIVE PRESSURE SCBA.

FIREFIGHTING IS DEFINED BY ANSI Z88.5-1971 AS BEING IMMEDIATELY DANGEROUS TO LIFE. FOR FIREFIGHTING, THE ONLY DEVICE PROVIDING ADEQUATE PROTECTION IS THE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS.

IV. G. PROTECTION FACTORS

PROTECTION FACTORS ARE A MEASURE OF THE OVERALL EFFECTIVENESS OF A RESPIRATOR. FILTERING EFFICIENCY IS A PART OF THE PROTECTION FACTOR AND BECOMES A SIGNIFICANT CONSIDERATION FOR LESS EFFICIENT AIR PURIFYING RESPIRATORS.

THE PROTECTION FACTORS USED IN THE PREPARATION OF THE STANDARDS ARE BASED ON QUANTITATIVE FIT TESTS PERFORMED AT LOS ALAMOS AND ELSEWHERE, AND IN SOME INSTANCES ON PROFESSIONAL JUDGMENT. IN APPENDIX I, THE PROTECTION FACTORS FOR EACH CLASS OF RESPIRATORS LISTED IN THE CHECKLISTS ARE SHOWN. THE ENTRIES IN EACH LIST ARE FOR AN ENTIRE CLASS OF RESPIRATORS, AND ARE ASSIGNED THE PROTECTION FACTOR OF THE LOWEST PERFORMING DEVICE WITHIN EACH CLASS.

IV. H. VARIATIONS WITH 30 CFR II

1. THE TYPE A SUPPLIED-AIR RESPIRATOR IS ALLOWED IN 30 CFR II FOR USE IN IMMEDIATELY DANGEROUS TO LIFE AND HEALTH ATMOSPHERES. HOWEVER, AIR SUPPLY REQUIREMENTS OF 50 L/MIN. IS INSUFFICIENT TO MAINTAIN A POSITIVE PRESSURE IN THE FACEPIECE UNDER ALL WORKING CONDITIONS. THEREFORE, THIS DEVICE SHOULD HAVE THE SAME PROTECTION FACTOR AS APPLIED TO OTHER AIR-PURIFYING AND ATMOSPHERE SUPPLYING RESPIRATORS HAVING A NEGATIVE PRESSURE IN THE FACEPIECE (SEE APPENDIX I). 30 CFR

11 WILL REQUIRE A REVISION TO ELIMINATE APPROVAL OF TYPE A FOR IDLM ATMOSPHERES.

2. AN AMENDMENT TO 30 CFR 11 IS BEING PROCESSED WHICH WILL DELETE USE OF GAS MASKS FOR ENTRY AND USE IN IDLM ATMOSPHERES. THEREFORE, IN THIS DECISION LOGIC GAS MASKS ARE NOT ALLOWED IN CONCENTRATIONS GREATER THAN THE IDLM OR ENTRY AND ESCAPE FROM UNKNOWN CONCENTRATIONS.
3. IN THE SAME AMENDMENT DESCRIBED ABOVE, MAXIMUM USE CONCENTRATIONS (MUC) FOR GAS MASKS ARE BEING DELETED. THIS DECISION LOGIC IS CONSISTENT WITH THIS AMENDMENT. HOWEVER, CANISTERS APPROVED PRIOR TO THIS AMENDMENT WILL HAVE THE MUC SPECIFIED ON THE LABEL WHICH WILL BE INCONSISTENT WITH THE SUBSTANCE STANDARDS FOR MOST SUBSTANCES.
4. 30 CFR 11 DOES NOT CONTAIN PROTECTION FACTOR REQUIREMENTS. PROTECTION FACTORS ARE USED IN THE DECISION LOGIC. AN AMENDMENT TO 30 CFR 11 IS PLANNED TO INCLUDE PROTECTION FACTOR REQUIREMENTS FOR OFM RESPIRATORS. FUTURE AMENDMENTS ARE CONTEMPLATED FOR OTHER TYPES OF RESPIRATORS.
5. 30 CFR 11 DOES NOT PERMIT THE USE AN ESCAPE GAS MASK AGAINST ACID GASES OR ORGANIC VAPORS WITH POOR WARNING PROPERTIES. A CHANGE TO 30 CFR 11 IS NECESSARY TO PERMIT THE USE OF AN ESCAPE GAS MASK AGAINST SUBSTANCES WITH POOR WARNING PROPERTIES.

#### IV. I      ESCAPE

WHERE ESCAPE RESPIRATORS ARE PROVIDED THEY SHALL BE SELECTED FROM THE ESCAPE CATEGORY IN TABLE 2. THE EMPLOYER SHALL PROVIDE AND ENSURE EMPLOYEES CARRY AN ESCAPE RESPIRATOR WHERE EXPOSURE MAY OCCUR TO EXTREMELY TOXIC SUBSTANCES (AN EXTREMELY TOXIC SUBSTANCE IS DEFINED AS A GAS OR VAPOR HAVING A RAT EXPOSURE MORTALITY LC50 OF LESS THAN 10 PPM,

THE FOLLOWING STATEMENT IS ADDED TO THE INTRODUCTION TO THE RESPIRATOR TABLE FOR THESE SUBSTANCES:

EMPLOYERS SHALL PROVIDE EACH EMPLOYEE WORKING IN AREAS WHERE \*\*NAME\*\* MAY BE RELEASED INTO THE WORKPLACE AIR WITH AN APPROVED ESCAPE RESPIRATOR AS SPECIFIED IN TABLE 2. THE EMPLOYER SHALL ENSURE THAT EACH EMPLOYEE CARRY THE ESCAPE RESPIRATOR IN THE AREA WHERE \*\*NAME\*\* MAY BE RELEASED INTO THE WORKPLACE.

