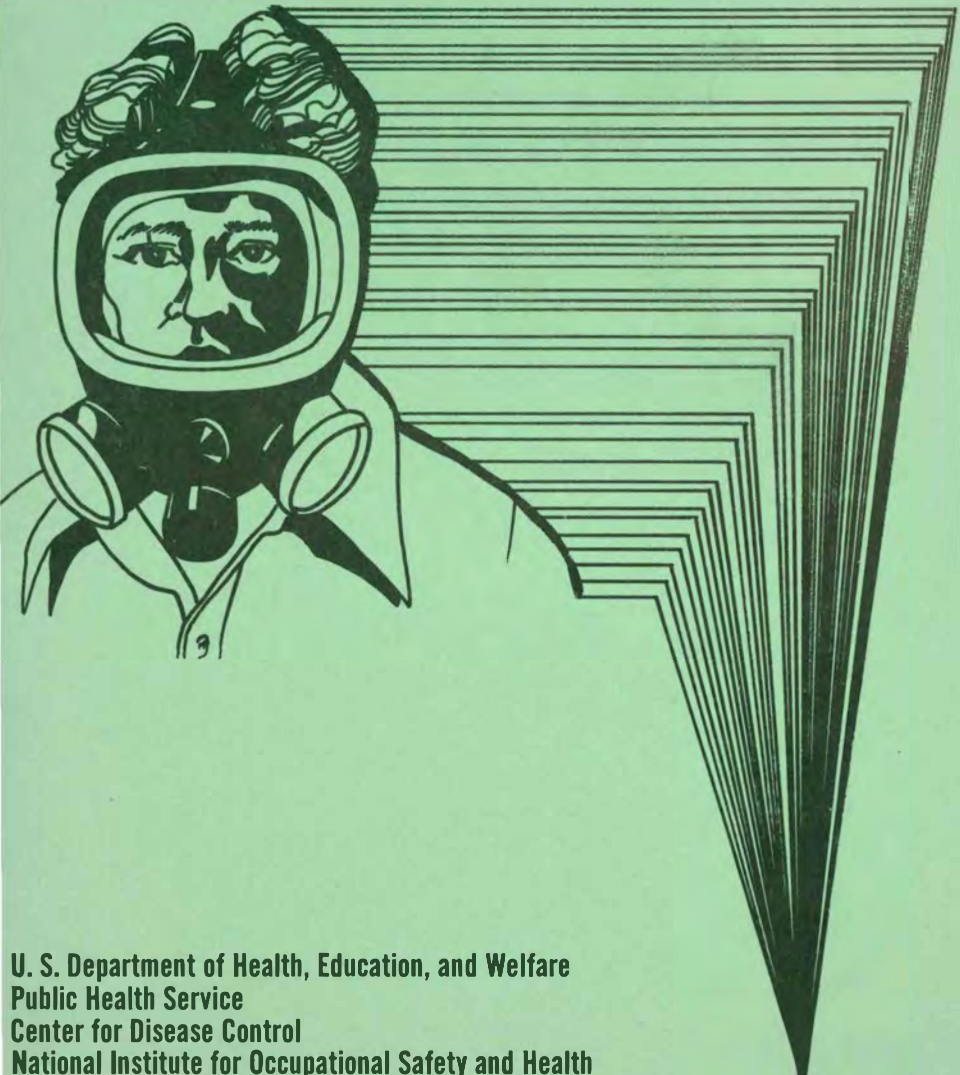
NIOSH

Respiratory Protection...

An Employer's Manual



U. S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

RESPIRATORY PROTECTION: AN EMPLOYER'S MANUAL

U.S. Department of Health, Education, and Welfare
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National Institute for Occupational Safety and Health
Division of Technical Services
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PREFACE

The Occupational Safety and Health Act of 1970 describes legal requirements for both the selection and maintenance of respiratory protective equipment and the instruction of employees in its use. The National Institute for Occupational Safety and Health (NIOSH) in the Department of Health, Education, and Welfare (DHEW) has written this manual to aid employers in setting up a respirator program.

The manual discusses respiratory protection requirements as they apply to the General Industry Standards, i.e., 29CFR1910. Not included are respiratory protection requirements as mandated by 29CFR1915-17 (ship repairing, ship building, ship breaking), 29CFR1918 (longshoring) and 29CFR1926 (construction). Readers desiring information pertaining to respiratory protection for these activities should consult the appropriate titles listed.

This manual discusses the major components of an acceptable program — as described by Federal law. A section is also included which can be used as the basis for an employee training program.

The manual is written especially to aid the small or non-technically oriented employer in complying with the OSHA requirements for respiratory protection. It is meant to complement, not to replace, other publications which may be available including NIOSH Publication 76-189, "A Guide to Industrial Respiratory Protection," and materials prepared by the American Industrial Hygiene Association (AIHA) and the American Conference of Governmental Industrial Hygienists (ACGIH).

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ACKNOWLEDGMENTS

This Manual was prepared under the direction of Gerald J. Karches, Chief, Technical Information Development Branch (TIDB), Division of Technical Services, National Institute for Occupational Safety and Health (NIOSH), with the help of individuals from the Division of Safety Research. P.A. Froehlich, Chief, Technical Publications Development Section, TIDB, had responsibility for preparation of the Manual. Principal contributors to its development were: Thomas F. Bloom, Industrial Hygiene Engineer; TIDB, Walter Ruch, Ph.D., Regional Consultant for Occupational Safety and Health, Region X; George Pettigrew Regional Consultant for Occupational Safety and Health, Region VI; Donna Berry, Industrial Hygienist, TIDB. Comments on this manual are encouraged.

I. GENERAL OVERVIEW: THE EMPLOYER AND RESPIRATORY PROTECTION

A. WHY RESPIRATORY PROTECTION IS REQUIRED

The Occupational Safety and Health Administration (OSHA) has set maximum exposure standards for many airborne toxic materials. If employee exposure to these substances exceeds the standard, the law requires that feasible engineering controls and/or administrative controls be installed or instituted to reduce employee exposure to acceptable levels. If these controls do not prove feasible, or while they are being installed/instituted, the *employer is required* to provide appropriate respiratory protection for the employee. Respiratory protection is also *required* when working in oxygen deficient atmospheres, i.e., where the oxygen content in the breathable air is insufficient. Respiratory protection may also be necessary for routine but infrequent operations, for non-routine operations in which the employee is exposed briefly to high concentrations of a hazardous substance, e.g., during maintenance or repair activities, or during emergency conditions.

B. THE RESPIRATORY PROTECTION PROGRAM

Providing respiratory protective equipment to the employee, however, is only one aspect of the employer's responsibility pertaining to the use of respiratory protective equipment as a control measure. A respiratory protection program must be implemented.

The basic elements of a program are outlined briefly in the following text.

The program is "established" by management, and an individual is designated to head the program. This person develops the standard operating procedure. This operating procedure describes the following program aspects:

- The basis for selection of a specific type of respiratory protective equipment.
- Provision for medical screening of each employee assigned to wear respiratory equipment to determine if he/she is physically or psychologically able to wear a respirator.
- Provisions for assigning respiratory protective equipment to employees for their exclusive use, where practical.
- Provisions for testing for the proper fit of the respiratory protective equipment.
- Provisions for regularly cleaning and disinfecting the respiratory protective equipment.
- Provisions for proper storage of respiratory protective equipment.
- Provisions for periodic inspection and repair of respiratory protective equipment.
- A periodic evaluation by the administrator of the program to assure its continued functioning and effectiveness.
- An employee training program in which the employee can become familiar with the respiratory protective equipment, and be trained in the proper use and the limitations of the equipment.

The above "program" *must* be instituted as a control measure only after it has been determined that: (1) employee exposure to chemical agents exceeds established limits (OSHA standards), and (2) engineering controls to alleviate the exposure are not feasible, or (3) while engineering controls are being implemented. However, even if you do not have operations in which employee exposure to a substance will exceed the standards, a respirator protection program *should* be developed to address the *infrequent necessary* use of respirators.

The following sections discuss, in some detail, each of the above aspects. The Exhibits referenced provide *examples* of what might be included in a company's safety manual. See Appendix IX.

II. ESTABLISHMENT OF THE RESPIRATORY PROTECTION PROGRAM

Designation of Responsible Person to Administer the Program. This individual is responsible for coordinating the various aspects of the program. The person's technical and professional background should enable him or her to make sound decisions based on an evaluation and understanding of workplace hazards. Preferably, the individual should be a safety engineer, industrial hygienist, or physician. In a small company, especially where respirator usage is limited, the program may be directed by the company owner, foreman, or other supervisory personnel. Regardless of who assumes responsibility for the program, the individual should have the full support of high level management.

III. RESPIRATOR SELECTION PROCEDURE

The proper selection of respiratory protective equipment involves three *basic* steps: (1) the identification of the hazard, (2) the evaluation of the hazard, and (3) finally the selection of the appropriate approved respiratory equipment based on the first two considerations.

A. IDENTIFICATION OF THE HAZARD

Identification (and evaluation) of the hazard forms the basis for a decision on the need for the respirator program. If a survey of operations and work environments indicates that no employees are being exposed to contaminant concentrations exceeding established limits (OSHA standards) then a respirator program is not required. However, your company may be using unregulated substance(s) for which there is no standard. An "in-house" evaluation may have indicated the *need* for respiratory protection equipment for this substance.

Whether management is undertaking a survey (and evaluation) to determine the need for a program, or has already determined (from in-house or outside consultants) the need for respiratory equipment, this section will provide insight for both management and employees into the selection process.

When a survey to determine the need for respirators is to be undertaken, it is important, initially, to know something about the different kinds of hazardous atmospheres which may require the use of respirators.

1. Gaseous Contaminants

Gaseous contaminants add another invisible material to what is already a mixture of invisible gases — the air we breathe. These contaminants are of two types.

a. Gases are the normal form of some substances, e.g., carbon dioxide. Such substances are solids or liquids only at much lower temperatures or much higher pressures than are commonly found in an industrial environment. Carbon dioxide, for instance, is a gas at room temperature. But it also occurs as solid "dry ice" at low temperatures, or as a liquid in pressurized tanks.

b. Vapors are like gases except that they are formed by the evaporation of substances, such as acetone or trichloroethylene, which ordinarily occur as liquids.

2. Particulate Contaminants

Particulate contaminants are made up of tiny particles or droplets of a substance. Many of these particles are so small that they float around in the air indefinitely and are easily inhaled. There are three types of particulates:

a. Dusts are solid particles produced by such processes as grinding, crushing, and mixing of powder compounds. Examples are sand and plaster dust.

b. Mists are tiny liquid droplets given off whenever a liquid is sprayed, vigorously mixed, or otherwise agitated. Acid mists around diptanks used for metal cleaning, and oil mists near newspaper printing presses are two examples.

c. Fumes are solid condensation particles of extremely small particle size. Fumes are found in the air near soldering, welding, and brazing operations, as well as near molten metal processes such as casting and galvanizing.

3. Combination Contaminants

The two basic forms — gaseous and particulate — frequently occur together. Paint spraying operations, for example, produce both paint mist (particulate) and solvent vapors (gaseous).

4. Oxygen Deficient Atmospheres

In an oxygen deficient atmosphere, the problem is not the presence of something harmful, but the absence of something essential. These atmospheres are most commonly found in confined and usually poorly ventilated spaces. Oxygen deficient atmospheres are classified as immediately dangerous to life (see following discussion). Examples are silos, petrochemical tanks, and the holds of ships. In some situations, an oxygen deficient atmosphere is purposely maintained. For instance, fruit is sometimes kept in warehouses with a high carbon dioxide concentration and a small oxygen concentration. Oxygen deficient atmospheres occur in two different ways:

a. Oxygen may be "used up'' by a chemical reaction. This is what happens when fire burns.

b. Oxygen is replaced by another gas. If a room with normal air (approximately 21% oxygen) fills up with another gas, e.g., helium, there will be a smaller amount of oxygen available for breathing because some of it will have been displaced by the helium gas.

A more detailed discussion of oxygen deficient atmospheres can be found in Appendix II.

5. Immediately Dangerous to Life or Health

This is a term which is used to describe very hazardous atmospheres where employee exposure can:

a. Cause serious injury or death within a short time. Examples are employee exposure to high concentrations of carbon monoxide or hydrogen sulfide.

b. Cause serious delayed effects. Employee exposure to low concentrations of radioactive materials or cancer-causing agents are examples.

B. EVALUATION OF THE HAZARD

A walk-through survey of the plant to identify employee groups or processes, or worker environments where the use of respiratory protective equipment may be required, is the next step in the respirator selection process.

