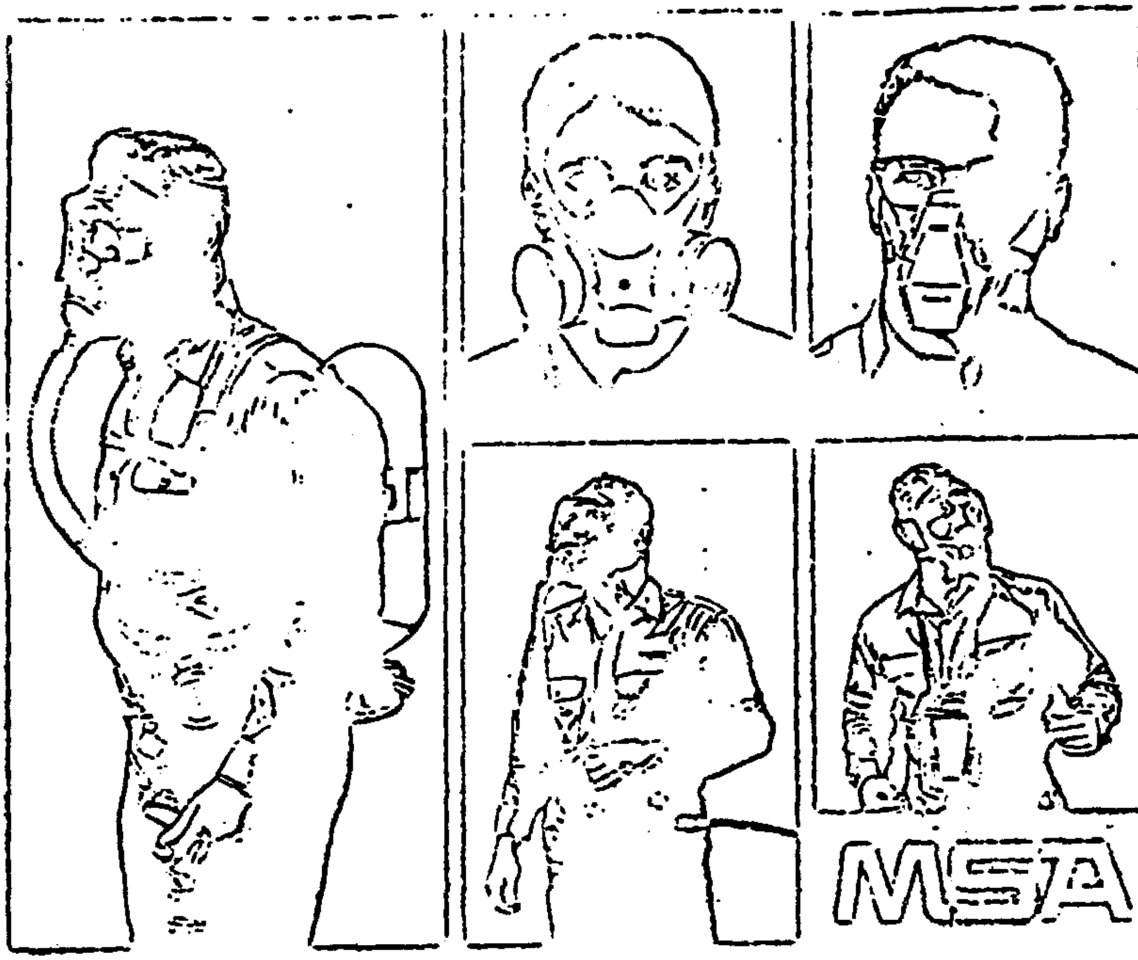

basic elements of respiratory protection

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respiratory protection

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basic elements of respiratory protection

Preface

This booklet is intended for anyone concerned with establishing and maintaining a respiratory protection program. It presents certain basic information for guidance purposes. However, it does not purport to be all inclusive in content or scope. For more complete information on specific problems the reader is referred to the following documents:

1. *American National Standard Practices for Respiratory Protection, ANSI Z88.2-1969*—Available from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
2. *Respiratory Protective Devices Manual* — Available from Committee on Respirators, P.O. Box 435, Lansing, Michigan 48902.
3. *Breathing Apparatus for the Fire Service*—Available from National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02110.
4. *Threshold Limit Values* — Available from Secretary-Treasurer, The American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, Ohio 45202.

For more complete information on the respiratory protective equipment described in this booklet, contact Mine Safety Appliances Company, 400 Penn Center Blvd., Pittsburgh, Pa. 15235.

Only qualified, trained personnel should use any respiratory protective device.

Introduction

A successful respiratory protection program must contain eight basic elements. These are listed below not necessarily in order of importance:

1. Administration.
2. Knowledge of respiratory hazards.
3. Assessment of respiratory hazards.
4. Control respiratory hazards.
5. Selection of proper respiratory protective equipment.
6. Training.
7. Inspection, maintenance and repair of equipment.
8. Medical surveillance.