IV. J. "ENTRY INTO TANKS OR CLOSED VESSELS; OR . . ."  
ITEM (D)(4)(IV) IS A VARIABLE PROVISION IN THE INTRODUCTORY STATEMENTS TO THE RESPIRATOR TABLES WHICH LISTS THE SPECIFIC OPERATIONS WHERE A RESPIRATOR IS CONSIDERED TO BE AN ACCEPTABLE MEANS OF CONTROL. EXAMPLES OF WHERE THIS MAY OCCUR ARE FOR OPERATIONS WHICH REQUIRE OCCASSIONAL ENTRY INTO TANKS OR OTHER CLOSED VESSELS.

#### APPENDIX I

##### A. PROTECTION FACTORS FOR PARTICULATE FILTER RESPIRATORS

| PROTECTION FACTOR<br>(MINIMAL) | PERMISSIBLE RESPIRATORY PROTECTION                               |
|--------------------------------|------------------------------------------------------------------|
| 5X                             | ANY DUST AND MIST RESPIRATOR (30 CFR 11.130)                     |
| 5X                             | ANY DUST AND MIST RESPIRATOR, EXCEPT SINGLE USE (30 CFR 11.130). |

|       |                                                                                               |
|-------|-----------------------------------------------------------------------------------------------|
| 10X   | ANY DUST AND MIST RESPIRATOR, EXCEPT SINGLE-USE OR QUARTER-MASK RESPIRATOR (30 CFR 11.130).   |
| 10X   | ANY FUME RESPIRATOR OR HIGH EFFICIENCY PARTICULATE FILTER RESPIRATOR (30 CFR 11.130).         |
| 10X   | ANY HIGH EFFICIENCY PARTICULATE FILTER RESPIRATOR (30 CFR 11.130)                             |
| 50X   | A HIGH EFFICIENCY PARTICULATE FILTER RESPIRATOR WITH A FULL FACEPIECE (30 CFR 11.130).        |
| 1000X | A POWERED AIR-PURIFYING RESPIRATOR WITH A HIGH EFFICIENCY PARTICULATE FILTER (30 CFR 11.130). |

#### B. PROTECTION FACTORS FOR CHEMICAL CARTRIDGES AND GAS MASKS

| PROTECTION FACTOR<br>(MINIMAL) | PERMISSIBLE RESPIRATORY PROTECTION                                                                   |
|--------------------------------|------------------------------------------------------------------------------------------------------|
| 10X                            | ANY CHEMICAL CARTRIDGE RESPIRATOR WITH AN ** NAME ** CARTRIDGE(S) (30 CFR 11.150)                    |
| 50X                            | A CHEMICAL CARTRIDGE RESPIRATOR WITH FULL FACEPIECE AND ** NAME ** CARTRIDGE(S) (30 CFR 11.150)      |
| 50X                            | A GAS MASK WITH A CHIN-STYLE ** NAME ** CANISTER (30 CFR 11.90(A))                                   |
| 50X                            | A GAS MASK WITH A FRONT OR BACK-MOUNTED ** NAME ** CANISTER (30 CFR 11.90 (A))                       |
| 1000X                          | A POWERED AIR-PURIFYING CHEMICAL CARTRIDGE RESPIRATOR WITH A ** NAME ** CARTRIDGE (UNLISTED DEVICE). |
| ESCAPE                         | ANY GAS MASK PROVIDING PROTECTION AGAINST ** NAME ** VAPORS (30 CFR 11.90).                          |

NOTE: THE APPROVAL \*\* NAME \*\* MAY CONSIST OF ACID GASES OR ORGANIC VAPORS AS A CLASS OR SPECIFIC ACID GASES, AMMONIA, OR ORGANIC VAPORS. IT MAY ALSO CONSIST OF COMBINATIONS OF ACID GASES, ORGANIC VAPORS, AND OTHER GASES AND VAPORS.

#### C. PROTECTION FACTORS FOR COMBINATION CHEMICAL CARTRIDGES AND PARTICULATE FILTERS AND GAS MASKS AND PARTICULATE FILTERS

| PROTECTION FACTORS<br>(MINIMAL) | PERMISSIBLE RESPIRATORY PROTECTION                                                                                                  |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 10X                             | ANY CHEMICAL CARTRIDGE RESPIRATOR WITH ** NAME ** CARTRIDGE(S) AND ** NAME ** FILTER(S) (30 CFR 11.150 AND 11.130)                  |
| 50X                             | A CHEMICAL CARTRIDGE RESPIRATOR WITH A FULL FACEPIECE, ** NAME ** CARTRIDGE(S), AND ** TYPE ** FILTER(S) (30 CFR 11.150 AND 11.130) |
| 50X                             | A GAS MASK WITH A CHIN-STYLE ** NAME ** CANISTER AND ** TYPE ** FILTER (30 CFR 11.90(A) AND 11.130)                                 |
| 50X                             | A GAS MASK WITH A FRONT OR BACK MOUNTED ** NAME ** CANISTER AND ** TYPE ** FILTER (30 CFR 11.90(A) AND 11.130).                     |

1000X A POWERED AIR PURIFYING CHEMICAL CARTRIDGE RESPIRATOR WITH A \*\* NAME \*\* CARTRIDGE AND HIGH EFFICIENCY PARTICULATE FILTER.