1. The Hazard Survey

The walk-through survey to identify and quantify the hazardous substances or conditions that require respiratory protective equipment can be facilitated by reference to the below listed Appendices and by use of the Hazard Evaluation Form (see Figure 1).

a. Appendix I: This Appendix discusses some typical methods and instruments used in determining the concentration of airborne contaminants. However, only qualified individuals must use these instruments and interpret the results. If the facility does not have in-house qualified personnel, outside consultation will be required (see Appendix V).

b. Appendix II: This Appendix discusses oxygen deficient atmospheres and points out some of the "definitions" of an oxygen deficient atmosphere.

c. Appendix III: This Appendix itemizes specific OSHA standards where the use of respiratory protective equipment is required.

d. Appendix VII: This Appendix describes some of the various types of respiratory protective equipment used in reducing and

Figure 1

Respiratory Protective Equipment
Hazard Evaluation Form

Company ______________________ Date ____________

Division ______________________ By ____________

Department ______________________ Page ____________

Employee	Job Description	Respiratory Equipment Required by OSHA Standard see Appendix III	Exposure Substance(s)	Oxygen Deficient Atmosphere see Appendix II		Measured Concentration see Appendix I	OSHA Limit see Appendix V	Respiratory Protection Required		Respiratory Equipment Type-SCP see Appendix IV & VII	Remarks
				YES	NO			YES	NO		

preventing exposure to air contaminants. The Appendix does not attempt to cover all makes and models of available respiratory protective equipment.

The Hazard Evaluation Form (see Figure 1) should be filled out, as completely as possible, during the walk-through survey. Be sure to enter any details about the work environment which could (ultimately) affect the choice of (or negate the requirement for) respiratory protective equipment.

Exhibit II illustrates a statement governing the procedure for selection of respiratory protective equipment.

C. PURCHASE OF RESPIRATORY EQUIPMENT

If the evaluation of results of the walk-through survey indicate the need for corrective action, and if the decision has been made to use respiratory protective equipment, the next step is the actual purchase of the equipment. The program administrator should have the authority to approve the purchase of respiratory protective equipment.

1. Approval

When purchasing respiratory protective equipment, be sure to purchased *approved* equipment for the particular contaminant. An approved respirator is one that has been tested and 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. A *NIOSH* approved respirator contains the following:

- An assigned identification number placed on each unit, e.g., TC-21C-101.
- A label identifying the type of hazard the respirator is approved to protect against.
- Additional information on the label which indicates limita-

tions and identifies the component parts approved for use with the basic unit.

b. In the past, the Bureau of Mines (BOM) approved respirators. The BOM no longer grants approval; however, some older respirators which were BOM-approved may still be used.

- BOM-approved self-contained breathing apparatus (SCBA) may be used until March 31, 1979.
- BOM-approved supplied air respirators may be used until March 31, 1980.
- BOM-approved gas masks may be used until a date as yet not established.

IV. MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

The use of any type of respirator may impose some physiological stress on the user. *Air-purifying respirators,* for example, make breathing more difficult because the filter or cartridge impedes the flow of air. The special exhalation valve on an *open circuit pressure demand respirator* requires the wearer to exhale against significant resistance. The bulk and weight of an SCBA can be a burden. If the wearer is using an *airline respirator,* he/she might have to drag up to 300 feet of hose around. All of the above factors can significantly increase the employee's workload. The wearer should at least have a cursory medical examination to determine if he/she is medically able to wear respiratory protective equipment without aggravating a pre-existing medical problem. Some medical aspects to be considered by an examining physician are detailed in Appendix VI.

While a medical examination by a physician is the preferred screening mechanism for respirator usage, the following checklist will give a good indication of the prospective user's ability to wear a respirator.

- Lung —History of asthma or emphysema.
  —Difficulty in breathing.
  —Previously documented lung problems.

- Heart: —High blood pressure.
  —Artery diseases.
  —Documented heart problems.
- Other —Missing or arthritic fingers.
  —Facial scars.
  —Claustrophobia.
  —Poor eyesight.

A "yes" answer to any of the preceding questions would constitute a warning sign regarding the use of respirators. A medical opinion to confirm any of the above situations (answered "yes") should then be obtained.

Exhibit IV illustrates a policy statement concerning the medical aspect of respirator usage.

V. ISSUANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

Where practical, the user should be given respiratory protective equipment for his/her exclusive use. A system of user cards and a journal can be established to keep track of all employees who are issued respiratory protective equipment. The administrator issues a wallet-sized card to the user showing what respirator the user is to wear and what the contaminant is. A record of issuance of the card is kept in the journal. The user can only obtain the respirator specified on his card. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark must not affect the fit or performance in any way.

Exhibit V illustrates a policy statement and a use card and journal scheme.

VI. RESPIRATORY PROTECTIVE EQUIPMENT FITTING

It is essential that respiratory protective equipment be properly fitted to the employee when it is issued. All the care that went into the design and manufacture of a respirator to maximize protection will not protect the wearer fully if there is an improper match between facepiece and wearer, or improper wearing practices. There are two considerations with respect to proper fit.

- Assuming that there are several brands of a particular type of *facepiece* available (you should provide several to choose from), which *one* fits best?
- How does the *user* know when the respirator fits properly?

The answers to the above questions can be determined by the use of a fitting test.

A. TYPES OF FITTING TESTS

There are two types of fitting tests: qualitative and quantitative tests. *Qualitative* tests are fast, usually simple, but not as accurate an indicator of improper fit as the quantitative test. The *quantitative* test, although more accurate, requires the purchase of expensive equipment, requires a specially trained operator, and in many instances is of limited use due to its complexity and bulk.

Two other qualitative fit tests, the positive pressure fit test and the negative pressure fit test, can be used as a quick check of the fit of the respirator facepiece before beginning or during work in the hazardous atmosphere. These tests would apply only to the air-purifying respirators.

Appendix VIII presents a discussion on the various types of fitting tests — both qualitative and quantitative. The program administrator should choose the best method(s) suited for the program and demonstrate and explain the method(s) to the respiratory protective equipment users.

B. FREQUENCY OF FITTING TESTS

Fitting tests should be repeated at appropriate intervals, particularly when there is a change in the wearer's physical status — such as growth of facial hair or change in face contours.

C. SPECIAL PROBLEMS IN RESPIRATOR FITTING

Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal. Items such as beards and sideburns can prevent satisfactory sealing. The sealing problem is especially critical when non-powered air-purifying respirators are used. The negative pressure developed in the facepiece of these respirators during inhalation can lead to leakage of contaminant into the facepiece when there is a poor seal. Some atmosphere supplying respirators of the *airline type,* due to their mode of operation, can also lead to leakage at the sealing surface. Therefore, individuals who have stubble (even a few days' growth may permit excessive leakage of contaminant), a moustache, sideburns, or a beard that passes between the skin and the sealing surface should not wear a respirator.

Corrective lenses that have temple bars or straps should not be used when a full-facepiece respirator is worn since the bars or straps could pass through the facepiece to face seal. Manufacturers of respiratory protective equipment can provide kits for installing eyeglasses in their respirator facepieces. These glasses or lenses must be mounted by a qualified individual to insure proper fitting.

Contact lenses should not be worn while wearing a respirator, especially in a highly contaminated atmosphere. A properly fitted respirator (primarily a full facepiece respirator) may stretch the skin around the eyes, thus increasing the possibility that the contact lens will fall out. Also, contaminants that do penetrate the respirator may get underneath the contact lens and cause severe discomfort. The user's first reaction would be to remove the facepiece to remedy the situation — which could be fatal in a lethal environment.

Exhibit VI illustrates a policy statement concerning equipment fitting procedures.

VII. MAINTENANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

On-going maintenance of respiratory protective equipment is an important part of the program. Wearing poorly maintained or malfunctioning equipment may be, in a sense, as dangerous as not wearing a respirator. Employees wearing a malfunctioning respirator think they are protected, when, in reality, they are not. The consequences of this situation can be fatal.

While OSHA places strong emphasis on the importance of an adequate maintenance program, it does permit the tailoring of the maintenance program to the type of plant and hazards involved. All maintenance programs should follow manufacturer's instructions and should include provisions for:

- Cleaning and disinfecting of equipment;
- Storage;
- Inspection for defects; and
- Repair

Exhibit VI illustrates a policy statement concerning respiratory protective equipment maintenance.

A. CLEANING AND DISINFECTING

In large programs where respiratory protective equipment is used routinely, respirators should be cleaned and disinfected daily. In small programs where respirators are used occasionally, periodic cleaning and disinfecting is appropriate. Individual workers who maintain their own respirator should be trained in the cleaning of respirators.

1. Methods

The actual cleaning may be done in a variety of ways.

a. The respiratory protection equipment should be washed with detergent in warm water using a brush, throughly rinsed in clean water, and then air dried in a clean place. Care should be taken to prevent damage from rough handling. This method is an accepted procedure for a small respirator program or where each worker cleans his/her own respirator.

b. A standard domestic-type clothes washer may be used if a rack is installed to hold the facepieces in a fixed position. (If the facepieces are placed loose in a washer, the agitator may damage them.) This method is especially useful in large programs where respirator usage is extensive.

2. Detergents and Disinfectants

If possible, detergents containing a bactericide should be used. Organic solvents should not be used, as they can deteriorate the rubber facepiece.

a. If the above combination is not available, a detergent may be used, *followed by a disinfecting rinse.* Reliable disinfectants may be made from some available household solutions.

- Hypochlorite solution (50ppm of chlorine) made by adding approximately 2 tablespoons of chlorine bleach per gallon of water. A 2-minute immersion disinfects the respirators.
- Aqueous solution of iodine (50ppm made by adding approximately 1 teaspoon of tincture of iodine per gallon of water). Again, a 2-minute immersion is sufficient and will not damage the rubber and plastic in the respirator facepieces. Check with the manufacturer to find out the proper temperature for the solutions.

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

B. RINSING

The cleaned and disinfected respirators should be rinsed thoroughly in clean water (120°F maximum) to remove all traces of detergent, cleaner and sanitizer, and disinfectant. *This is very important to prevent dermatitis.*

C. DRYING

The respirators may be allowed to dry by themselves on a clean surface. They also may be hung from a horizontal wire, like drying clothes, but care must be taken not to damage the facepieces.

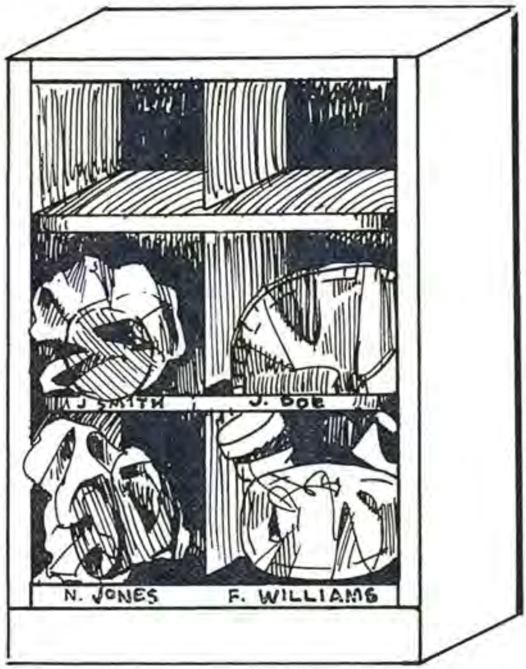
D. STORAGE OF EQUIPMENT

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.

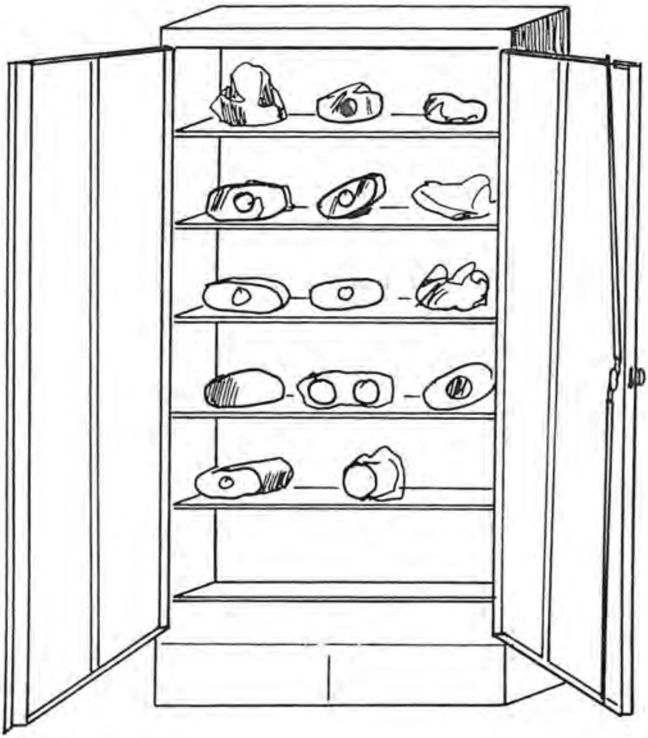
After cleaning and disinfecting the respirators, they should be placed individually in heat-sealed or resealable plastic bags until reissue. They should be stored in a single layer with the facepiece and exhalation valve in a more or less normal position to prevent the rubber or plastic from taking a permanent distorted "set."

1. 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 with six compartments is shown below.