Administration

Responsibility and authority for administration of a respiratory protection program must be assigned to one individual who may and probably will have assistance. The necessity for central authority and responsibility is to insure that there is coordination and direction. The respiratory protection program will vary widely dependent upon many factors and may involve specialists such as safety personnel, industrial hygienists, health physicists, and physicians or a single individual with no special training. In any case, overall responsibility must reside in a single individual if the program is to achieve optimum results.

Respiratory Hazards

Toxic materials can enter the body in three ways: (1) through the gastrointestinal tract, (2) through the skin, and (3) through the lungs. Of these three modes of entry, the human respiratory system presents the quickest and most direct avenue of entry because of its intimate association with the circulatory system and the constant need to oxygenate our tissue cells to sustain life processes. Hence, there are two basic respiratory hazards:

1. Oxygen deficient air.
2. Air laden with contaminants.

Oxygen Deficiency

The normal content of oxygen in the air is 20.9 per cent by volume. Oxygen concentrations below 16 per cent will not support combustion and are considered unsafe for human exposure because of harmful effects on bodily functions, mental processes, and coordination. At low oxygen concentrations, collapse can be immediate, without warning and death can ensue within minutes. While 16 per cent oxygen (at sea level) is generally considered the lower limit for safe human exposure, the partial pressure of oxygen within the lung is the important factor. Therefore, under conditions of significantly reduced atmospheric pressure, which occur at high altitudes, the low safe limit is higher than 16 per cent by volume. Current legislation requires that the oxygen percentage in a working place be not less than 19.5

In assessing exposure conditions, it is important to remember that oxygen deficiency can occur in confined spaces by displacement of air by other gases and vapors; or by means of oxidation processes such as fire, rusting, aerobic bacteria, etc., where oxygen is consumed.

Air Contaminants

Air contaminants include particulate matter in the form of discrete particles of solids or liquids, gaseous material in the form of a true gas or vapor, or a combination of both gaseous and particulate matter.

Particulate Hazards

Particulate contaminants may be classified according to their physical and chemical characteristics and their biological effect on the body. The particle diameter in microns (1 micron = 1/25,400 inch) is of utmost importance. Particles below 10 microns in diameter have a greater opportunity to enter the respiratory system and particles below 5 microns in diameter are more apt to reach the deep lung or alveolar spaces. In the healthy lung, particles from 5 to 10 microns in diameter are generally removed from the respiratory system by the constant cleansing action of the ciliated epithelium in the upper respiratory tract. However, with excessive "dust" exposures or diseased systems the efficiency of the cleansing action can be markedly reduced.

Types of Particulate Matter

The various types of airborne particulate contaminants (sometimes called "aerosols" or "dispersoids") may be classified as follows:

Dust—Mechanically generated solid particulate matter (usually found in the harmful size range of from 0.5 to 10 microns).

Mist and Fog — Liquid particulate matter (usually found in the size range from 5 to 100 microns).

Fumes — Solid condensation particles of fine diameter, commonly generated from molten metal as metal fumes (size range from 0.1 to 1.0 micron).

Smoke—Chemically generated particulate matter of organic origin. (Usually found in the size range from 0.01 to 0.3 micron).

Living Organisms — Airborne bacteria and virus (usually found in the size range from 0.001 to 15 microns).

Classification of Particulate Matter According to Biological Effects

The fate of particles which reach the deep lung or alveolar spaces depends to a large degree on their solubility, particle size, chemical characteristics, and metabolism in the body. Hence, particulate contaminants can be classified according to their biological effects as follows:

Inert Aerosols — Which produce minor irritation or discomfort, but in sufficient quantity can overwhelm the protective mechanism of the upper respiratory tract.

Allergy Producers — Which can cause severe reactions with some sensitized individuals.

Chemical Irritants—Which can damage the sensitive mucous membranes or lung tissue by chemical reaction.

Fibrosis Producers — Which can cause the development of scar tissue in the lung such as silicosis from quartz (silicon dioxide) exposures and asbestosis from asbestos exposures.

Cancer Producers—Such as asbestos, chromates and radioactive particulate matter.

Systemic Poisons—Such as lead, cadmium, arsenic which can damage certain critical organs and systems.

Fever Producers—Such as the fumes of zinc and copper.

Gaseous Contaminants

Gaseous contaminants occurring as true gases such as sulfur dioxide, carbon monoxide, etc., or vapors from organic liquids can likewise be classified according to their chemical characterisics and biological effect on the body.

Types of Gaseous Contaminants

Chemically, gaseous contaminants may be classified as follows:

Inert Gases—Such as helium, argon, neon, etc., which do not metabolize in the body but produce an oxygen deficiency by displacement of air.

Acidic Gases—Such as sulfur dioxide, hydrogen sulfide, hydrogen chloride etc. which are acids or produce acids by reaction with water.

Alkaline Gases—Such as ammonia, phosphine etc., which are alkalis or produce alkalis by reaction with water.