ESCAPE ANY GAS MASK PROVIDING PROTECTION AGAINST \*\* NAME \*\* AND PARTICULATES (30 CFR 11.90 AND 11.130)

\*\* NAME \*\* REFERS TO ANY ACID GAS, ALKALINE GAS, ORGANIC VAPOR, OR OTHER SPECIFIC GAS OR VAPOR.  
 \*\* TYPE \*\* REFERS TO DUST AND MIST, FUME, OR HIGH EFFICIENCY PARTICULATE.

#### D. PROTECTION FACTORS FOR SUPPLIED-AIR RESPIRATORS

| PROTECTION FACTOR<br>(MINIMAL) | PERMISSIBLE RESPIRATORY PROTECTION                                                                                                                                                                               |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10X                            | ANY SUPPLIED AIR-RESPIRATOR (30 CFR 11.110(A))                                                                                                                                                                   |
| 50X                            | ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE, HELMET, OR HOOD, (30 CFR 11.110(A))                                                                                                                           |
| 1000X                          | A TYPE C SUPPLIED-AIR RESPIRATOR OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE OR CONTINUOUS FLOW MODE (30 CFR 11.110(A))                                                                               |
| 2000X                          | A TYPE C SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HOOD, OR HELMET OPERATED IN CONTINUOUS FLOW MODE (30 CFR 11.110(A)) |

THIS CATEGORY IS NOT FULLY COVERED BY PRECEDING CATEGORY.

#### E. PROTECTION FACTORS FOR SELF-CONTAINED BREATHING APPARATUS

| PROTECTION FACTOR<br>(MINIMAL)   | PERMISSIBLE RESPIRATORY PROTECTION                                                                                                                                                                                                                                                                        |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10X                              | ANY SELF-CONTAINED BREATHING APPARATUS (30 CFR 11.70(A))                                                                                                                                                                                                                                                  |
| 50X                              | ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE (30 CFR 11.70(A))                                                                                                                                                                                                                            |
| 10,000+X<br>OR FIRE-<br>FIGHTING | SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE (30 CFR 11.70(A))                                                                                                                                                                    |
| 10,000+X                         | A COMBINATION RESPIRATOR WHICH INCLUDES A TYPE C SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE OR CONTINUOUS FLOW MODE AND AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR POSITIVE PRESSURE MODE (30 CFR 11.70(B)) |
| ESCAPE                           | ANY ESCAPE SELF-CONTAINED BREATHING APPARATUS (30 CFR 11.70(A))                                                                                                                                                                                                                                           |

APPENDIX II - LITERATURE REFERENCES

THE FOLLOWING ARE THE PRIMARY REFERENCE SOURCES USED IN THIS DECISION LOGIC.

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## APPENDIX D

EFFECT OF SOLVENT VAPOR ON  
RESPIRATOR CARTRIDGE EFFICIENCY

Gary O. Nelson and Charles A. Harder

The following cartridge pairs were tested at 1000 ppm, 50% relative humidity, 22°C, and 53.3 liters/min (equivalent to a moderately heavy work rate). The time to achieve a 1% breakthrough is noted for each cartridge pair. Cartridges were preconditioned at room temperature and 50% relative humidity for at least 24 hours prior to testing.

| <u>Solvent</u>           | <u>Time to Reach 1% Breakthrough</u><br><u>(10 ppm) (minutes)</u> |
|--------------------------|-------------------------------------------------------------------|
| Aromatics (a)            |                                                                   |
| Benzene                  | 73                                                                |
| Toluene                  | 94                                                                |
| Ethyl benzene            | 84                                                                |
| m-Xylene                 | 99                                                                |
| Cumene                   | 81                                                                |
| Mesitylene               | 86                                                                |
| Alcohols (a)             |                                                                   |
| Methanol                 | 0.2                                                               |
| Ethanol                  | 28                                                                |
| Isopropanol              | 54                                                                |
| Allyl alcohol            | 66                                                                |
| n-Propanol               | 70                                                                |
| Sec-Butanol              | 96                                                                |
| Butanol                  | 115                                                               |
| 2-Methoxyethanol         | 116                                                               |
| Isoamyl alcohol          | 97                                                                |
| 4-Methyl-2-pentanol      | 75                                                                |
| 2-Ethoxyethanol          | 77                                                                |
| Amyl alcohol             | 102                                                               |
| 2-Ethyl-1-butanol        | 76.5                                                              |
| Monochlorides (a)        |                                                                   |
| Methyl chloride          | .05                                                               |
| Vinyl chloride           | 3.8                                                               |
| Ethyl chloride           | 5.6                                                               |
| Allyl chloride           | 31.                                                               |
| 1-chloropropane          | 25.                                                               |
| 1-chlorobutane           | 72                                                                |
| Chlorocyclopentane       | 78                                                                |
| Chlorobenzene            | 107                                                               |
| 1-chlorohexane           | 77                                                                |
| o-chlorotoluene          | 102                                                               |
| 1-chloroheptane          | 82                                                                |
| 3-(chloromethyl heptane) | 63                                                                |

|                            |     |
|----------------------------|-----|
| Dichlorides (a)            |     |
| Dichloromethane            | 10  |
| Trans-1,2-Dichloroethylene | 33  |
| 1,1-Dichloroethane         | 23  |
| cis-1,2-Dichloroethylene   | 30  |
| 1,2-Dichloroethane         | 54  |
| 1,2-Dichloropropane        | 65  |
| 1,4-Dichlorobutane         | 108 |
| o-Dichlorobenzene          | 109 |