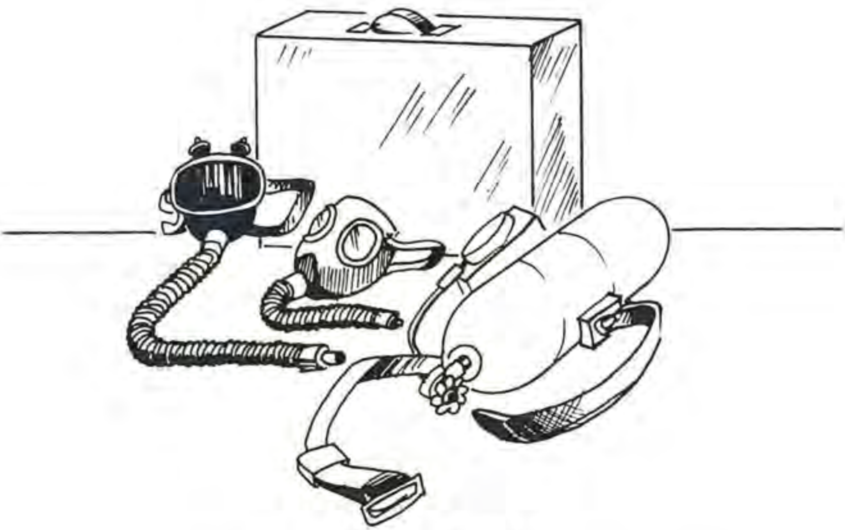
Note that each compartment is clearly labeled with the user's name and that the respirators are in plastic bags.



Another acceptable method of storage in a standard steel storage cabinet is shown above. Note that the respirators are stored in a single layer.

2. Air-supplying Respiratory Protective Equipment

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



Storage Chest for SCBA

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

E. REPAIR OF RESPIRATORY PROTECTIVE EQUIPMENT

Continued usage of respiratory protective equipment may require periodic repair or replacement of component parts of the equipment. Such repairs and parts replacement must be done by a qualified individual(s).

Replacement of parts and repair of *air-purifying* respirators should, in most cases, present little problem. Most, if not all, equipment manufacturers supply literature which detail the component parts of their respirator and also include servicing information. The manufacturer will also provide replacement parts. Replacement parts for respiratory protective equipment *must* be those of the manufacturer of the equipment. *Substitution of parts from a different brand or type of respirator will invalidate the approval of the respirator.*

Defective air-supplying respiratory protective equipment, with the exception of the SCBA, can be repaired and worn if broken parts are replaced by a qualified individual — again with the aid of the manufacturer's literature and parts. Maintenance of SCBA equipment, however, is more difficult, primarily because of the valve and regulator assembly. Because of this, regulations *require* SCBA equipment to be returned to the manufacturer for adjustment or repair.

VIII. INSPECTION FOR DEFECTS

An important part of a respirator maintenance program is the inspection of the devices. If performed carefully, inspections will identify damaged or malfunctioning respirators.

Exhibit VII illustrates a policy statement concerning inspection procedures.

A. INSPECTION SCHEDULES

All respiratory protective equipment must be inspected:
- before and after each use; and
- during cleaning.

Equipment designated for emergency use must be inspected:
- after each use;
- during cleaning; and
- at least monthly.

Self-contained breathing apparatus must be inspected
- at least monthly.

B. RECORDKEEPING

A record must be kept of inspection dates and findings for *respirators maintained for emergency use.*

C. INSPECTION CONSIDERATIONS

This section itemizes some of the primary defects to look for in inspection of the components of the respirator. When appropriate, information within the parentheses are suggested actions to be taken. In many cases, you will have to contact the manufacturer of the equipment or the equipment vendor.

1. Disposable respirator — check for:

- holes in the filter (obtain new disposable respirator);
- straps for elasticity and deterioration (replace straps — contact manufacturer); and
- metal nose clip for deterioration, if applicable (obtain new disposable respirator).

2. Air-purifying respirators (quarter-mask, half-mask, full facepiece, and gas mask)

a. Rubber facepiece — check for:
- excessive dirt (clean all dirt from facepiece);
- cracks, tears, or holes (obtain new facepiece);
- distortion (allow facepiece to "sit" — free from any constraints and see if distortion disappears; if not, obtain new facepiece); and
- cracked, scratched, or loose fitting lenses (contact respirator manufacturer to see if replacement is possible; otherwise, obtain new facepiece).

b. Headstraps — check for:
- breaks or tears (replace headstraps);
- loss of elasticity (replace headstraps);
- broken of malfunctioning buckles or attachments (obtain new buckles); and
- excessively worn serrations on the head harness which might allow the facepiece to slip (replace headstrap).

c. Inhalation valve, exhalation valve — check for:
- detergent residue, dust particles, or dirt on valve or valve seat (clean residue with soap and water);

• cracks, tears, or distortion in the valve material or valve seat (contact manufacturer for instructions); and
• missing or defective valve cover (obtain valve cover from manufacturer).

d. Filter element(s) — check for:
• proper filter for the hazard;
• approval designation;
• missing or worn gaskets (contact manufacturer for replacement);
• worn threads — both filter threads and facepiece threads (replace filter or facepiece, whichever is applicable);
• cracks or dents in filter housing (replace filter);
• deterioration of gas mask cannister harness (replace harness); and
• service life indicator, or end of service date — for expiration, gas mask (contact manufacturer to find out if your filter element has one; if not, ask what will indicate the "end of service").

e. Corrugated breathing tube (gas mask) — check for:
• cracks or holes (replace tube);
• missing or loose hose clamps (obtain new clamps); and
• broken or missing end connectors (obtain new connectors).

3. Atmosphere Supplying Respirators

a. Check *facepiece, headstraps, valves, and breathing tube,* as for air-purifying respirators.

b. Hood, helmet, blouse, or full suit, if applicable — check for:
• rips and torn seams (if unable to repair the tear adequately, replace);
• headgear suspension (adjust properly for you);
• cracks or breaks in faceshield (replace faceshield); and
• protective screen to see that it is intact and fits correctly over the faceshield, abrasive blasting hoods, and blouses (obtain new screen).

c. Air supply system — check for:
• breathing air quality;

- breaks or kinks in air supply hoses and end fitting attachments (replace hose and/or fitting);
- tightness of connections;
- proper setting of regulators and valves (consult manufacturer's recommendations); and
- correct operation of air-purifying elements and carbon monoxide or high-temperature alarms.

d. Self-contained breathing apparatus (SCBA)

- consult manufacturer's literature.

IX. RESPIRATOR USE UNDER SPECIAL CONDITIONS

A. DANGEROUS ATMOSPHERES

If respiratory protective equipment usage in atmospheres "immediately dangerous to life or health" (see page 5 for definition) is anticipated, special preparations must be made. A standard operating procedure for work in high hazard areas must be written.

The standard operating procedure must cover at least the following:

- Individuals designated to enter into dangerous atmospheres must have training with the proper equipment, i.e., self-contained breathing apparatus (SCBA). These individuals *must* be equipped with safety harnesses and safety lines so that they can be removed from the atmosphere if necessary.
- Designation and provision of a standby individual, equipped with proper rescue equipment, who *must* be present in a *nearby* safe area for possible emergency rescue.
- Provision for communication between persons in the dangerous atmosphere and the standby person *must* be made. Communication may be visual or by voice, signal line, telephone, radio, or other suitable means.

Other important data such as toxicologic information and emergency phone numbers should also be included.

B. CONFINED SPACES

Confined spaces are defined as enclosures that are usually difficult to get out of, such as storage tanks, tank cars, boilers, sewers, tunnels, pipelines, and tubs. In many cases, confined spaces contain toxic air contaminants, are deficient in oxygen (see Appendix II), or both. As a result, special precautions must be taken:

- Before entering a confined space, tests should be made to determine the *presence* and *concentration* of any flammable gas, toxic airborne particulate, vapor, gas, and oxygen concentration (see Appendix I).
- If a flammable substance in the *explosive range* is present, the confined space must be force ventilated to keep the concentration well below the lower explosive limit. The concentration of contaminant or oxygen percent should be continuously monitored while individuals are working in the confined space.
- Only individuals specially trained should be allowed to enter confined spaces and the *proper* respiratory protective equipment must be worn.
  —Air-purifying respirators and airline and hose mask-type supplied-air respirators may be worn in a confined space only if the tests show that the atmosphere contains adequate oxygen and that air contaminants are well below levels immediately dangerous to life or health. While individuals wearing these types of respirators are in a confined space, the atmosphere must be monitored continuously.
  —If the atmosphere in a confined space is immediately dangerous to life or health due to a high concentration of air contaminant or oxygen deficiency, those entering the space must wear a positive pressure SCBA or a combination airline and a positive pressure self-contained breathing respirator.
- A standby individual with proper rescue equipment, including an SCBA, must be present outside the confined space for possible emergency rescue. Communication must be maintained via voice, signal line, telephone, etc., between individuals in the confined space and the standby person. Those individuals inside the confined

space must be equipped with safety harnesses and safety lines to allow removal in case of emergency.

C. LOW AND HIGH TEMPERATURE

Use of respiratory protective equipment in low temperatures can create several problems. The lenses of the full facepiece equipment may fog due to condensation of the water vapor in the exhaled breath. Coating the inner surface of the lens with an anti-fogging compound will reduce fogging. Nose cups that direct the warm, moist exhaled air through the exhalation valve without touching the lens are available from the manufacturer for insertion into the full facepiece. At low temperatures, the *exhalation* valve can freeze onto the valve seat due to the moisture in the exhaled air. The user will be aware when this situation occurs by the increased pressure in the facepiece. When unsticking the valve, be careful so as not to tear the rubber diaphragm.

Respirator usage in hot environments can put additional stress on the user. The stress can be minimized by using a light-weight respirator with low breathing resistance. In this respect, an *airline* type atmosphere-supplying respirator equipped with a vortex tube can be used. Since the vortex tube may either cool or warm the supplied air (depending on the connection and setting), this protection scheme can be used in both hot and cold environments.

X. RESPIRATORY PROTECTION PROGRAM: SURVEILLANCE EVALUATION

Two important aspects of the respirator program are the periodic surveillance of the work areas requiring usage of respirators, and an evaluation of the overall respirator program for effectiveness.

Exhibit IX illustrates a policy statement concerning program evaluation.

A. SURVEILLANCE OF WORK AREA CONDITIONS AND WORKER EXPOSURE

Many things such as changes in operation or process, implementation of engineering controls, temperature, and air movement can affect the concentration of the substance(s) which originally required the use of respirators. To determine the continued necessity of respiratory protection or need for additional protection, measurements of the contaminant concentration should be made whenever the above changes are made or detected. (See Appendix I.) A record of these measurements should be kept.

B. 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 protective 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 who require corrective lenses properly fitted?
- Are users prohibited from wearing contact lenses when using respirators?
- Is the facepiece to face seal tested in a test atmosphere?

f. Maintenance of respiratory protective 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?

XI. EMPLOYEE TRAINING PROGRAM

NOTES TO THE INSTRUCTOR

A. OUTLINE FORMAT

The suggested outline format allows the instructor to adapt the training program to the individual requirements of the facility. This may be accomplished in the following way:

- Where indicated in the outline, record the appropriate information for your facility, e.g., in what locations of your operations are respirators required, or which chemical exposures necessitate the use of respirators?
- Refer to specific information in the individual Appendices. For example, one Appendix contains a discussion of the various types of respirators available. Employees need not be aware of all the types, but only the one(s) they will be required to wear. Therefore, when the outline indicates that information from an Appendix is to be inserted at that point in the presentation, only that portion of the Appendix pertinent to your facility need be covered.

B. TRAINING FORMAT

When planning the training session, remember that trainees usually retain only about 20 percent of what they hear, about 40 percent of what they see, and about 70 percent of what they both see and hear. For best results, therefore, a program of lectures, supplemented by audiovisual materials and demonstrations, is recommended. Some suggestions are presented in the following text.

- Cover the material presented in the outline.
- Break the lecture at 30-45 minute intervals to allow the trainee to stand up and move around.
- Use blackboard, chart pad, or flip chart for emphasizing subject sequence and major points.
- Obtain slides and/or films from the National Safety Council, your trade association, or the manufacturer/supplier of the equipment you use and intersperse in the presentation, as appropriate.
- Illustrate specific areas with personal experiences or examples related to your operations.
- Have examples, as appropriate, of the respirators used in your facility available in the classroom.
- Highlight areas concerned with their operation or requirements.
- Supplement the material in this manual by covering company operating procedures and/or instructional material supplied by the equipment manufacturer/supplier.

C. INSTRUCTIONS TO TRAINEES

An integral part of the training program is the free exchange of information — and questions — between instructor and trainees. Therefore, the following comments (made by the instructor) are suggested at the beginning of the training session.

> "During this session your full participation is needed.
>
> - If you don't understand what's being discussed, ask questions.
> - If you have been involved in or are aware of accidents pertaining to specific areas covered, share them with us.
> - If you are aware of better approaches to reduce hazardous conditions, give us the benefit of your experience.
> - Finally, if there is additional information or guidance we can provide, identify the areas for us."