Organic Compounds — Which can exist as true gases or vapors from organic liquids.

Organometallic Compounds—Comprised of metals attached to organic groups such as tetraethyl lead and organic phosphates.

Classification of Gaseous Contaminants According to Biological Effects

Gaseous contaminants may be classified according to biological effects as follows:

Asphyxiants—Which interfere with the uptake, transport or utilization of oxygen in the body. Simple asphyxiants such as nitrogen, methane, hydrogen, etc. can create an oxygen deficiency by air displacement.

Chemical Asphyxiants — Such as carbon monoxide interfere with the uptake and transport of oxygen by the hemoglobin of the red blood cells while hydrogen cyanide interferes with "internal respiration" or oxidation of the tissue cells.

Chemical Irritants — Such as acid and alkaline gases which can irritate the respiratory system and cause the development of pulmonary edema or fluid in the lung.

Anesthetics—Such as chloroform, ether, carbon tetrachloride which can cause loss of feeling, unconsciousness, and death.

Systemic Poisons—Such as metallic mercury vapor, hydrogen sulfide, arsine etc. which can damage critical organs and systems of the body.

Threshold Limit Values

The degree of effect of both gaseous and particulate contaminants depends largely upon the airborne concentration and the amount of exposure.

Accordingly, a listing of Threshold Limit Values (T.L.V.'s) are published yearly by the American Conference of Governmental Industrial Hygienists as guides for exposure concentration which a healthy individual normally can tolerate for 8 hours a day, five days a week without harmful effects. Airborne particulate concentrations are generally listed as milligrams per cubic meter of air (mg/m^3) and gaseous concentrations are listed as parts per million (ppm) by volume.

The latest listing of Threshold Limit Values can be obtained at nominal cost from the American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, Ohio 45202.

Hazard Assessment

Proper assessment of the hazard is the first important step to protection. This will require thorough knowledge of the process, related equipment, raw materials, end-products, and by-products which can possibly create an exposure hazard. Air samples must be taken with proper sampling instruments during all conditions of operation to assess the atmosphere for oxygen content and concentration levels of particulate and/or gaseous contaminants. The sampling device and the type and frequency of sampling (continuous or spot) will be dictated by the exposure and operating conditions. Breathing zone samples are recommended and sampling frequency should be sufficient to assess the average exposure under the variable operating and exposure conditions.

Should exposure concentrations exceed the recommended limits, hazard control procedures should be implemented promptly.

Also, in assessing the overall hazard potential, consideration should be given to possible emergency conditions which can arise in order to assure that proper emergency control equipment and procedures are available and thoroughly understood by affected personnel.

Hazard Control

Obviously, hazard control should start at the process, equipment, and plant design levels where effluents can be effectively controlled at the outset. With operating processes, the problem becomes more difficult. However, in all cases, consideration should be given to the use of effective engineering controls to eliminate and/or reduce exposure to respiratory hazards. This would include consideration of process encapsulation or isolation, use of less toxic materials in the process and suitable exhaust ventilation, filters and scrubbers to control the effluents.

However, since it is not always practical to effect and maintain engineering controls, proper respiratory protective devices should be made available and used for respiratory protection when required. Since there are many types of such devices, it is important that they be selected with utmost care to ensure that the proper protection is afforded and that personnel be thoroughly trained in their use and limitations. Only equipment approved by the National Institute for Occupational Safety and Health (NIOSH) / Mining Enforcement and Safety Administration (MESA) should be selected where possible.

Selection

Respiratory protective devices vary in design, application, and protective capability. The user must, therefore, assess the inhalation hazard and understand the specific use and limitations of available equipment to assure proper selection.

Respiratory protective devices are tested and approved by NIOSH/MESA for protection against a wide range of inhalation hazards, from oxygen-deficient and/or highly toxic atmospheres to those containing "nuisance" dusts. While not all types of respiratory protective devices are covered under the current NIOSH approval requirements, it is desirable to select NIOSH/MESA-approved equipment whenever possible.

Respiratory protective devices fall into three classes: air-purifying, supplied-air, and self-contained breathing apparatus.

Air Purifying Devices

Air-purifying devices remove contaminants from the atmosphere and can be used only in atmospheres containing sufficient oxygen to sustain life (at least 19.5 percent by volume at sea level) and within specified concentration limitations of the specific device. Various chemicals remove specific gases and vapors, and mechanical filters remove particulate matter. The useful life of an air-purifying device is dependent upon the concentration of the contaminants, the breathing volume of the wearer, and the capacity of the air purifying medium.

The basic types of air-purifying devices are:

Mechanical Filter Respirators provide respiratory protection against particulate matter such as nonvolatile dusts, mists, or metal fumes. Selection of the appropriate respirator is based on the type, toxicity, and particle size of the particulate matter. Specific types of mechanical filter respirators are approved under NIOSH/MESA 30 CFR Part 11, Subpart K.