|                        |     |
|------------------------|-----|
| Trichlorides           |     |
| Chloroform             | 33  |
| Methyl chloroform      | 40  |
| Trichloroethylene      | 55  |
| 1,1,2-Trichloroethane  | 72  |
| 1,2,3-Trichloropropane | 111 |

|                               |     |
|-------------------------------|-----|
| Tetra- and Pentachlorides (a) |     |
| Carbon tetrachloride          | 77  |
| Perchloroethylene             | 107 |
| 1,1,2,2-Tetrachloroethane     | 104 |
| Pentachloroethane             | 93  |

|                           |    |
|---------------------------|----|
| Acetates (a)              |    |
| Methyl acetate            | 33 |
| Vinyl acetate             | 55 |
| Ethyl acetate             | 67 |
| Isopropyl acetate         | 65 |
| Isopropenyl acetate       | 81 |
| Propyl acetate            | 79 |
| Allyl acetate             | 76 |
| sec-Butyl acetate         | 83 |
| Butyl acetate             | 77 |
| Isopentyl acetate         | 71 |
| 2-Methoxyethyl acetate    | 93 |
| 1,3-Dimethylbutyl acetate | 61 |
| Amyl acetate              | 73 |
| 2-Ethoxyethyl acetate     | 80 |
| Hexyl acetate             | 67 |

|                       |     |
|-----------------------|-----|
| Ketones (b)           |     |
| Acetone               | 37  |
| 2-Butanone            | 82  |
| 2-Pentanone           | 104 |
| 3-Pentanone           | 94  |
| 4-Methyl-2-Pentanone  | 96  |
| Mesityl oxide         | 122 |
| Cyclopentanone        | 141 |
| 3-Heptanone           | 91  |
| 2-Heptanone           | 101 |
| Cyclohexanone         | 126 |
| 5-Methyl-3-heptanone  | 86  |
| 3-Methylcyclohexanone | 101 |
| Diisobutyl ketone     | 71  |
| 4-Methylcyclohexanone | 111 |

|                             |      |
|-----------------------------|------|
| Alkanes (b)                 |      |
| Pentane                     | 61   |
| Hexane                      | 52   |
| Methylcyclopentane          | 62   |
| Cyclohexane                 | 69   |
| Cyclohexene                 | 86   |
| 2,2,4-Trimethylpentane      | 68   |
| Heptane                     | 78   |
| Methylcyclohexane           | 69   |
| 5-Ethylidene-2-norbornene   | 87   |
| Nonane                      | 76   |
| Decane                      | 71   |
| Amines (b)                  |      |
| Methyl amine                | 12   |
| Ethyl amine                 | 40.5 |
| Isopropyl amine             | 66   |
| Propyl amine                | 90   |
| Diethyl amine               | 88   |
| Butyl amine                 | 110  |
| Triethyl amine              | 81   |
| Dipropyl amine              | 93   |
| Diisopropyl amine           | 77   |
| Cyclohexyl amine            | 112  |
| Dibutyl amine               | 76   |
| Miscellaneous Materials (b) |      |
| Acrylonitrile               | 49   |
| Pyridine                    | 119  |
| 1-Nitropropane              | 143  |
| Methyl iodide               | 12   |
| Dibromomethane              | 82   |
| 1,2-Dibromoethane           | 141  |
| Acetic anhydride            | 124  |
| Bromobenzene                | 142  |

(a) MSA cartridges

(b) AO cartridges

## APPENDIX E

### STANDARD OPERATING PROCEDURE

#### RESPIRATOR FIT TESTING USING IRRITANT SMOKE

#### FIELD TEST - PLASTIC BAG ENCLOSURE OR HARVARD HOOD

##### Method No. 4

1. Respirators equipped with high-efficiency filters will be used for this test.
2. Both ends are broken on an MSA ventilation smoke tube. One end is inserted into the tube connected to the positive pressure end of a two-way respirator bulb and the other end covered by a 1-2" length of tygon, surgical or rubber tubing. The test aerosol is generated by squeezing the aspirator bulb.
3. The test subject will don the respirator and a visual inspection of the facepiece to face seal made by the tester. An obvious leak in the facepiece to face seal shall be reason to abort the test and record that mask as unsatisfactory. Expression of discomfort created by the mask shall also be reason to abort the test.
4. The smoke will be generated into the input of the harvard hood or a hole punched in the top of the plastic bag enclosure until a concentration can be detected throughout the bag or hood visually.
5. If a half-mask is being tested, THE SUBJECT SHALL BE INSTRUCTED TO CLOSE HIS EYES FOR THE DURATION OF THE TEST. The test subject shall be instructed to enter the bag or hood and breathe shallowly during a short (30-60 seconds) sedentary period. The subject shall be instructed to move their head from side-to-side and up and down to assure that the respirator has an adequate seal. Leakage at any time shall be cause to terminate the test. Two or three minutes should be sufficient to evoke a response to the irritant smoke even if the subject tries to "hold their breath".
6. Any indication of detection of the smoke by the test subject, during fitting, indicates a failure of that respirator. If leakage is detected, the subject shall be removed from the test atmosphere and the facepiece to face seal visually inspected for obvious leakage. If any doubt about the condition of the respirator or the filter exists, another like respirator shall be tested to assure the leakage was due to facepiece to face seal.