NOTES TO INSTRUCTOR

EMPLOYEE TRAINING PROGRAM

A. Why is respiratory protective equipment required?

1. The Occupational Safety and Health Administration

OSHA has set maximum exposure standards for many airborne toxic materials and has set standards governing specific working environments to protect your health. A recent evaluation of your working environment revealed that:

Notes to Instructor	Employee Training Program
Name work area List substances	*a.* In work areas (****), atmospheric concentrations of substances (****) were found to be above acceptable limits.
Describe activities Describe chemical exposure	*b.* Maintenance activities (****) during which you are exposed to (****) a high concentration for a short period of time, lead to excessive exposure.
Describe areas	*c.* Several areas (****) were found to be "oxygen deficient." (see Appendix II)
Name storage areas Describe emergency situation which could exist in your plant	*d.* Hazardous substances are stored at (****) and if these substances spill, etc., an emergency condition will exist, or (****).

2. Status of Engineering Controls

Suggested phraseology

(****) Since the company recognizes that respiratory protection is not the accepted method for control of airborne hazards, we are taking steps to implement *engineering* control solutions.

Plan to have . . .
Describe what controls are to be/being implemented

a. We (****) installed the following engineering controls (****)

Discuss administrative controls (rotating work schedules, spreading work over two shifts, etc.)

b. And the following administrative controls (****).
However, while the above steps are being implemented, respiratory protection will be required.

B. Respirator Selection and Procedure

Selection procedure of the proper equipment normally involves three steps: the *identification* of the hazard; the *evaluation* of the hazard; and finally the *selection* of the appropriate respiratory equipment based on the first two steps.

NOTES TO INSTRUCTOR

Discuss only those contaminant atmospheres representing problems in your facility. See following discussion.

EMPLOYEE TRAINING PROGRAM

1. Identification of the Hazard

Before we get into the "specifics" about the respiratory protective equipment you will be wearing, a few statements about hazard identification.

There are several kinds of hazardous atmospheres which may require the use of respirators. (****)

a. Gaseous Contaminants

Gases are the normal form of substances like carbon dioxide or hydrogen sulfide. These substances are solids or liquids only at very low temperatures or extremely high pressures. Carbon dioxide, for instance, is a gas at room temperature. But it also occurs as solid "dry ice" formed at low temperatures.

Vapors are exactly like gases except that they are formed by the evaporation of substances, such as acetone or trichlorethylene, which ordinarily occur as liquids.

b. Particulate Contaminants

Particulates are tiny particles, solid or liquid, generated by such processes as grinding, crushing, and mixing of a compound, either a solid or a liquid. There are three types of particulates.

Dusts are solid particles produced by such processes as grinding, crushing, and mixing of powder compounds. Examples are sand and plaster dust. By comparison to the following two types of particulates, dust particles are usually large.

Mists are tiny liquid droplets, usually formed whenever a liquid is sprayed, vigorously mixed, or otherwise agitated. Acid mists around diptanks used for metal cleaning, and oil mists near newspaper printing presses, are two examples.

Fumes are solid condensation particles of extremely small particle size. Fumes are found in the air near soldering, welding, and brazing operations, as well as near molten metal processes such as casting and galvanizing.

Two basic forms — gaseous and particulate — frequently occur together. Paint spraying operations, for example, produce both paint mist (particulate) and solvent vapors (gases).

A further discussion of ODA's can be found in Appendix II.

a. Oxygen Deficient Atmospheres (****). Oxygen deficient atmospheres (ODA) are most commonly found in confined spaces which have poor ventilation. Examples are silos, petrochemical tanks, degreasers, and the holds of ships.

NOTES TO INSTRUCTOR

After explaining to the employee the *type* of hazardous atmosphere (*a* and/or *b* and/or *c*) requiring respiratory protection, you should then discuss the hazard specifics. Check vendor literature, toxicologic references, or Material Safety Data Sheet (or contact OSHA or NIOSH regional offices).

See Figure I.
Refer to Appendix I to describe the type instrument used (optional).
See Appendix V.

See Appendix IV.

EMPLOYEE TRAINING PROGRAM

2. *Hazard Specifics (****)*
   a. Hazard Name
   - Organic vapor (name)
   - Particulate (name)
   - Gas (name)

   b. Toxicity Data (****)
   - Effects

3. *Evaluation of the Hazard (****)*
   a. To determine the concentration of the hazard, as identified above, measurements were made. (****) The concentration and/or work environment examined were compared with the published Federal Standards (****).
4. *Selection of the Respirator*
   a. After it was determined that respirators were required, the Standards Completion Program (SCP) was consulted to find out the required respiratory protection equipment (****).

C. Use and Proper Fitting of Respiratory Protective Equipment

1. Use of Respiratory Protective Equipment

Using Appendix VII and information supplied by the manufacturer, show the employee how to put on the selected respirator. Show the various components of the respirator, and how the respirator functions to remove the contaminants.

At this time, you should have available at least two different types (different manufacturers) of selected respiratory equipment — for the employee to try on.

2. Proper Fitting

So that respiratory protective devices, which use tight fitting facepieces, give maximum protection, there must be a proper "match" between the facepiece and your face. A poor face seal can cause contaminants to be inhaled through the respirator sealing surfaces, instead of through the canister, filter, or air supply system. (****)

a. In most cases, there are several different brands of the same type of respiratory protection equipment approved for use against a specific hazard or work environment. (****)

NOTES TO INSTRUCTOR

EMPLOYEE TRAINING PROGRAM

Refer to Appendix VIII for discussion of fitting tests. The qualitative fit tests can be used as a quick test to ascertain the proper fit. However, if respirator use will be in an extremely hazardous atmosphere, or for emergencies, the quantitative fit test should be used.
Demonstrate how the qualitative fit test works. Show illustration of a quantitative test set-up (if there is not an actual set-up on the premises).

b. However, just because a respirator "feels comfortable" it does not mean that it is protecting you to the fullest extent from the hazard. The key word is *proper* fit. To determine if the fit is proper, several tests can be used. (****)

Consult Appendix VII and the specific respiratory protective equipment — under Limitations.

D. Limitations of Respiratory Equipment (****)

However, the respiratory protective equipment that you will use does have some limitations on its usage.

E. Maintenance and Storage of Respiratory Equipment

To maintain the proper functioning of respirators requires that they be regularly cleaned and disinfected, and stored in a convenient and clear location.

Refer to Section VII(A) for details concerning cleaning of equipment. Several suggested cleaning methods are given. Discuss provisions.

1. Cleaning (****)

Your respiratory protective equipment should be cleaned daily after use. The company has made provisions for doing this. (****)

Refer to Section VII(B) and discuss storage provisions by company.

2. Storage (****)

Equipment must be stored properly at the conclusion of the work shift.

Refer to Section VIII for discussion on inspection for defects.

3. Inspection for Defects (****)

This is one of the most important functions associated with respirator usage. These inspections can identify damage to malfunctioning respiratory protective equipment.

NOTES TO INSTRUCTOR

Before you discuss this section with the user, you should first prepare the summary — as it applies to your usage.

EMPLOYEE TRAINING PROGRAM

F. Summary(****)

A summary of those aspects of the proper use of respiratory protective equipment. Reasons for Respiratory Protective Equipment.

1. *Respirator Selection Procedure*
   a. Identification of hazard.
   b. Hazard specifics.
   c. Evaluation of the hazard.
   d. Selection of the respirator.

2. *Proper Fitting and Usage*

   a. Use.
   b. Fitting.

3. *Limitations*

4. *Maintenance and Storage*

APPENDIX I

MECHANISMS FOR DETERMINATION OF CONCENTRATIONS OF HAZARDOUS SUBSTANCES

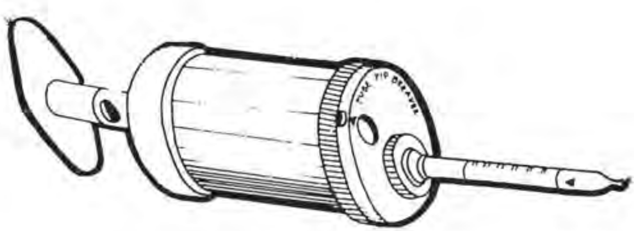
Once the hazard has been recognized and the hazardous substance identified, it is necessary to determine the *amount* (concentration) of contaminant present. The company may have qualified individuals in-house to make these measurements; however, if personnel are not availabe, it is best to seek outside assistance (see Appendix V).

A. EVALUATION METHODS

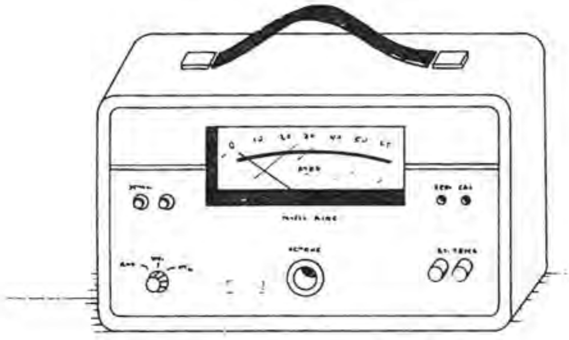
If the company has individuals capable of making determinations of the presence and concentrations of hazardous substances, there are several types of instrumentation available which can measure airborne contaminants. In evaluating a hazard for the purpose of respirator selection, it is usually sufficient to obtain a close estimate of the concentration rather than an *exact* level of the contaminant. This can, in many cases, be accomplished by the use of indicator tubes or direct-reading instruments, as opposed to collection of a sample on a media with subsequent laboratory analysis.

1. Gaseous and Vapor Contaminants

Gaseous contaminants are usually measured in parts per million (ppm) — parts of contaminants *per* million parts of air, or parts of contaminants per billion parts of air (ppb). A common *screening* device used is the detector tube. These tubes are available for many of the gases found in the work environment — from several different manufacturers. If possible, only detector tubes approved by NIOSH for the specific contaminant should be used for determination of gas and vapor concentrations. When using detector tubes, it is important to remember that the sample taken (into the tube) represents the concentration at a point in time and place and does not necessarily reflect the 8-hour time-weighted average (TWA) 40-hour week upon which the OSHA limits are based. Consequently, several samples at scheduled intervals through the 8-hour workday are recommended. As new detector tubes are approved, the reader can keep up to date by requesting *Cumulative Supplement - NIOSH* Certified Equipment (see Appendix XI). Direct-reading instruments are also available to measure many gases and vapors.



Detection Tube Measurement Equipment



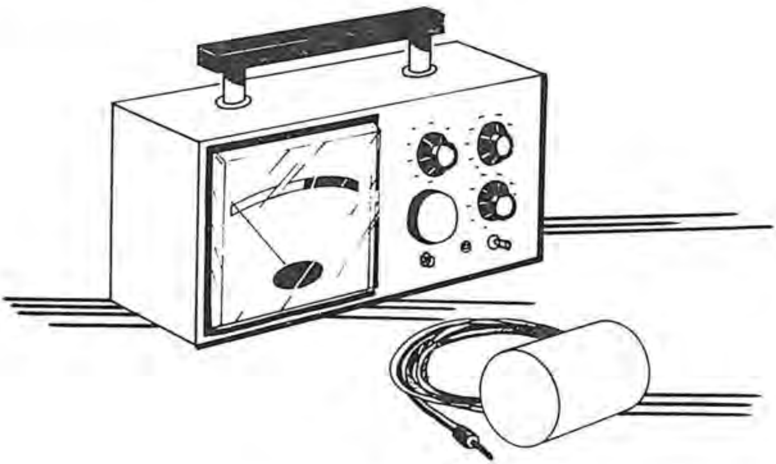
Direct-Reading Instrument for Carbon Monoxide

2. Particulate Contaminants

A majority of regulated particulate contaminants are usually measured in milligrams per cubic meter (mg/m^3) — milligrams of contaminant per cubic meter of air, million particles per cubic foot (mppcf) — millions of particles per cubic feet of air, e.g., 5mppcf would be five million particles per cubic foot of air, or fibers per cubic centimeter (fibers/cc) — fibers of contaminant per cubic centimeter of air. In contrast to the availability of measuring devices for gas and vapor contaminants, few direct-reading instruments are available for measurement of particulates. Those that are available indicate the *total* dust or *respirable dust concentration* and do not distinguish between the various materials making up the total dust concentration. To assess a specific particulate contaminant exposure, other than for nuisance dust, for respirator selection, in many cases it will usually be necessary to collect a sample on a filter with subsequent laboratory analysis.

3. Oxygen Deficient Atmospheres

There are several direct-reading instruments for measurement of oxygen content. One type is shown below:



Oxygen Indicator

B. INTERPRETATION OF MEASUREMENTS

The measured concentration (in appropriate units) is then compared with either the permissible exposure level (PEL), mandated in OSHA regulations, or the threshold limit value (TLV), recommended by the American Conference of Governmental Industrial Hygenists (ACGIH). These values, as determined by these groups, are the maximum concentration to which a worker may be exposed day after day without adverse affects.

APPENDIX II

OXYGEN DEFICIENT ATMOSPHERES

An atmosphere that does not contain enough oxygen to support the body metabolic process is called "oxygen deficient."

A. GENERAL PRINCIPLES

1. Normal Atmosphere

Earth's atmosphere has an essentially fixed composition of the following gases in the dry state.

Gas	*Volume*
Nitrogen	78.09
Oxygen	20.95
Argon	0.93
Carbon Dioxide	0.04

Normal air always contains small amounts of other gases such as neon, helium, and krypton. Water vapor, an important constituent of the normal atmosphere, may be up to 5% of the total volume.