Chemical Cartridge Respirators provide respiratory protection against certain gases and vapors in concentrations not in excess of 0.1 percent by volume. Specific types of chemical cartridge respirators are approved under NIOSH/MESA 30 CFR Part 11, Subpart L.

Combinations of Chemical Cartridge and Mechanical Filter Respirators provide respiratory protection where exposure is both gaseous and particulate.

Gas Masks provide respiratory protection against certain specific gases and vapors in concentrations up to 2 percent by volume or as specified on the canister label and against particulate matter. Specific gas masks are approved under NIOSH/MESA 30 CFR Part 11, Subpart I. NIOSH/MESA are accepting for testing and approval vinyl chloride gas masks and certain chin-style masks.

Supplied-Air Devices

Supplied-air devices deliver breathing air through a supply hose connected to the wearer's facepiece. It is imperative that the air delivered be free of contaminants. The air source must be located in clean air and monitored frequently. With the exception of Hose Masks with Blowers, these devices should be used only in atmospheres not immediately dangerous to life or health.

The basic types of supplied-air devices are:

Air-Line Respirators with constant flow, demand, or pressure-demand flow.

Hose Masks with or without blower.

Supplied-air devices are approved under NIOSH/MESA 30 CFR Part 11, Subpart J.

Self-Contained Breathing Apparatus

Self-contained breathing apparatus provide complete breathing protection for various periods of time based on the amount of breathing air or oxygen supplied and the breathing demand of the wearer.

The basic types of self-contained breathing apparatus are:

Oxygen Cylinder Rebreathing Type.

Chemical Oxygen Rebreathing (self-generating) Type.

Demand and Pressure-demand Types.

Self-contained breathing apparatus are approved under NIOSH/MESA 30 CFR Part 11, Subpart H.

There is one limitation applicable to all respiratory protective equipment. Certain gases are capable of harming the body by means other than through the respiratory tract. For example, ammonia, in concentrations of approximately 3 percent or higher, can cause skin burns — particularly on moist skin. To avoid that possibility, protective clothing should be worn in addition to the proper respiratory protection. Similarly, protective clothing should be worn when appreciable amounts of gases such as hydrocyanic acid are present. Hydrocyanic acid, a gas at slightly above room temperature, is capable of penetrating the skin and causing systemic poisoning, although to do so, concentrations considerably higher than those required for poisoning through the respiratory tract must be present.

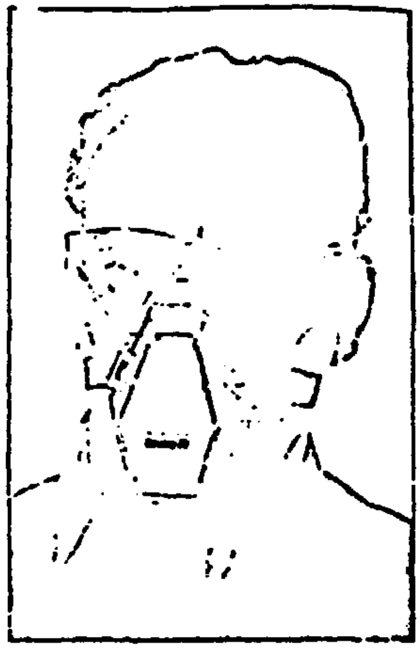

Figure 1—Dustfoe® 77 Respirator is a single-filter unit providing respiratory protection against dusts and mists having Threshold Limit Value not less than 0.05 milligram per cubic meter or 2.0 million particles per cubic foot.

Figure 2—Comfo' II Respirator with Type H Ultra Filter* Cartridges is a twin-filter unit providing respiratory protection against radionuclides and dusts, fumes, and mists having a Threshold Limit Value less than 0.05 milligram per cubic meter, where the contaminant concentration does not exceed 10 times the concentration limit for the radionuclide involved or 10 times the TLV.

Figure 3—Ultra-Twin™ Respirator is a full facepiece unit with receptacles for two Type H Ultra Filter Cartridges providing protection against inhalation of dusts, fumes, and mists having a Threshold Limit Value less than 0.05 milligram per cubic meter, and against radionuclides.

Figure 4—Ultra Filter® Respirator is a full facepiece unit with a single oval cartridge providing respiratory protection against radionuclides and dusts, fumes, and mists having a Threshold Limit Value less than 0.05 milligram per cubic meter.

Mechanical Filter Respirators

Mechanical filter respirators offer respiratory protection against airborne particulate matter including dusts, mists, metal fumes, and smokes. They consist essentially of a soft resilient facepiece of either half-mask or full-face design, to which is directly attached one of several types of mechanical filters made up of some fibrous material which removes the harmful particles by physical trapping as air is inhaled through the material. Gaseous matter such as air itself will pass through the filter, but solid or liquid particles are trapped in much the same manner as rocks and pebbles are separated from sand in a screening process. The filter must be highly efficient, however, to stop the small harmful particles. Mechanical filter respirators do not provide protection against gases, vapors, or oxygen deficiency.