## APPENDIX F

### STANDARD OPERATING PROCEDURE DISASSEMBLY, CLEANING AND MAINTENANCE OF RESPIRATORS

1. Remove cartridges, canisters or filters and all gaskets that are not affixed to seats.
2. Visually inspect facepieces and parts; discard faulty items.
3. Remove all elastic headbands.
4. Remove exhalation valve cover.
5. Remove speaking diaphragm or speaking diaphragms-exhalation valve assembly, or pressure-demand exhalation valve assembly.
6. Remove inhalation valves.
7. Wash, sanitize and rinse facepieces (see specific procedure for operation of washing equipment). (Maximum water temperature 140°F). Parts removed from respirators may be washed separately as necessary.
8. Dry masks (see specific procedures for drying). (See Appendix G.)
9. Hand wipe facepieces, valves and valve seats with damp, lint-free cloth to remove any soap or water residues, mold release powders or foreign materials not removed by washing.
10. Disassemble and hand clean the pressure-demand and exhalation valve assembly, exercising care to avoid damage to the rubber diaphragm.
11. Visually inspect facepieces and all parts for deterioration, distortion, or other faults that might affect the performance of the respirators.
12. Replace any questionable or obviously faulty parts or assemblies including rubber components that show weather checking when flexed or stretched, and distorted facepiece. Replace only with parts specifically designed for the particular respirator.
13. Reassemble mask and visually inspect completed assembly.
14. Install new or retested and disinfected filters, cartridges or canisters.
15. Clean and apply fogproof to lens per fogproof manufacturer's instructions (full facepieces only).
16. Install lens cover.
17. Fogproof outside of lens cover.
18. Individually seal each mask in plastic bag.

Appendix G  
Respirator Drying Cabinet

1 steel cabinet with double doors, 18 x 36 x 78 inches  
(Fig. 1)  
3 shelves (furnished with cabinet)  
3 pieces of 1/4 inch stainless steel mesh wire, 15-3/4 x 35-3/4  
inches for shelves  
1 piece of regular screen, 10 x 10 inches for exhaust port on top  
1 small portable electric heater with fan, 115V, 1650W  
32 eye bolts, size #10  
32 clothes pins with metal hanging clips  
1 thermometer, 0 to 180°F range  
miscellaneous bolts and nuts, size #10

CABINET MODIFICATION

On one side, an 8 x 8 inch square hole 2 inches from the inside bottom is cut and the heater bolted in place (Fig. 2). The two-wire heater power cable is removed and replaced with a three-wire cord for electrical safety. On top of the cabinet, an 8 x 8 inch exhaust port is cut and a piece of screen wire placed over it. The center section of each shelf beginning 1-1/2 inch from the edges is removed, and stainless steel mesh is bolted in place. To this wire on the bottom and second shelves (Fig. 2), the small eye bolts are screwed into place approximately 3 inches apart, and spaced so that eight masks can hang in a double row from each shelf without touching each other. The clothes pins are held to the eye bolts by metal clips. The spring

clips mounted on the shelves are for identifying the origin of masks. The thermometer is suspended by a small clamp.

The temperature inside the cabinet is maintained at 120 to 140°F. After the cabinet has been loaded with masks, the temperature averages from about 125°F on the top shelf to 135°F at the bottom of the low hanging masks (Fig. 3).

The unit is normally loaded at one time with 10 to 15 full face and 24 half mask respirators and their filter holders. The practical capacity, using the hangers and shelves, is 30 full face masks or 60 half mask respirators. The average during time is from 1 to 1-1/2 hours. The total cost for materials and labor is less than \$150.00.