2. Definition of Oxygen Deficient Atmosphere

An accurate description of an oxygen deficient atmosphere (ODA) is important for strictly physiological reasons and also for proper respirator selection. However, no one definition (value) has been universally accepted. The following table is a partial listing of definitions, based primarily on the volume percent (vol. %) of the oxygen in the atmosphere at sea level.

Definitions of Oxygen Deficient Atmosphere

Source	Oxygen Content (vol%)	Conditions for Determination
ACGIH Threshold Limit Values For 1973	18.0	"... under normal atmosphere pressure ..."
Federal Regulations 29 CFR Part 1915.S1 (Maritime Standards)	16.5	(not specified)
29 CFR Part 1910.94 (Ventilation Standards)	19.5	(not specified)
(Respirator Approval Tests)	19.5	"... by volume at sea level ..."
ANSI Standards Z88.2-1969 (Respirator Practices)	16.0	"... normal air ..."
Z88.5-1973 (Firefighting)	19.5	"... where oxygen partial pressure is less than 148 mm Hg at sea level ..."
K13.1-1973 (Marketing of air-purifying canisters and cartridges)	19.5	"... at sea level ..."

Note ANSI Standard Z86.1-1972, "Commodity Specification for Air," as revised in October 1974, specified 19.5-23.5 vol% O_2 for all grades of breathing air.

With the "acceptable" oxygen levels ranging from 16-19.5 vol% to choose from, the user's only guide is to follow the guidelines listed in the regulation by which his work is governed.

3. Effects

The symptoms of oxygen deficiency depend on the oxygen concentration present. The table below indicates physiological effects for varying oxygen content.

Effects of Oxygen Deficiency

O_2 Vol % At Sea Level	Physiological Effect
16-12	Increased breathing volume. Accelerated hearbeat. Impaired attention and thinking. Impaired coordination.
14-10	Very faulty judgment. Very poor muscular coordination. Muscular exertion causes rapid fatigue that may cause permanent heart damage. Intermittent respiration.
10-6	Nausea. Vomiting. Inability to perform vigorous movement, or loss of all movement. Unconsciousness, followed by death.
Less than 6	Spasmatic breathing. Convulsive movements. Death in minutes.

It is difficult to visualize the effect of ODA. The individual is not aware of the nature of his situation. Gradual depression of the central nervous system affects powers of discrimination, logic, and auditory acuity, with muscular weakness and lack of coordination. Since no distressful sensations are produced, the entire experience is comfortable and even pleasant. In reality, however, breathing in an ODA is like breathing under water.

APPENDIX III

RESPIRATOR REQUIREMENTS AS REQUIRED BY SPECIFIC OSHA STANDARDS

Several standards promulgated by OSHA require the use of a specific respirator type:

A. Abrasive Blasting

1. 1910.94 (a) (5-6)
   (d) (iv)

B. Spray Finishing

1. 1910.94 (c) (6) (iii)

C. Open Surface Tanks

1. 1910.94 (d) (a) (vi)
   (d) (11) (v)
   (d) (11) (vi)

D. Storage and Handling of Anhydrous Ammonia

1. 1910.111 (b) (10) (ii)

E. Welding, Cutting, and Brazing

1. 1910.252 (f) (1)
   (f) (4)
   (f) (5-10)

F. Pulp, Paper, and Paperboard Mills

1. 1910.261	(b) (2)	(g) (10)
	(d) (1) (i)	(g) (11) (ii)
	(f) (6) (iii)	(g) (15) (ii)
	(g) (2)	(g) (15) (v)
	(g) (4)	(h) (2) (iii-iv)
	(g) (6)	(ii-iii)

G. Textiles

1. 1910.262 (qq) (1-2)

H. Sawmills

1. 1910.265 (c) (17) (ii-iii)

I. Pulpwood Logging

1. 1910.266 (c) (1) (v)

J. Asbestos

1. 1910.1001 (d) (1-2)

K. Cotton Dust

1. 1910.1043 (f) (2)
2. 1910.1046 (d)

L. Carcinogens

1. 1910.1003-1016 (c) (4) (iv)
(c) (5) (i)
(c) (6) (vii) (a)
2. 1910.1017 (g) (4)
3. 1910.1029 (g) (2)

M. General Respirator Requirements

1. 1910.134

NOTE: Any of the above specific requirements may be modified or deleted by OSHA in response to the legislative process. Additions to the list are also possible. The reader can find out the status of the above requirements by contacting the nearest OSHA regional office.

APPENDIX IV

RESPIRATOR REQUIREMENTS AS SUGGESTED BY THE STANDARDS COMPLETION PROGRAM AND NIOSH CRITERIA DOCUMENTS

The Standards Completion Program (SCP), a joint OSHA/NIOSH venture undertaken to provide additional information (toxicity, handling requirements, sampling collection and analysis, fire data, etc.) for all presently regulated substances contained in OSHA Standards, has also determined respiratory protection "requirements"* for these substances. NIOSH Criteria Documents, which are transmitted to OSHA as recommended standards, also contain respiratory protection "requirements"† for the substance in question.

Respiratory protective equipment requirements under the SCP may be obtained by contacting the nearest OSHA regional office (see Appendix V).

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*The SCP information has not been promulgated into law and so respirator requirements, at this time, are not *required.*

†NIOSH Criteria Documents are *recommended* standards, and do not carry legal status.

APPENDIX V

SOURCES OF ASSISTANCE

Outside assistance may be required to determine the present OSHA standard for a substance, the protective equipment requirements suggested under the SCP, or the requirements recommended by NIOSH Criteria Documents. In addition, if in-house qualified personnel are not available, outside assistance will be necessary to determine the extent of employee exposure to hazardous substance.

Depending upon the employee's specific needs, several sources for such information or services are available: (a) Occupational Safety and Health Administration (OSHA-DOL); (b) National Institute for Occupational Safety and Health (NIOSH-DHEW); (c) State Occupational Safety and Health Programs; and (d) private consultants.

The following code system indicates which information or services can be obtained from a particular source:

CODE	INFORMATION
#1	OSHA Standards
#2	SCP Requirements
#3	Criteria Document Recommendation
#4	Consultative Services

A. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
Information/Services Available: #1, #2

Persons may call the nearest OSHA regional office to obtain respiratory protective information. (This will not result in a citation or inspection.) Federal OSHA personnel cannot make on-site consultative visits; however, Federal OSHA has contracted with several educational institutions to perform on-site consultative services — without citation. Contact the OSHA regional office for information concerning these services.

OSHA REGIONAL OFFICES

Region I
U.S. Department of Labor
Occupational Safety and Health Administration
JFK Building, Room 1804
Boston, Massachusetts 02203 .... Telephone: 617/223-6712/3

Region II
U.S. Department of Labor
Occupational Safety and Health Administration
1515 Broadway (1 Astor Plaza), Room 3445
New York, New York 10036 .... Telephone: 212/971-5941/2

Region III
U.S. Department of Labor
Occupational Safety and Health Administration
15220 Gateway Center, 3535 Market Street
Philadelphia, Pennsylvania 19104 .... Telephone: 215/596-1201

Region IV
U.S. Department of Labor
Occupational Safety and Health Administration
1375 Peachtree Street, N.E., Suite 587
Atlanta, Georgia 30309 .... Telephone: 404/526-3573/4 or 2281/2

Region V
U.S. Department of Labor
Occupational Safety and Health Administration
230 S. Dearborn, 32nd Floor
Chicago, Illinois 60604 .... Telephone: 312/353-4716/7

Region VI
U.S. Department of Labor
Occupational Safety and Health Administration
555 Griffin Square Building, Room 602
Dallas, Texas 75202 .... Telephone: 214/749-2477/8/9 or 2567

Region VII
U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building, Room 3000, 911 Walnut Street
Kansas City, Missouri 64106 .... Telephone: 816/374-5861

Region VIII
U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building, Room 15010, 1961 Stout Street
Denver, Colorado 80202 .... Telephone: 303/837-3883

Region IX
U.S. Department of Labor
Occupational Safety and Health Administration
9470 Federal Building, 450 Golden Gate Avenue
Post Office Box 36017
San Francisco, California 94102 .... Telephone: 415/556-0584

Region X
U.S. Department of Labor
Occupational Safety and Health Administration
6048 Federal Office Building, 909 First Avenue
Seattle, Washington 98174 .... Telephone: 206/442-5930

B. NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Information/Services Available: #3

Persons may contact NIOSH regional offices to obtain technical information about respiratory protective equipment.

NIOSH REGIONAL OFFICES

DHEW, Region I
JFK Federal Bldg.
Room 1401
Boston, Massachusetts 02203
617/223-6668

DHEW, Region II
26 Federal Plaza, Room 3300
New York, New York 10007
212/264-2485

DHEW, Region III
P. O. Box 13716
Philadelphia, PA 19101
215/596-6716

DHEW, Region IV
101 Marietta Tower
Atlanta, GA 30323
404/221-2396

DHEW, Region V
300 South Wacker Dr.
33rd Floor
Chicago, IL 60606
312/886-3651

DHEW, Region VI
1200 Main Tower Bldg.
Dallas, Texas 75202
214/655-3081

DHEW, Region VII
601 E. 12th St.
5th Floor West
Kansas City, Missouri 64106
816/374-5332

DHEW, Region VIII
11037 Federal Bldg.
Denver, Colorado 80294
303/837-3979

DHEW, Region IX
50 United Nation Plaza, Rm. 231
San Francisco, CA 94102
415/556-3781

DHEW, Region X
1321 Second Ave., Mail Stop 502
Seattle, Washington 98101
206/442-0530

C. STATE OCCUPATIONAL SAFETY AND HEALTH PROGRAMS
Information/Services Available: #1, #4.

Employers who are interested in the following services but do not know which state agency provides which service, should contact the nearest OSHA or NIOSH regional office for information.

1. State with Approved OSHA Plan

Presently, all states which have an approved OSHA plan, except Utah, have a consultative service program. This program, which is separate from the compliance program, provides on-site consultation to *employers* requesting assistance. Such consultations will not result in a citation or penalty.

2. States under Agreement with OSHA to Provide Consultative Service

Several states that do not have an OSHA plan have elected to enter into an agreement with OSHA to provide consultation. This program, conducted by an agency designated by the governor of each state, provides on-site consultation to employers requesting assistance. Such consultations will not result in a citation or penalty.

D. PRIVATE CONSULTATIVE SERVICES Information/Service Available: #4

A list of consultants can be obtained by writing the American Industrial Hygiene Associates; 475 Wolf Ledges Parkway; Akron, Ohio 44311.

APPENDIX VI

MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

A. GENERAL INFORMATION

So that the examining physician can render a qualified opinion regarding respirator usage by an employee, the physician, initially, should obtain from the employer the following information.

- Type of respiratory protection equipment to be used, and its modes of operation;
- The tasks that the employer will perform while wearing the respirator;
- Estimation of the energy requirements of the task (see Table 1);
- Visual and audio requirements associated with the task;
- Length of time that the user will wear the respiratory protective equipment; and
- The substance(s) to which the employee will be exposed, and the related toxicity data.

B. MEDICAL TESTS

The following medical tests might be considered by the examining physician in his/her evaluation:

- Pulmonary function test;
  - —FVC
  - —FEV_1
- Chest X-ray;
- Electrocardiogram;

- Blood tests;
- Eye test;
- Hearing test;
- Observation of the fit of the respirator on the employee; and
- Medical tests specific to the substance to which the employee will be exposed.

TABLE 1

Some Selected Types of Work Classed According to Estimated Workload Level*

Workload	*Energy expenditure range*
Level 1 — Resting	100 kcal/hr or less
Level 2 — Light	101 to 200 kcal/hr
Sitting at ease: light hand work (writing, typing, drafting, sewing, bookkeeping); hand and arm work (small bench tools, inspecting, assembly or sorting of light materials); arm and leg work (driving car under average conditions, operating foot switch or pedal). *Standing:* drill press (small parts); milling machine (small parts); coil taping; small armature winding; machining with light power tools; casual walking (up to 2 mph).	
Level 3 — Moderate	201 to 300 kcal/hr
Hand and arm work (nailing, filing); arm and leg work (off road operation of trucks, tractors or construction equipment); arm and truck work (air hammer operation, tractor assembly, plastering, intermittent handling of moderately heavy materials, weeding, hoeing, picking fruits or vegetables); pushing or pulling light-weight carts or wheelbarrows; walking 2-3 mph.	
Level 4 — Heavy	Above 301 kcal/hr
Heavy arm and truck work; transferring heavy materials; shoveling; sledge hammer work; sawing, planing or chiseling hardwood; hand mowing, digging, ax work; climbing stairs or ramps; jogging, running, walking faster than 4 mph; pushing or pulling heavily loaded hand carts or wheelbarrows; chipping castings; concrete block laying.	

*For accurate determination of a worker's energy expenditure on the job by measuring oxygen uptake of the man, refer to "Ergonomics Guides," *American Industrial Hygiene Association Journal,* 32 (8): Aug. 1971, p. 560-564.