There are many classes of mechanical filter respirators consistent with the various classes of airborne particulate matter. Although one respirator can be made to provide effective protection against all true particulates, in most cases it will be too expensive and perhaps too cumbersome for the great majority of exposures. Hence, many special-purpose respirators are offered to provide the most economical and efficient protection against specific particulate hazards.

Note:
Not all particulate matter is stable. Some will hydrolize and release acid gases while others are volatile, producing vapors. Mechanical filter respirators as such will not offer protection against gases or vapors.

NIOSH/MESA, the official approval agency for respiratory protective equipment, tests and certifies mechanical filter respirators under 30 CFR Part 11, Subpart K. They will approve respirators for one or any combination of the following particulate hazards: nuisance, fibrosis-producing and/or toxic dusts; mists and fumes; radon daughters and radionuclides.

Other than the difference between a half-mask facepiece and a full facepiece, which is used when the particulate exposure is harmful or irritating to the eyes as well as the respiratory tract, the filter is the most essential distinction among classes with respect to breathing area (size), resistance to breathing, efficiency in filtering particulates of specific size ranges, and time required to clog the filter.

For example, in choosing a respirator for protection against particulates more toxic than cadmium which will have to effectively filter particles as small as tobacco smoke, the user must accept an increase in bulk, weight, and cost of the product as compared to the need for a respirator to protect against so-called nuisance dusts.

In selecting a mechanical filter respirator, it is important that the right type be chosen; and it is equally important that the respirator be approved. The illustrations and captions will serve as a guide in the selection of proper respirators (Figures 1 to 4).

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Figure 5—Comfo® II Chemical Cartridge Respirator with floating-yoke suspension.

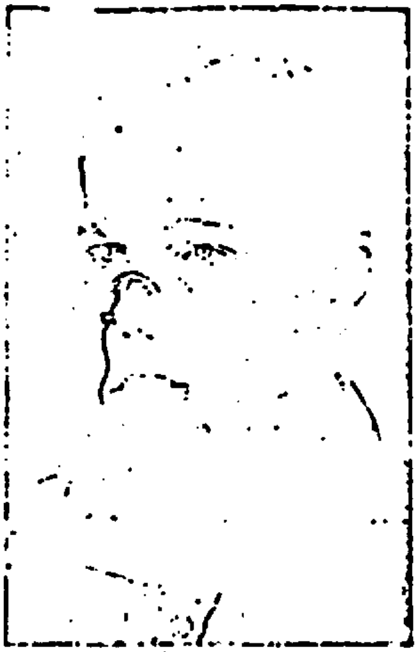

Figure 6—MSA® Mouthpiece Respirator for escaping from gaseous atmospheres.

Chemical Cartridge Respirators

Chemical cartridge respirators afford protection against light concentrations (10 ppm to 1000 ppm by volume, depending upon the contaminant) of certain acid gases, alkaline gases, organic vapors, and mercury vapors by utilizing various chemical filters to purify the inhaled air. They differ from mechanical filter respirators only in that they use cartridges containing chemicals to remove harmful gases and vapors.

Many gases and vapors are dangerous or irritating to breathe. Some are hazardous or discomforting, or both, in extremely low concentrations. Although not usually immediately harmful to life or health, light concentrations of these gaseous materials may cause nausea and headache that reduce worker output and sometimes produce chronic disorders which may eventually be fatal. Worker health as well as efficiency is involved.

Organic vapors, such as the vapors of acetone, alcohol, benzene, carbon tetrachloride, and gasoline; acid gases, such as chlorine and sulfur dioxide; and other gaseous materials, such as gases of ammonia and mercury vapor, are the contaminants with which we are concerned.

The simplest and most convenient type of respiratory protective equipment to use in these cases is the chemical respirator (Figure 5) equipped with the proper chemical filtering elements.

These filtering elements are usually called "cartridges," and the most common types are listed below:

GMA Cartridge, for protection against certain organic vapors; provides for concentrations up to 1000 ppm (0.1 percent by volume).

GMB Cartridge, for 10 ppm chlorine and 50 ppm sulfur dioxide and hydrogen chloride.

GMC Cartridge, for protection against certain acid gases and/or organic vapors.

GMD Cartridge, for protection against ammonia, in concentrations up to 300 ppm.

The Mersorb Cartridge is satisfactory for use against all exposures to metallic mercury vapor under conditions of normal temperatures and pressures. Under these conditions, the air is saturated with mercury vapor at a concentration of about 4 ppm. This chemical cartridge respirator will afford a long service life at this concentration, but the cartridges should be changed after each 8 hours of use to provide for an adequate safety factor.

NIOSH/MESA Subpart L covers chemical cartridge respirators. NIOSH/MESA will issue certificates of approval to manufacturers whose products meet their performance requirements, and the approval number will be shown on the respirator and/or packing carton. It is good practice to use only NIOSH/MESA-approved equipment whenever possible.