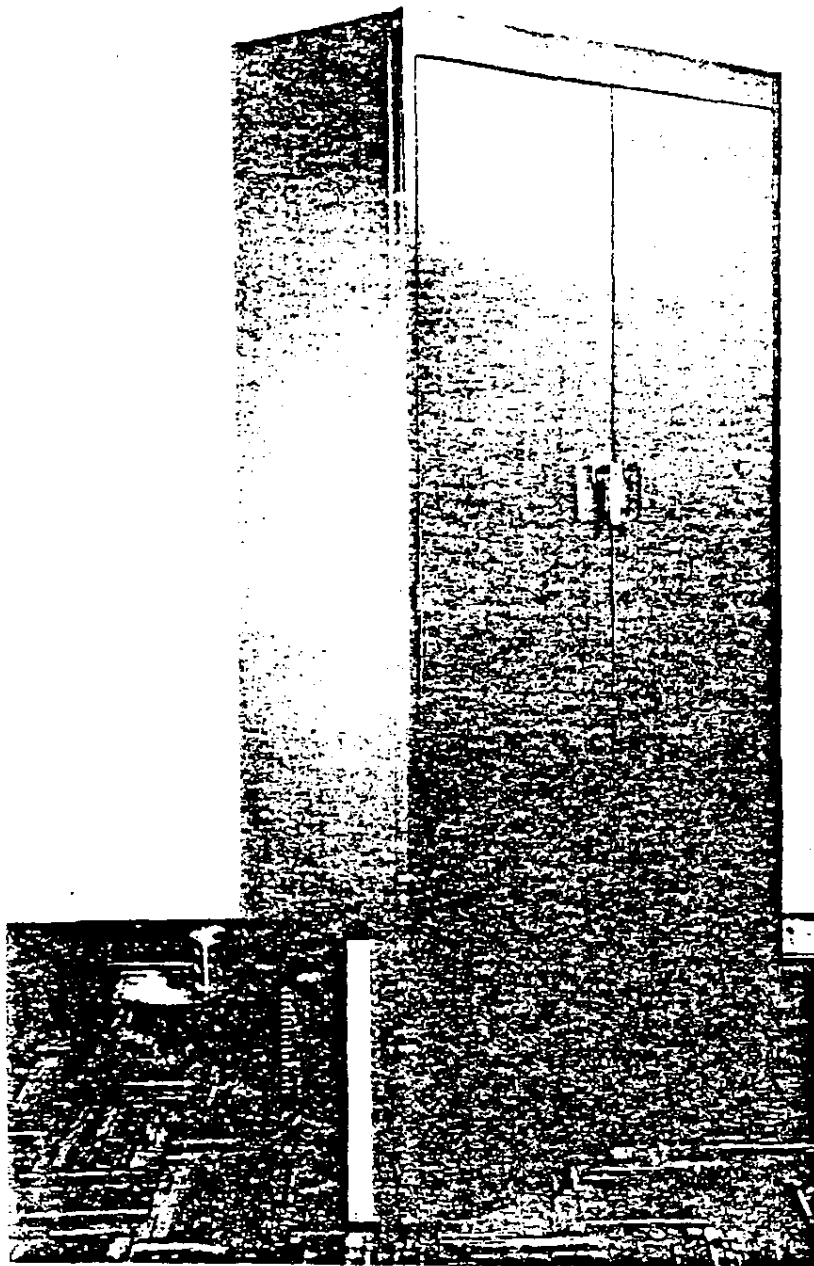


Fig. 1. Outside of cabinet (closed) showing heater unit

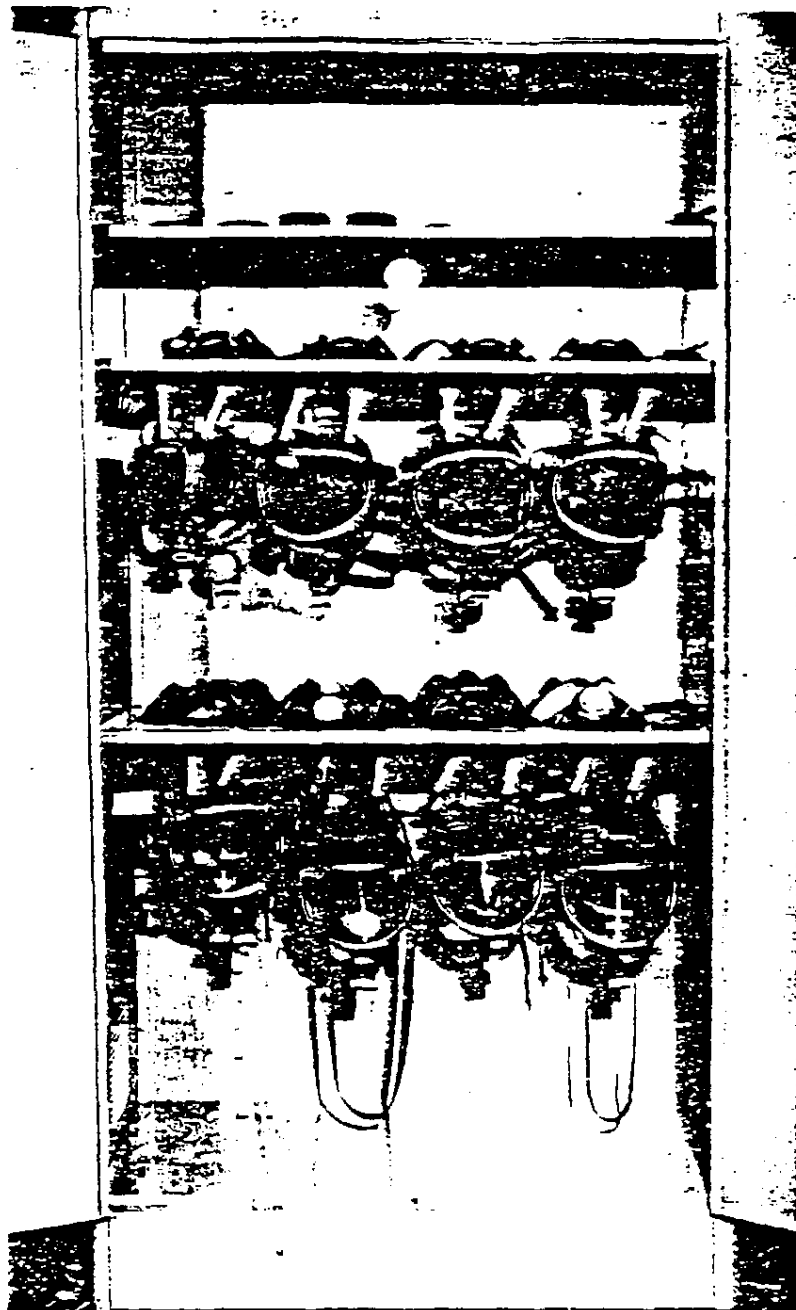


Fig. 3. Inside of cabinet loaded with masks

## APPENDIX H

### PROGRAM EVALUATION

In general, the respirator program should be evaluated at least annually, with program adjustments, as appropriate, made to reflect the evaluation results. Program function can be separated into administration and operation.

#### 1. Program Administration

- a. Is program responsibility vested in one individual who is knowledgeable and who can coordinate all aspects of the program?
- b. What is the present status of the implementation of engineering controls, if feasible, to alleviate the need of respirators?
- c. Are there written procedures/statements covering the various aspects of the respirator program?
  - designation of administrator;
  - respirator selection;
  - purchase of approved equipment;
  - medical aspects of respirator usage;
  - issuance of equipment;
  - fitting;
  - maintenance, storage, repair;
  - inspection; and
  - use under special condition.