C. MEDICAL FACTORS

Some factors to be considered by the examing physician in determining the prospective user's ability to wear a respirator are:

- Emphysema — individual may be unable to breathe adequately against the additional resistance of a respirator;
- Asthma — if the user suffers an asthma attack he would be likely to remove the respirator because of being unable to breath properly;
- Chronic bronchitis;
- Heart disease;
- Anemia;
- Hemophilia;
- Poor eyesight;
- Poor hearing;
- Hernia — can be aggravated by wearing/carrying respiratory protective equipment (SCBA);
- Lack of use of fingers or hands — respirators such as gas masks, supplied-air respirators, and self-contained breathing apparatus require connection and disconnection of parts and manipulation of valves and fittings during use. Persons with missing or disabled fingers may have difficulty in using these devices, particularly in an emergency where there is no one present to assist them; and
- Epileptic seizures.

D. EMOTIONAL/MENTAL FACTORS

Mental factors must also be taken into consideration when employees are required to wear respirators. Some individuals become claustrophobic when wearing a respirator. These individuals should not be required to wear respirators if the condition is severe enough to cause panic.

E. OTHER FACTORS

Scars, hollow temples, very prominent cheekbones, deep skin creases, and lack of teeth or dentures may cause respirator facepiece sealing problems. Dentures or missing teeth may cause problems in sealing a mouthpiece in a person's mouth. Full dentures should be retained when wearing a respirator, but partial dentures may or may not have to be removed, depending upon the possibility of swallowing them. With full lower dentures, problems in fitting quarter-masks can be expected, as the lower part of the mask tends to unseat the denture.

APPENDIX VII

RESPIRATORY PROTECTIVE EQUIPMENT

I. AIR-PURIFYING — PARTICULATE REMOVING FILTER RESPIRATORS

A. Description

These are generally called "dust," "mist," or "fume" respirators, and by a "filtering" action remove particulates before they can be inhaled.

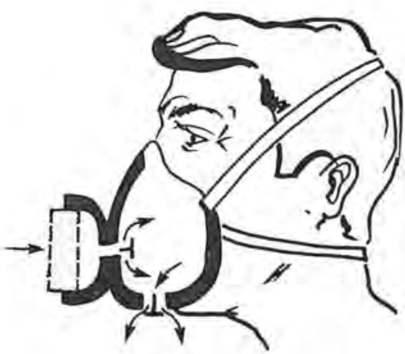
1. Single-use, dust

Single-Use Respirator

The single-use respirator is a respirator which is completely disposed of after use. They are for individual use and should be discarded when resistance becomes excessive or the respirator is damaged. Generally, these respirators are approved only for pneumoconiosis or fibrosis producing dust such as coal dust, silica dust, and asbestos.

2. Quarter-mask dust and mist, half-mask dust and mist

The quarter-mask covers the mouth and nose; the half-mask fits over the nose and *under the chin.* The half-mask usually produces a better facepiece to face seal than does the quarter-mask and is therefore preferred for use against more toxic materials. Dust and mist respirators are designed for protection against dusts and mists whose TLV is greater than .05mg/M^3 or 2 mppcf.



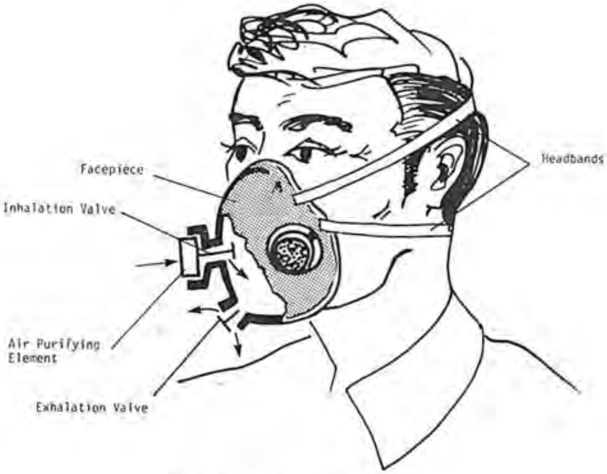
Quarter-mask Respirator

3. Quarter-mask fume; half-mask fume

These masks, similar to those in 2 above, utilize a filter element which can remove metal *fumes* in addition to dusts and mists from the inhaled air. The filters are approved for metal fumes having a TLV *above* .05mg/M^3 or 2 mppcf.

4. Half-mask, high efficiency

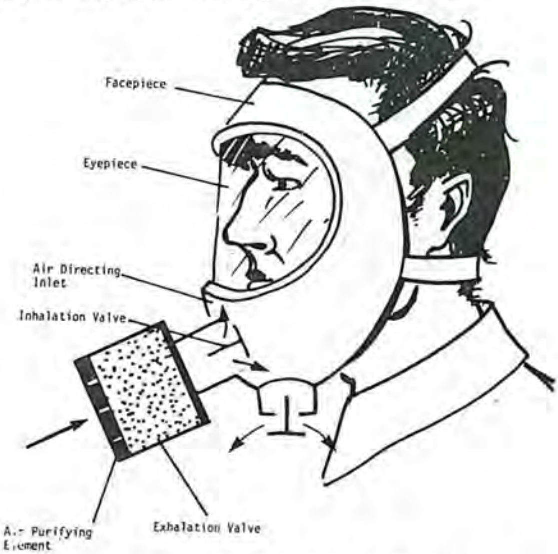
These masks are the same as in 2 and 3, above, but use a high efficiency filter. Because of this high efficiency filter, they can be used against dusts, mists, fumes and combinations of those whose TLV is *less* than .05mg/M^3 or 2 mppcf.



Half-mask Respirator

5. Full facepiece

Full facepiece respirators cover the face from the hairline to below the chin. In addition to providing more protection to the face, the full facepiece gives a better seal than do the half- or quarter-masks. These respirators provide protection against dusts, mists, fumes, or any combination of these contaminants depending upon the type of filter used.



Full Facepiece Respirator

6. Powered dust, mist, and fume respirators

These respirators use a blower that passes the contaminated air through the cartridge or canister where the contaminant is removed and passes the purified air into the facepiece. The air purifying element can be a filter to remove particulates, a cartridge or canister to remove gases or vapors, or a combination to remove both. The face covering can be a half-mask, full-face mask, or hood or helmet.

Powered Air-Purifying Respirator — Front View

The advantage to using a powered air-purifying respirator is that it supplies air at a positive pressure within the facepiece, hood, or helmet, so that any leakage is outward. The protection provided depends on the air-purifying element and the type and concentration of the contaminants.

Powered respirators must deliver at least 4 cubic feet per minute (cfm) to a tight fitting facepiece such as a mask and at least 7 cfm to a loose fitting helmet or hood. If the powered respirator is battery operated, it should provide the airflows mentioned for at least 4 hours without having to recharge the battery.

Powered Air-Purifying Respirator — Back View

B. Approvals

NIOSH approves air-purifying and powered air-purifying particulate removing respirators to protect the wearer against one or more of the following hazards:

- Dust exposure, where the OSHA allowable daily exposure for the dust is not less than $0.05 mg/M^3$;

- Mist exposure, where the OSHA allowable daily exposure for the mist is not less than 0.05 mg/M^3 or 2 mppcf;
- Metal fume exposure, where the OSHA allowable daily exposure for the fume is not less than 0.05 mg/M^3;
- Dust, fume and mist exposure, where the OSHA allowable daily exposure for the dust, fume, or mist is less than 0.05 mg/M^3;
- Exposure to radon daughters (radioactive material) and radon daughters attached to dusts, fumes, and mist;
- Exposure to asbestos containing dusts or mists; and
- Exposure to dusts or mists which cause the formation of scar tissue in the lungs (pneumoconiosis and fibrosis producing).

NOTE: No approved dust, fume, or mist respirator can be worn with the "facelets" or other cloth or plastic cover between the facepiece and face. These covers introduce excessive leakage, and also negate the approval.

C. Limitations

1. Air-purifying respirators do *not* provide oxygen, so they must *never be worn in oxygen deficient atmospheres.*

2. Particulate removing air-purifying respirators offer *no* protection against atmospheres containing contaminant gases or vapors.

3. These respirator types should not be used for abrasive blasting operations.

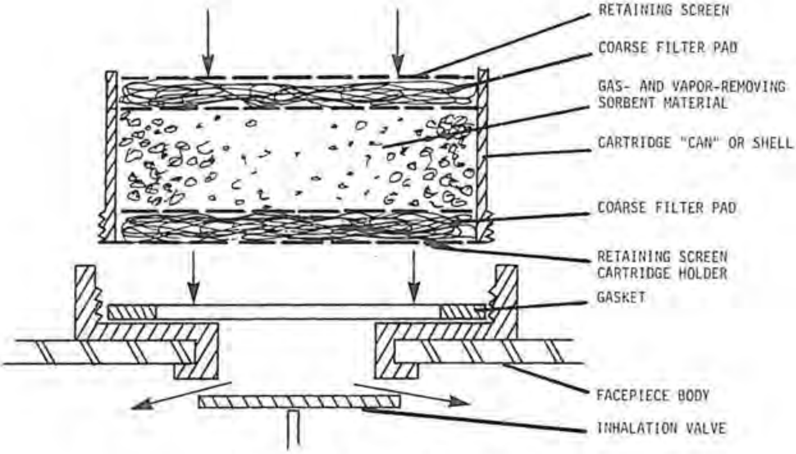
D. Problems

1. The air flow resistance of a particulate-removing respirator filter element increases as the quantity of particles it retains increases, thus increasing the breathing resistance. *As a rule of thumb,* when comfortable breathing is impaired because of dust build-up, the filter should be replaced.
2. Performance of some filter materials is affected by open storage in very humid atmospheres. Care should be taken in storing filter elements.

II. AIR-PURIFYING — CHEMICAL CARTRIDGE AND CANISTER RESPIRATORS, GAS AND VAPORS

A. Description

Vapor and gas-removing respirators use cartridges or canisters containing chemicals to trap or react with specific vapors and gases and remove them from the air breathed. The basic difference between a cartridge and a canister is the volume of the sorbent. Generally, a "cartridge" refers to a chemical filtering element which attaches directly to the facepiece, whereas a "canister" refers to the chemical filter element held in a harness and which is connected to the facepiece via a corrugated breathing tube. Some typical cartridge and canister respirators are discussed below.



Typical Chemical Cartridge

1. Half-mask and quarter-mask respirators

These are available for protection against single chemicals such as ammonia or against entire classes such as organic vapors. Be sure to read the label on the cartridge or canister since it tells what the cartridge or canister protects against, what the maximum concentration in which the element can be used, and in some instances, the service life or expiration date of the element.

2. Full facepiece

The full facepiece respirator may use a canister or cartridge(s) as the protective element. The front, back, and chin-mounted full-facepiece canister respirators are also referred to as "gas masks."

B. Approvals

NIOSH approves chemical cartridge or canister respirators to protect the wearer against many of the organic vapors, acid gases, and gaseous contaminants encountered in the work environment. Consult with a manufacturer or distributor of respiratory protective equipment to determine what type of cartridge or canister is appropriate for the contaminant and concentration.

C. Limitations — Chemical Cartridge or Canister

1. These respirators do not supply oxygen, so they must *never be worn in oxygen deficient atmospheres.*
2. They must not be used if the chemical to be protected against lacks adequate warning properties — odor, taste, or irritation, unless their use is permitted by applicable OSHA or MHSA standards. Warnings such as these are necessary to alert you that the sorbent is saturated, and the contaminant is passing through the cartridge or canister, and you are breathing contaminated air.
3. They must not be used in atmospheres immediately dangerous to life or health, except for escape.
4. They provide protection only from the specific gases or vapors they were designed to protect against (they may be worthless for other gases or vapors).

III. ATMOSPHERE SUPPLYING RESPIRATORS — SUPPLIED-AIR

Atmosphere supplying respirators, rather than removing the hazardous material from the air, exclude the workplace air altogether and provide clean air from an independent source. There are two kinds of atmosphere supplying respirators: a *supplied-air respirator* in which the user is supplied with respirable air through a hose, and a *self-contained respirator* in which the user carries a supply of respirable air.

A. Description — Supplied-air Respirator

Supplied-air respirators use a central source of breathing air that is delivered to the wearer through an air supply line or hose. There are essentially two major groups of supplied-air respirators — the airline device and the hose mask with or without a blower.

1. Airline Devices

The distinction of airline devices is that they use a stationary source of compressed air delivered through a high-pressure hose. Airline devices can be equipped with half- or full-face masks, helmets, or hoods, or the device can come as a complete suit. Airline respirators can be used for protection against either particulates, gases, or vapors. They provide a high degree of protection against these contaminants but they *cannot be used in atmospheres immediately dangerous to life or health* because the user is completely dependent on the integrity of the air supply hose and the air source. If something happens to either the hose or air supply, he cannot escape from the contaminated area without endangering his life.