Mouthpiece-type chemical cartridge respirators (Figure 6) offer protection against intermittent exposure to light concentrations of gases and vapors or may be used for self-rescue in times of catastrophe. The mouthpiece design promotes compactness —such a respirator can be conveniently carried by the workman during all working hours or stored conveniently near the work location for immediate availability.

Chemical Cartridge Respirators are non-emergency respiratory protective devices and should never be used in immediately dangerous atmospheres, except for escape purposes.

However, to clarify this general statement, it will be well to list four other major negative rules which apply to Chemical Cartridge Respirators:

A. Do not use Chemical Cartridge Respirators for protection against

MSA
respiratory
protection

Figure 7—MSA Belt-Mounted Respirator is a combination mechanical-chemical filter respirator.

gaseous material which is extremely toxic in very small concentrations. Example: hydrogen cyanide. A concentration of 100 parts per million is very dangerous within one hour. The toxicity is entirely too great to chance the minimum protection afforded by Chemical Cartridge Respirators.

B. Chemical Cartridge Respirators should not be used for exposures to harmful gaseous matter which cannot clearly be detected by odor. Example: methyl chloride and hydrogen sulphide. The former is odorless; and the latter, although foul smelling, paralyzes the olfactory nerves so quickly that detection by odor is unreliable.

C. Chemical Cartridge Respirators should not be used against any gaseous material in concentrations which are highly irritating to the eyes. Example: although a Chemical Cartridge Respirator can be made to afford good respiratory protection against sulfur dioxide in concentrations up to 500 parts per million, serious eye irritation begins in the range of between 20 and 30 parts per million, and it is impossible to remain in an atmosphere containing 200 parts per million for more than one minute without satisfactory eye protection.

D. Obviously, Chemical Cartridge Respirators cannot be used for protection against gaseous material which is not effectively stopped by chemical fills utilized, regardless of concentration. Example: carbon monoxide.

The following is a partial list of gaseous material for which Chemical Cartridge Respirators should not be recommended for respiratory protection regardless of concentration or time of exposure:

1. Acrolein
2. Aniline
3. Arsine
4. Bromine
5. Carbon disulfide
6. Carbon monoxide
7. Dimethylaniline
8. Dimethyl sulfate
9. Hydrogen cyanide
10. Hydrogen fluoride
11. Hydrogen Selenide
12. Hydrogen sulfide
13. Methanol
14. Methyl bromide
15. Methyl chloride
16. Methylene bisphenyl isocyanate
17. Nickel carbonyl
18. Nitro compounds:
    - Nitrobenzene
    - Nitrogen oxides
    - Nitroglycerine
    - Nitromethane
19. Ozone
20. Phosgene
21. Phosphine
22. Phosphorus trichloride
23. Stibine
24. Sulfur chloride
25. Toluene diisocyanate
26. Vinyl chloride

Note: The above list is far from complete and is offered only as a guide to proper evaluation of the many contaminants found in industry.

Combination mechanical filter/chemical filter respirators (Figure 7) utilize dust, mist, or fume filters with a chemical cartridge for dual or multiple exposure. Respirators with independently replaceable mechanical filters are sometimes used for this type because the dust filter normally plugs before the chemical cartridge is exhausted. One combination mechanical/chemical filter respirator employs a back-mounted filter element and is especially well suited for spray painting and welding operations, where the air contaminant is concentrated in front of the worker.

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Figure 8—MSA Industrial Gas Mask.

Figure 9—MSA Super Size Gas Mask.

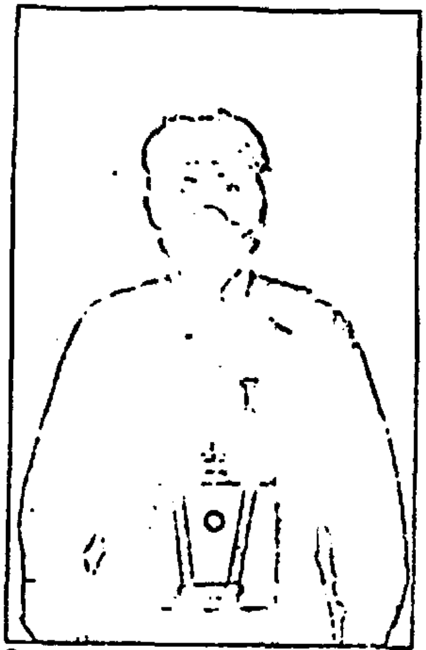

Figure 10—MSA Type N Gas Mask with Window-Calor® Canister.