#### 2. Program Operation

- a. Respiratory protective equipment selection
  - \* Are work area conditions and employee exposures properly surveyed?
  - \* Are respirators selected on the basis of hazards to which the employee is exposed?
  - \* Are selections made by individuals knowledgeable of selection procedures?
- b. Are only approved respirators purchased and used and do they provide adequate protection for the specific hazard and concentration of the contaminant?
- c. Has a medical evaluation of the prospective user been made to determine their physical and psychological ability to wear respiratory protective equipment?

d. Where practical, have respirators been issued to the users for their exclusive use, and are there records covering issuance?

e. Respiratory protection equipment fitting -

- Are the users given the opportunity to try on several respirators to determine whether the respirator they will subsequently be wearing is the best fitting one?
- Is the fit tested at appropriate intervals?
- Are those users prohibited from wearing contact lenses when using respirators?
- Is the facepiece to face seal tested in a test atmosphere?

f. Maintenance of respiratory protection equipment -

Cleaning and Disinfecting

- Are respirators cleaned and disinfected after each use when different people use the same device, or as frequently as necessary for devices issued to individual users?
- Are proper methods of cleaning and disinfecting utilized?

Storage

- Are respirators stored in a manner so as to protect them from dust, sunlight, heat, excessive cold or moisture, or damaging chemicals?
- Are respirators stored properly in a storage facility so as to prevent them from deforming?
- Is storage in lockers and tool boxes permitted only if the respirator is in a carrying case or carton?

Inspection

- Are respirators inspected before and after each use and during cleaning?
- Are qualified individuals/users instructed in inspection techniques?
- Is respiratory protective equipment designated as "emergency use" inspected at least monthly (in addition to after each use)?
- Is a record kept of the inspection of "emergency use" respiratory protective equipment?

### Repair

- Are replacement parts used in repair those of the manufacturer of the respirator?
- Are repairs made by knowledgeable individuals?
- Are repairs of SCBA made only by certified personnel or by a manufacturer's representative?

### Special Use Conditions

- Is a procedure developed for respiratory protective equipment usage in atmospheres immediately dangerous to life or health?
- Is a procedure developed for equipment usage for entry into confined spaces?

### Training

- Are users trained in proper respirator usage?
- Are users trained in the basis for selection of respirators?

## APPENDIX I

### RESPIRATOR TERMINOLOGY

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CONFINED SPACE           | An enclosure having limited means of egress; and poor natural ventilation which may contain hazardous contaminants or be oxygen deficient such as storage tank, process vessel, boiler, silo, tank car, pipeline, tube, duct, sewer, underground utility vault, tunnel, and pit.                                                                                                                                    |
| EMERGENCY RESPIRATOR USE | Wearing a respirator when a hazardous atmosphere suddenly occurs which requires immediate use of a respirator either for escape only from the hazardous atmosphere or for entry into the hazardous atmosphere to carry out maintenance or some other task.                                                                                                                                                          |
| EXHALATION VALVE         | A device that allows exhaled air to leave a respirator and prevents outside air from entering through the valve.                                                                                                                                                                                                                                                                                                    |
| FACEPIECE                | That portion of a respirator that covers the wearer's nose and mouth in a quarter-mask (above the chin) or half-mask (under the chin) facepiece or that covers the nose, mouth, and eyes in a full facepiece. It is designed to make a gas-tight or particle-tight fit with the face and includes the headbands, exhalation valve(s), and connections for an air-purifying device or respirable gas source or both. |
| HAZARDOUS ATMOSPHERE     | Any atmosphere, either immediately or not immediately dangerous to life or health, which is oxygen deficient or which contains a toxic or disease-producing contaminant exceeding the legally established permissible exposure limit (PEL), or where applicable, the Threshold Limit Value (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH).                              |
| HELMET                   | That portion of a respirator which shields the eyes, face, neck, and other parts of the head.                                                                                                                                                                                                                                                                                                                       |
| HIGH EFFICIENCY FILTER   | A filter which has an efficiency equal to or exceeding 99.97% for removal of monodisperse dioctyl phthalate (DOP) particles having a mean particle diameter of 0.3 micrometer from air.                                                                                                                                                                                                                             |
| HOOD                     | That portion of a respirator which completely covers the head, neck, and portions of the shoulders.                                                                                                                                                                                                                                                                                                                 |