A great advantage of the airline respirator is that it can be used for long continuous periods. There are three types of airline respirators.

a. Demand Airline Device

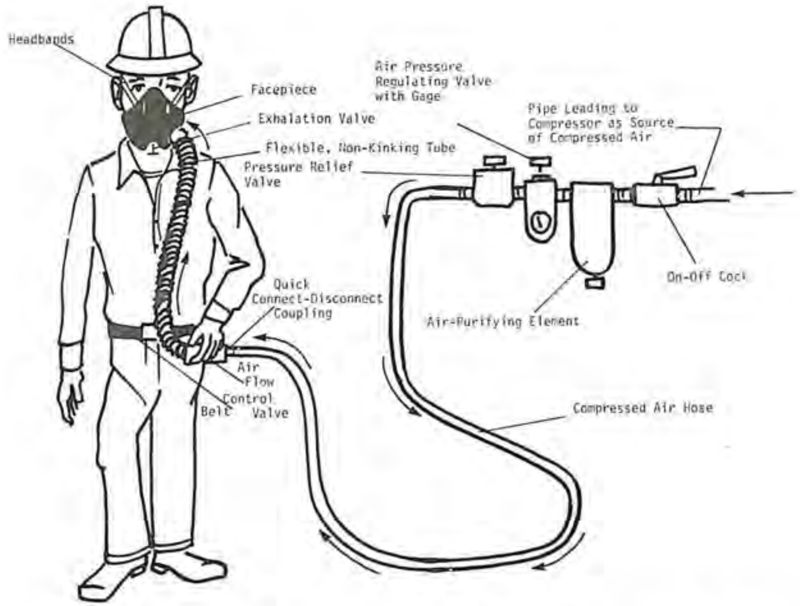
In a demand device, the air enters the facepiece only on "demand" of the wearer, i.e., when the person inhales. This is due to the nature of the valve and pressure regulator. An example of a demand, half-mask airline device is shown below.

During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air may enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Demand devices are also available with a full-face mask, which provides a better seal than does the half-mask.

b. Pressure Demand Airline Devices
The pressure demand device has a regulator and valve design such that there is a continuous flow (until a fixed static pressure is attained) of air into the facepiece at all times, regardless of the "demand" of the user. The airflow into the mask creates a positive pressure outward. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of this type of device.

c. Continuous-flow Airline Device
The continuous-flow airline respirator maintains a constant airflow at all times and doesn't use a regulator, but uses an airflow control valve or orifice which regulates the flow of air. A continuous-flow full facepiece device is shown below.

The continuous-flow device creates a "positive" pressure in the facepiece, and as a result, does not have the problem of inward leakage of contaminant.



A special type of continuous-flow device that provides protection against flying particles of abrasive materials is also available. The abrasive blasting airline respirator, shown below incorporates a *loose fitting* facepiece.

d. Air Supply System.
Supply air sources (compress or tanks) for the above respirator types must meet the following requirements.

i. The air compressor must be located where contaminated air cannot enter the system.

ii. The air receiver must be of sufficient capacity to enable the wearer to escape in the event of compressor failure.

iii. Alarms indicating compressor failure and overheating must be installed into the system.

iv. If the compressor is oil-lubricated it must have a high temperature and/or carbon monoxide (CO) alarm. If there is no CO alarm, frequent carbon monoxide tests of the air must be made to insure that the CO level does not exceed 20 parts per million.

v. All airline couplings must be incompatible with outlets for other gas systems.

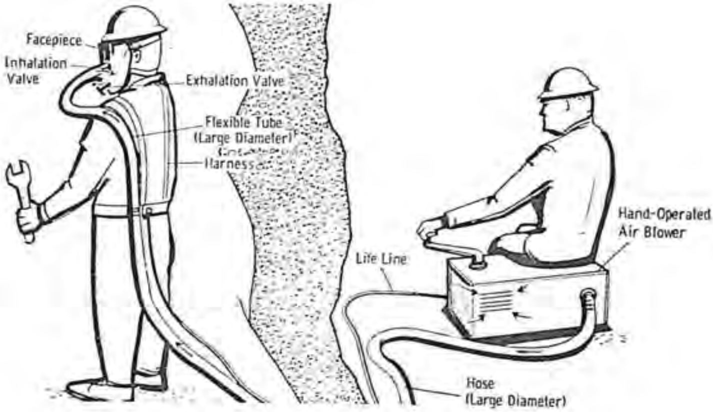
vi. Breathing air quality must meet the requirements of Grade D breathing air as described by the Compressed Gas Association. Grade D requirements are:

- *The oxygen content of the compressed air should be between 19.5-23.5% oxygen and the rest mainly nitrogen;*
- *Hydrocarbon concentrations must not exceed 5 parts per million;*
- *Carbon monoxide concentration must not exceed 20 parts per million;*
- *Carbon dioxide concentrations must not exceed 1000 parts per million; and*
- *There must not be any pronounced odor present.*

2. Hose Masks
Hose masks supply air from an uncontaminated source through a strong, large diameter hose to the facepiece, and do *not* use compressed air or have any pressure regulating devices. (An advantage of the hose mask *with* a blower is its minimal resistance to breathing.) Advantages of the hose mask *without* a blower are its theoretically long use periods and its simple construction, low bulk, easy maintenance, low initial cost, and minimal operating cost. Two types are available:

a. Those masks with hand or motor operated air blowers have a full facepiece mask. The hose length can be up to 300 feet. It must not be used at atmospheres immediately dangerous to life or health.

b. Hose masks without blowers must have a *tight fitting* full facepiece. Helmets and hoods cannot be used. The hose mask without a blower can have up to 75 feet of hose.



Hose Mask Respirator with Hand-operated Blower

Air Line Continuous Flow Respirator with Full Facepiece

B. Approvals

1. Airline Devices

Airline supplied air respirators are approved for use at a *specific air pressure* (at the point of attachment of the air-supply hose to the air-supply system) and a specific *range of air supply hose length.* For example, a supplied air respirator might be approved for use with compressed air at pressures from 40-80 pounds per square inch *and* with air-supply hose length of between 15 and 250 feet. Approvals are not made for specific contaminants.

2. Hose Mask Devices

An approved hose mask *with* a blower may have up to 300 feet of air supply hose in multiples of 25 feet, but one *without* a blower may have only up to 75 feet in multiples of 25 feet. The hand- or motor-operated blower must deliver at least 50 liters per minute (lpm) of air through the maximum length of hose.

C. Limitations

1. Airline Devices

a. These devices *must not* be used in atmospheres immediately dangerous to life or health since the user is dependent upon an air hose which, if cut, crushed, or damaged, leaves him with little or no protection.

b. The trailing air supply hose of the airline respirator severely restricts the wearer's mobility. This may make the airline respirator unsuitable for those who must move frequently between widely separated work stations.

2. Hose Mask

a. The hose mask with a blower cannot be used in atmospheres immediately dangerous to life or health because the low air volume flow may result in a negative pressure being produced in the mask during inhalation allowing contaminated air to leak into the mask. Also, if the air hose is cut or obstructed, the user will be unprotected.

b. The trailing air supply hose of the hose mask severely limits mobility, so it may be unsuitable if frequent movement among separated work stations is required.

c. A severe restriction of the hose mask *without a blower* is that it is limited to a maximum hose length of 75 feet. Also, it requires the wearer to inhale against the resistance to air flow offered by the air hose which may become significant during heavy work. Inhaling against this resistance may cause fatigue.

IV. ATMOSPHERE SUPPLYING RESPIRATORS — SELF-CONTAINED BREATHING APPARATUS (SCBA)

The self-contained breathing apparatus (SCBA) allows the user to carry a respirable breathing supply with him/her, and does not need a stationary air source such as a compressor to provide breathable air. The air supply may last from 3 minutes to 4 hours depending on the nature of the device.

Self-contained Breathing Apparatus (SCBA)

A. Description — SCBA

1. Closed Circuit SCBA

Another name for closed circuit SCBA is "rebreathing" device. The air is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored by a compressed oxygen source or an oxygen-generating solid. These devices are designed primarily for 1-4 hour use in toxic atmospheres. Because negative pressure is created in the facepiece during inhalation, there is increased leakage potential. Therefore, the devices should be used in atmospheres immediately hazardous to life and health only when their long-term use is necessary, as in mine rescue. Two types of closed circuit SCBA are available.

a. Compressed Oxygen Cylinder Type

In this device, breathable air is supplied from an inflatable bag. Exhaled air from the wearer is filtered to remove carbon dioxide and the oxygen consumed is replenished from an oxygen cylinder.

b. Oxygen-generating Type

This type of closed circuit SCBA uses an oxygen-generating solid which, when mixed with water vapor and carbon dioxide in the exhaled breath, or when burned (a chlorate candle), releases oxygen. The oxygen then passes to the inflatable bag. This closed circuit apparatus is lighter, simpler, and cheaper than the cylinder type. However, it is useful for only about 1 hour and, once initiated, cannot be turned off.

Oxygen-generating SCBA (closed circuit)

2. Open Circuit SCBA

An open circuit SCBA exhausts the exhaled air to the atmosphere instead of recirculating it. A tank of compressed air carried on the back supplies air via a regulator to the facepiece. Because there is no recirculation of air, the service life of the open circuit SCBA is shorter than a closed circuit system. Two types of open circuit SCBA are available, "demand" or "pressure demand."

a. Demand SCBA

In a demand SCBA, air flows into the facepiece only on "demand of the wearer," i.e., when the person inhales. This is due to the nature of the valves and pressure regulator. An example of a demand open circuit is show below. During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air can enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Because of this problem, a demand type open circuit SCBA should not be used in atmospheres immediately dangerous to life or health.

b. Pressure Demand SCBA

The pressure demand open circuit SCBA has a regulator and valve design which maintains a positive pressure in the facepiece at all times regardless of the "demand" of the user. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of the pressure demand device. A pressure demand SCBA is identical in appearance to a demand SCBA, but has a different regulator assembly and facepiece exhalation valve design.

3. Combination Atmosphere Supplying Respirator: Supplied Air and SCBA

Designed primarily as a long duration device, this respirator combines an airline respirator with an auxiliary air supply (usually compressed air) to protect against the possible failure of the primary air supply (the airline). The additional supply can be approved for 15 minutes or even longer. The choice depends upon how long it would take to escape from the toxic atmosphere if the primary air supply failed.

B. Approvals—All SCBA's

Because they provide a respirable breathing supply, all SCBA's (closed circuit, open circuit) may be used in *oxygen deficient at-*

mospheres as well as against *particulates, vapors, and gases.* However, *approvals* for SCBA's are based on: (1) entering into and escaping from; (2) escape only, from a hazardous atmosphere (oxygen deficient or contaminated), and (3) the work setting. If you have to use an SCBA, check the approval label to ascertain the conditions of use.

Combination Atmosphere Supplying Respirator: Supplied Air and SCBA

C. Limitations

1. The air supply is limited to the amount in the cylinder (SCBA's using a compressed air tank) and therefore the respirator cannot be used for extended periods without recharging or replacing the cylinders.
2. Because these respirators are bulky and heavy, they are often unsuitable for strenuous work or use in confined spaces.
3. Because of the *short* service time of the auxiliary air supply, the escape portion of the combination unit can be used only for escape from atmospheres immediately hazardous to life or

health unless the escape portion has a minimum of 15 minutes service life. Such devices can then be used for entry in IDLH atmospheres provided not more than 20% of the available breathing supply is used. These devices may always be used for entry into IDLH atmospheres when utilized with the external air supply.

APPENDIX VIII

RESPIRATOR FIT TESTS

The proper fitting of respiratory protective equipment requires the use of some type of fit test. The fit test is needed to determine a proper match between the facepiece of the respirator and face of the wearer.

A. TEST ATMOSPHERES

Regulations require that the user be allowed to test the facepiece to face seal of the respirator and wear it in a test atmosphere. The test atmosphere amounts to an enclosure in which 1) the user can enter with the equipment on, and 2) a "test" contaminant (of low toxicity) can be placed. While elaborate enclosures are available commercially, the employer can put together a "do it yourself" qualitative fit test enclosure by the use of a plastic bag (a dry cleaning bag), several hangers, and some cotton. Figure 3 shows this enclosure scheme.

B. TEST METHODS

There are two types of tests: qualitative tests and quantitative tests. The use of one or both types of tests depends on, among other considerations, the severity and extent of the respiratory hazard, and the size of the company. During any fitting test, the respirator headstraps must be as comfortable as possible. Tightening the straps will sometimes reduce facepiece leakage, but the wearer may be unable to tolerate the respirator for any length of time.

TEST ENCLOSURE

Figure 3

1. Qualitative Tests

Qualitative tests are fast, require no complicated expensive equipment, and are easily performed. However, these tests rely on the wearer's subjective response, and so are not entirely reliable. There are two major qualitative tests:

a. Isoamyl Acetate Test

Isoamyl acetate, a low toxicity substance with a banana like odor, is used widely in testing the facepiece fit *organic vapor* cartridge/canister respirators. The substance is applied to the cotton wad inside the enclosure (see Figure 3). The perspective user should put on the respiratory protection equipment in an area away from the test enclosure so that there is no prior contamination of the cartridges on "pre-exposure" to the isoamyl acetate. The user should perform the following:

- Normal breathing.
- Deep breathing, as during heavy exertion. This should not be done long enough to cause hyperventilation.
- Side-to-side and up-and-down head movements. These movements should be exaggerated, but should approximate those that take place on the job.
- Talking. This is most easily accomplished by reading a prepared text loudly enough to be understood by someone standing nearby.
- Other exercises may be added depending upon the situation. For example, if the wearer is going to spend a significant part of his time bent over at some task, it may be desirable to include an exercise approximating this bending.