Gas Masks

Application and Limitations

Gas masks have been used effectively for many years for respiratory protection against certain gases, vapors, and particulate matter which otherwise might be harmful to life or health. They provide simplicity of operation, compactness, ease of maintenance, and economy. However, because gas masks are air-purifying devices, designed solely to remove specific contaminants from the air, it is essential that their use be restricted to atmospheres which contain sufficient oxygen to support life (at least 19.5 percent by volume at sea level) and which contain generally no more than 2-percent concentrations of toxic gases and vapors by volume. It is imperative that the user assess the exposure conditions carefully before selecting a specific mask for respiratory protection. It is recommended that instruments be used where practicable in any situation to measure the concentration of oxygen and harmful gases and vapors present in the atmosphere under the various exposure and operating conditions. If the specific exposure concentrations are suspected of exceeding the specific limitations—only a self-contained breathing apparatus or a hose mask with blower should be used.

From a practical standpoint, gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces below or above ground where oxygen deficiency and high gas concentrations may occur.

Types of Gas Masks

Various gas masks with conventional-sized canisters are tested and approved by the U.S. Bureau of Mines under Schedule 14 for respiratory protection against specific gases and vapors in concentrations up to 2 percent by volume (3 percent ammonia), or as specified on the canister label (Figures 8, 9, 10). Each canister is specifically labeled and color coded to indicate the type of protection afforded (Figure 13). The Type N Gas Mask is the only one which protects against carbon monoxide (Figure 10) with the exception of a self-rescue device designed for escape from carbon monoxide in underground mining operations (Figure 11). NIOSH/MESA will accept for testing and approval vinyl chloride and certain chin-style masks under 30 CFR Part 11, Subpart I.

Chin-type canisters, because of their smaller size, should be limited to concentrations not in excess of 0.5 percent by volume (Figure 12). Most canisters contain a filter for the removal of dust and other particulate matter, indicated by a gray or orange stripe around the canister.

Service Life

The service life of an air-purifying device depends on the following factors:

1. The design, including the quality and amount of chemical fill, packing uniformity and density.

2. Variable exposure conditions, including concentration of contaminants in the air, breathing rate of the wearer, temperature and humidity. Generally, higher concentrations, breathing rates and humidity conditions adversely affect service life. Since the exposure conditions are subject to wide variation, it is most difficult to estimate the service life of a gas mask canister. However, for guidance purposes, actual man tests performed under Bureau of Mines Schedule 14F stipulate the following minimum service requirements at an average breathing rate of 25 liters per minute in concentrations of 2 per cent for most gases and vapors or 3 per cent ammonia:

Industrial Size	
Canisters	30 Minutes
Type N. Canister	
Acid Gases	15 Minutes
Organic Vapors	25 Minutes
Ammonia	15 Minutes
Carbon Monoxide	30 Minutes

Super Size Canisters, because of their greater volume of chemical fill, will last approximately twice as long as the equivalent Industrial Size Canister. Chin Style Canisters, because of their small size, should be used in concentrations not in excess of 0.5 per cent.

Figure 11—MSA Self-Rescuer[1] Respirator (carbon monoxide).

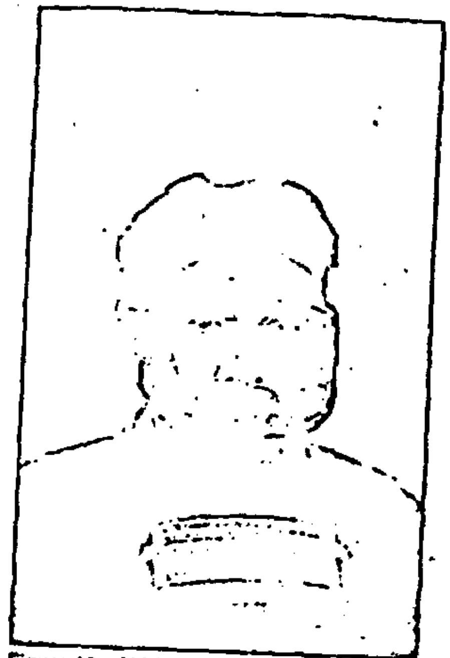

Figure 12—MSA Chin-Type Gas Mask.

It must be emphasized, however, that the above times are for guidance purposes only and are not to be taken as assured service life under actual exposure conditions which vary as stated.

Canister Replacement

It is generally recommended that gas mask canisters used for emergency purposes should be replaced after each use. Specific indications for canister replacement and/or return to fresh air are:

1. If canisters with window indicators show the specified color changes.
2. If any leakage is detected by smell, taste, eyes, nose or throat irritation.
3. If high breathing resistance develops.
4. If the canister shelf life is exceeded.

Warning Signs

Specific warning signs which require immediate return to fresh air are:

1. *Uncomfortable heat in the inhaled air.* (A properly operating canister will become warm on exposure to certain gases or vapors, but a canister which becomes extremely hot indicates that concentrations above the canister limit have been encountered.)
2. If nausea, dizziness or signs of distress develop.