|                                                               |                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH)                | Any atmosphere that poses an immediate hazard to life or produces immediate irreversible effects on health that will be debilitating.                                                                                                                            |
| MAXIMUM USE LIMIT OF FILTER, CARTRIDGE, OR CANISTER           | The maximum concentration of a contaminant for which an air-purifying filter, cartridge, or canister is approved for use.                                                                                                                                        |
| MPCa MAXIMUM PERMISSIBLE AIRBORNE CONCENTRATION               | These concentrations are set by the National Committee on Radiation Protection. They are recommended maximum average concentrations of radionuclides to which a worker may be exposed, assuming that he works 8 hours a day, 5 days a week, and 50 weeks a year. |
| NEGATIVE PRESSURE RESPIRATOR                                  | A respirator in which the air pressure inside the respiratory-inlet covering is positive during exhalation in relation to the air pressure of the outside atmosphere and negative during inhalation in relation to the air pressure of the outside atmosphere.   |
| NOT IMMEDIATELY DANGEROUS TO LIFE OR HEALTH                   | Any hazardous atmosphere which may produce physical discomfort immediately, chronic poisoning after repeated exposure, or acute adverse physiological symptoms after prolonged exposure.                                                                         |
| ODOR THRESHOLD LIMIT                                          | The lowest concentration of a contaminant in air that can be detected by the olfactory sense.                                                                                                                                                                    |
| OXYGEN DEFICIENCY-IMMEDIATELY DANGEROUS TO LIFE OR HEALTH     | An atmosphere which causes an oxygen partial pressure of 100 millimeters mercury column or less in the freshly inspired air in the upper portion of the lungs which is saturated with water vapor. See Appendix I.                                               |
| OXYGEN DEFICIENCY-NOT IMMEDIATELY DANGEROUS TO LIFE OR HEALTH | An atmosphere having an oxygen concentration below the minimum legal requirement (see Table 1) but above that which is immediately dangerous to life or health.                                                                                                  |
| PERMISSIBLE EXPOSURE LIMIT (PEL)                              | The legally established time-weighted average (TWA) concentration or ceiling concentration of a contaminant that shall not be exceeded.                                                                                                                          |
| POSITIVE PRESSURE RESPIRATOR                                  | A respirator in which the air pressure inside the respiratory-inlet covering is positive during exhalation and inhalation in relation to the air pressure of the outside atmosphere.                                                                             |

PROTECTION  
FACTOR

The ratio of the ambient concentration of an airborne substance to the concentration of the substance inside the respirator at the breathing zone of the wearer. The protection factor is a measure of the degree of protection provided by a respirator to the wearer.

RESPIRATOR

A device designed to protect the wearer from inhalation of harmful atmospheres. See Section 5, Classification, Description, and Limitations of Respirators, and Tables 3 and 4.

SERVICE LIFE

The period of time that a respirator provides adequate protection to the wearer, such as the period of time that an air-purifying device is effective for removing a harmful substance from inspired air.

TIME-WEIGHTED  
AVERAGE (TWA)

The average concentration of a contaminant in air during a specific time period.

## APPENDIX J

### OXYGEN DEFICIENCY -- IMMEDIATELY DANGEROUS TO LIFE OR HEALTH

An atmosphere which causes an oxygen partial pressure of 100 millimeters of mercury column or less in the freshly inspired air in the upper portion of the lungs which is saturated with water vapor is classified as "oxygen deficiency -- immediately dangerous to life or health." The rationale for this classification is that an oxygen partial pressure of 100 millimeters of mercury column in the freshly inspired air in the upper portion of the lungs, which is saturated with water vapor, corresponds to an oxygen partial pressure of 60 millimeters of mercury column in the alveoli of the lungs with a carbon dioxide partial pressure of 40 millimeters of mercury column is present in the alveoli of the lungs, and at these alveolar conditions the hemoglobin of the alveolar blood is 90% saturated, oxygen-deficiency symptoms become noticeable. Further details concerning oxygen deficiency will be found on pages 16 to 18 of "A Guide to Industrial Respiratory Protection," LA-6677-M, published by the Los Alamos Scientific Laboratory; on pages 140-148 of Volume I of "Patty's Industrial Hygiene and Toxicology," published by John Wiley and Sons, Incorporated, 1978; and in "Physiology of Respiration," published by Yearbook Medical Publishers Incorporated, 1965.

## APPENDIX

The oxygen partial pressure in the freshly inspired air in the upper portion of the lungs which is saturated with water vapor is calculated using the following equation:

Partial pressure of oxygen in freshly inspired air in upper portion of lungs in units of millimeters of mercury column =

$$\left( \begin{array}{l} \text{Atmospheric} \\ \text{air pressure} \\ \text{in units of} \\ \text{millimeters of} \\ \text{mercury} \\ \text{column} \end{array} - \begin{array}{l} 47.0 \\ \text{millimeters} \\ \text{of mercury} \\ \text{column} \end{array} \right) \times \begin{array}{l} \text{Decimal fraction} \\ \text{by volume of} \\ \text{oxygen in} \\ \text{atmospheric air} \\ \text{in workplace} \end{array}$$

NOTE: 47.0 millimeters of mercury column is the partial pressure of water vapor in the air in the upper portion of the lungs which is saturated with water vapor. The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Examples of calculations:

(1) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at sea level when the atmospheric air in the workplace has a normal oxygen concentration.

The atmospheric air pressure at sea level is 760.0 millimeters of mercury column.

The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$$(760.0 - 47.0) \times 0.2095 = 149.37 \text{ millimeters of mercury column}$$

(2) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at an altitude of 5000 feet above sea level when the atmospheric air has a normal oxygen concentration.

The atmospheric air pressure at an altitude of 5000

feet above sea level is 632.7 millimeters of mercury column.

The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$$(632.7 - 47.0) \times 0.2095 = 122.7 \text{ millimeters of mercury column}$$

(3) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at an altitude of 10 000 feet above sea level when the atmospheric air has a normal oxygen concentration.

The atmospheric air pressure at an altitude of 10 000 feet above sea level is 522.7 millimeters of mercury column.

The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$$(522.7 - 47.0) \times 0.2095 = 99.66 \text{ millimeters of mercury column}$$

(4) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at sea level when the concentration of oxygen in the atmospheric air in the workplace is 14.0% by volume.

The atmospheric air pressure at sea level is 760.0 millimeters of mercury column.

The concentration of oxygen in the atmospheric air in the workplace is 14.0% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$$(760.0 - 47.0) \times 0.14 = 99.82 \text{ millimeters of mercury column}$$

## APPENDIX K

### SELECTED REFERENCES

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