The major drawback of the iosamyl acetate test is that the odor threshold varies widely among individuals. Furthermore, the sense of smell is easily dulled and may deteriorate during the test so that the wearer can detect only high vapor concentrations. Another disadvantage is that isoamyl acetate smells pleasant, even in high concentrations. Therefore, a wearer may say that the respirator fits although it has a large leak. This is usually because the wearer likes the fit of the particular respirator or is following the respirator selection of someone else. Conversely, a wearer may claim that a particular respirator leaks if it is uncomfortable, etc. Therefore, unless the worker is highly motivated toward wearing respirators, the results of this test must sometimes be suspect.

b. Irritant Smoke Test

The irritant smoke test, similar to the isoamyl acetate test in concept, is used widely in testing the facepiece fit of *particular filter* respirators. 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).* The test substance is an irritant (stannic chloride or titanium tetrachloride) which is available commercially in sealed glass tubes. When the tube ends are broken and air passed through them (usually with a squeeze bulb), a dense irritating smoke is emitted. In this test, the user steps into the test enclosure and the irritant smoke is "sprayed" into the test hole. If the user detects any of the irritant smoke, it means a defective fit, and adjustments or replacement of the respirator is required. *The irritant smoke test must be performed with caution because the aerosol is highly irritating to the eyes, skin, and mucous membrane.* 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 giving a false indication of proper fit is reduced.

Irritant Smoke Test

c. Negative Pressure Test

This test (and the positive pressure test) should be used only as a very gross determination of fit. The wearer should use this test just before entering the hazardous atmosphere. In this test, the user closes off the inlet of the canister, cartridge(s), or filter(s) by covering with the palm(s) or squeezing the breathing tube so that it does not pass air; *inhales* gently so that the facepiece collapses slightly; and holds breath for about 10 seconds.

If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator is probably tight enough. This test, of course, can only be used on respirators with tight-fitting facepieces.

Although this test is simple, it has severe drawbacks; primarily that the wearer must handle the respirator after it has supposedly been positioned on his face. This handling can modify the facepiece seal.

Negative Pressure Test

d. Positive Pressure Test

This test, similar to the negative pressure test, is conducted by closing off the exhalation valve and exhaling gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage. For some respirators, this method requires that the wearer remove the exhalation valve cover; this often disturbs the respirator fit even more than does the negative pressure test. Therefore, this test should be used sparingly if it requires removing and replacing a valve cover. The test is easy for respirators whose valve cover has a single small port that can be closed by the palm or a finger.

2. Quantitative Tests

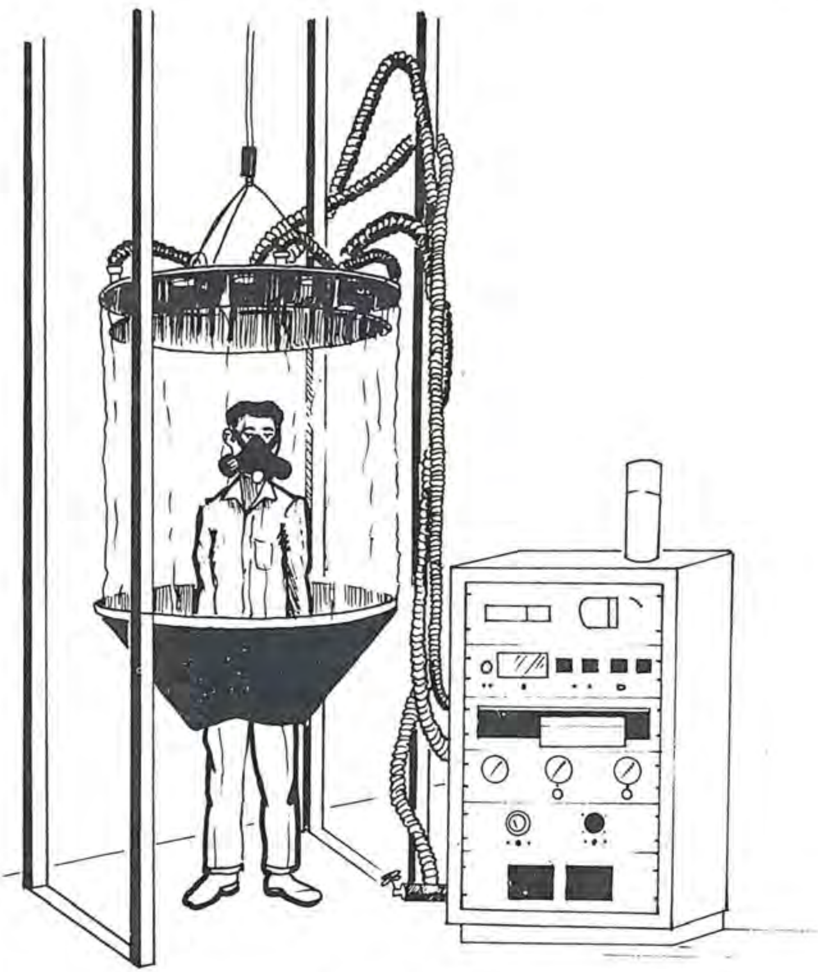
Quantitative respirator performance tests involve placing the wearer in an atmosphere containing an easily detectable, relatively nontoxic gas, vapor, or aerosol. The atmosphere inside the respirator is sampled continuously through a probe in the respiratory-inlet covering. The leakage is expressed as a percentage of the test atmosphere outside the respirator, called "percent of penetration," or simply "penetration." The greatest advantage of a quantitative test is that it indicates respirator fit numerically, and does not rely on a subjective response. The quantitative fit test is highly recommended when facepiece leakage must be minimized for work in highly toxic atmospheres or those immediately dangerous to life or health. However, these tests require expensive (up to $10,000) equipment that can be operated only by highly trained personnel. Also, it is difficult to use because of its complexity and bulk. Each test respirator must be equipped with a sampling probe to allow continual removal of an air sample from the facepiece so the same facepiece cannot be worn in actual service, since the test orifice negates the approval of the respirator.

a. Sodium Chloride (NaCl) Test

In this test, a liquid aerosol is generated continuously from a salt water solution (using a nebulizer), dried to produce discrete submicron salt particles, and dispersed into a test chamber or hood. A means is provided for sampling the atmosphere in the chamber or hood and inside the respirator. These samples are fed to the analyzing section where the aerosol's penetration inside the respirator is determined. The amount of penetration is displayed on a meter or recorder.

b. Dioctyl Phthalate (DOP) Test

The dioctyl phthalate (DOP) quantitative fitting test, which uses an air-generated DOP aerosol, differs from the NaCl test only in that the aerosol particle is liquid. The aerosol is generated using a nozzle-type atomizer, but, being an oil, DOP does not dry into solid particles when injected into a diluting air stream.



Quantitative Test

APPENDIX IX

LIST OF EXHIBITS

EXHIBIT I

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

Policy Statement: A respiratory protection program is hereby established so as to coordinate the use and maintenance of respiratory protective equipment as determined necessary to (1) reduce employee exposure to toxic chemical agents; and (2) allow employees to work safely in hazardous work environments, e.g., sand blasting and oxygen deficient atmospheres.

I. DESIGNATION OF PROGRAM ADMINISTRATOR

Management has designated ______________________ to be responsible for the respiratory program at this facility. He/she has been delegated authority by top management to make decisions and implement changes in the respirator program anywhere in this facility.

______________________ has been charged with the following responsibilities:

A. Supervision of respirator selection procedure;
B. Establishment of training sessions about respiratory equipment for employees;

C. Establishment of a continuing program of cleaning and inspection of equipment;
D. Designation of proper storage areas for respiratory equipment;
E. Establishment of issuance and accounting procedures for uses of respiratory equipment;
F. Establishment of medical screening program/procedures for employees assigned to wear respiratory equipment;
G. Establishment of a periodic inspection schedule of those workplaces/conditions — requiring respiratory equipment — to determine exposure and/or changing situations; and
H. A continuing evaluation of the above aspects to assure their continued functioning and effectiveness.

Any questions or problems concerning respirators or their use should be addressed to ________________________.

EXHIBIT II

__________ COMPANY

RESPIRATORY PROTECTION PROGRAM

Policy Statement: Management is concerned not only with meeting federal and/or state regulations, but also maintaining employee health.

II. PROCEDURE FOR SELECTION OF RESPIRATORY PROTECTIVE EQUIPMENT

A. Evaluation of the Hazard

Surveys of employee groups and/or processes pertinent to company operations shall be conducted by

__________________, Safety Director, ________ Company. The Hazard Evaluation Form shall be used in the formation of a decision to implement the use of respiratory protective equipment.

B. The Selection of Respiratory Protective Equipment

Upon completion of the walk-thru survey, the Safety Director, in consultation with the Vice-President-Engineering, shall review the results to determine the feasibility of engineering and/or administrative control techniques.

The Industrial Hygienist shall submit monthly reports to the Vice-President-Engineering as to the status of development of engineering controls, if required.

EXHIBIT III

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

III. PURCHASE OF RESPIRATORY PROTECTIVE EQUIPMENT

The program administrator shall have authority to purchase respiratory protective equipment. Respiratory equipment shall be selected only from current NIOSH approved listings.

EXHIBIT IV

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

IV. MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

Policy Statement: Only those individuals who are medically able to wear respiratory protective equipment shall be issued one.

EXHIBIT V

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

V. ISSUANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

Policy Statement: All individuals who are assigned to wear respiratory protective equipment shall be provided respiratory protective equipment for their exclusive use.

A system of respiratory wearer cards and journals shall be established to facilitate the accounting of users and equipment. The following user card and journal scheme has been adopted by _________ COMPANY.

The program administrator shall approve the issuance of all respirators and/or respiratory protective equipment.

RESPIRATOR USER CARD

CARD NUMBER ______________________________

NAME ______________________________________

OPERATION _________________________________

CONTAMINANTS/HAZARD PROCESS __________

RESPIRATOR TYPE ___________________________

DATE OF ISSUANCE __________________________

DATE OF EXPIRATION ________________________

APPROVED BY ______________________________

_________ COMPANY
RESPIRATORY PROTECTION PROGRAM
USER CARD JOURNAL

CARD NUMBER	ISSUED TO	HAZARD	RESPIRATOR TYPE	DATE ISSUED	DATE OF EXPIRATION	APPROVED BY

EXHIBIT VI

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

VI. FITTING PROCEDURES FOR RESPIRATORY PROTECTIVE EQUIPMENT

Policy Statement: The proper fitting of respiratory equipment to the user shall follow one or more methods as outlined in Appendix VIII in the NIOSH Employer Respirator Manual, or as stated in other equivalent publications.

EXHIBIT VII

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

VII. RESPIRATORY PROTECTIVE EQUIPMENT MAINTENANCE

Policy Statement: Respiratory equipment maintenance and storage shall be carried out in accordance with the instructions of the equipment manufacturer (and/or guidelines established by the NIOSH Employer Respirator Manual).

EXHIBIT VIII

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

VIII. INSPECTION PROCEDURES

Policy Statement: The program administrator shall develop a field inspection checklist for respiratory protective equipment. (The checklist, as itemized in the NIOSH Employer Manual, may be used as a guideline.) The administrator shall institute a continuing review of the inspection procedure so as to cover all uses of respiratory protective equipment at _________ COMPANY.

EXHIBIT IX

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

IX. PROGRAM EVALUATION

Policy Statement: The program administrator shall develop a procedure to evaluate the effectiveness of the program. Program review shall be done on a continuing basis. (Program review aspects may follow guidelines suggested by the NIOSH Employer Manual.)

APPENDIX X

REFERENCES

1. *A Guide to Industrial Respiratory Protection.* NIOSH pub 76-189.
2. *NIOSH Certified Equipment,* December 15, 1975. NIOSH pub 76-145.
3. *NIOSH Cumulative Supplement,* June 1977. NIOSH pub 77-195.
4. *Respiratory Protection: OSHA and the Small Businessman,* W. E. Ruch and B. H. Held (available from Ann Arbor Science Publishers, Inc., P.O. Box 1425, Ann Arbor, Michigan 45106).

APPENDIX XI

READER SERVICE CARD

The continued effective use of this manual will require the user to keep abreast of new developments in the field of respiratory protection, particularly as it relates to the introduction of new and/or updated equipment, and approvals issued for respiratory protective equipment. As a minimum, the user should be aware of NIOSH publication *Cumulative Supplement — NIOSH Certified Equipment,* which lists the approvals issued by NIOSH (to a specified date) for respiratory protective equipment.

The reader can obtain: (1) the initial publication of the *NIOSH Certified Personal Protective Equipment-1974* (Pub. No. 74-112), which details the requirements for approval of equipment; and (2) the updated *Cumulative Supplement (June 1977) NIOSH Certified Equipment* (Pub. No. 77-195) by being placed on the NIOSH mailing list.

I would like to be placed on the NIOSH mailing list.

Name ______________________________

Address ______________________________

City ______________________________

State ______________________ **Zip** ________

Thank you.

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