Figure 13—Color Code for Cartridges and Gas Mask Canisters (ANSI K13.1-1973)

Atmospheric Contaminants to be Protected Against	Color Assigned
Acid gases	White
Organic vapors	Black
Ammonia gas	Green
Carbon monoxide gas	Blue
Acid gases and organic vapors	Yellow
Acid gases, ammonia, and organic vapors	Brown
Acid gases, ammonia, carbon monoxide, and organic vapors	Red
Other vapors and gases not listed above	Olive
Radioactive materials (except tritium and noble gases)	Purple
Dusts, fumes, and mists (other than radioactive materials)	Orange

Notes:
(1) A purple stripe shall be used to identify radioactive materials in combination with any vapor or gas.
(2) An orange stripe shall be used to identify dusts, fumes, and mists in combination with any vapor or gas.
(3) Where labels only are colored to conform with this table, the canister or cartridge body shall be gray or a metal canister or cartridge body may be left in its natural metallic color.
(4) The user shall refer to the wording of the label to determine the type and degree of protection the canister or cartridge will afford.

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Figure 14—MSA Constant Flow Air-Line Respirator.

Figure 15—MSA Demand Flow Air-Line Respirator.

Figure 16—Blastfoe™ Abrasive Helmet.

Air-Line Respirators

Air-line respirators shall be used only in atmospheres not immediately dangerous to life or health or from which the wearer can escape without the use of the respirator. This limitation is necessary because the air-line respirator is entirely dependent upon an air supply which is not carried by the wearer of the respirator. If the air supply fails, the wearer is without respiratory protection and might not escape from the immediately dangerous atmosphere. Another limitation of air-line respirators is that the air-supply hose limits the wearer to a fixed distance from the air-supply source.

The air-line respirator is connected to a suitable compressed-air source by a hose of small inner diameter, and air is delivered to the user continuously or intermittently in sufficient volume to meet the wearer's breathing requirements.

Accessory equipment such as pressure regulators, pressure-relief valves, and air filters may be necessary to ensure that the air is at the proper pressure and quality for breathing.

Air-line respirators are furnished in many types, but there are three basic classes. There are constant flow, demand flow, and pressure demand flow, with the respirators equipped with half-masks or full facepieces. If eye protection is required, a full facepiece must be used.

Constant flow units (Figure 14) are normally used where there is an ample air supply such as provided by an air compressor. Demand type (Figure 15) and pressure demand type (Figure 18) are generally used where only compressed-air cylinders are available.

NIOSH/MESA approves air-line respirators under 30 CFR Part 11, Subpart J, which has the following significant requirements. The maximum hose length for which approval is granted is 300 feet, and the maximum permissible inlet pressure is 125 psig. Approval is sought for specific hose lengths and inlet pressures. With the longest hose length for which approval is sought assembled to the respirator and the lowest inlet pressure introduced to the air-supply hose, constant flow units must deliver at least four (4) cubic feet per minute (cfm) measured at the facepiece. The exhalation resistance at 85 liters per minute shall not exceed one (1) inch of water-column height.

When helmets or hoods are used, the same requirements must be met except that the flow rate must be at least six (6) cubic feet per minute. For both types of assemblies with the highest inlet pressure and shortest hose length, the maximum flow shall not exceed 15 cubic feet per minute.

Constant Flow Air-Line Respirators with facepieces alone are used where respiratory protection only is needed. A hood can be added for protection against sandblast or shot blast and frequently a helmet is used for this application with a hood or cape fitted to it (Figure 16). Similar units are used also for lead grinding (Figure 17).

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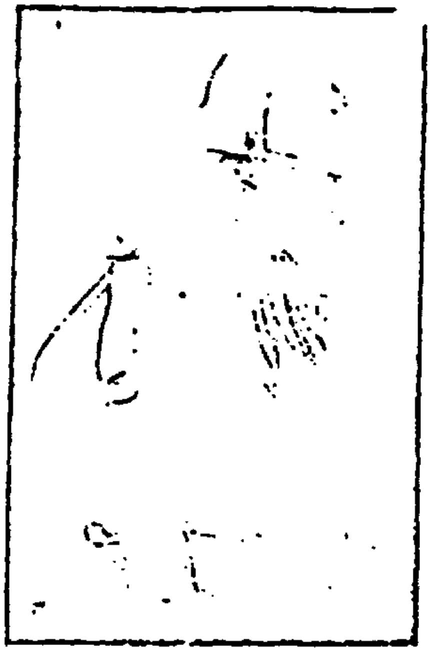

Figure 17—Leadloe™ Hood.

gure 18—MSA Pressure Demand Air-Line Respirator.

Demand type air-line respirators with half masks or full facepieces deliver air flow only during inhalation with exhalation to the atmosphere. Such respirators are normally used where the air supply is restricted to high pressure compressed air cylinders. A suitable pressure regulator is required to insure that the air is at the proper pressure for breathing. The same requirements for approval apply to the demand type as to the constant flow units, except the minimum flow at a maximum resistance of two (2) inches of water-column height measured at the facepiece shall be at least four (4) cubic feet a minute and not more than fifteen (15) cubic feet a minute with all hose lengths within the inlet pressure range for which approval is sought. The exhalation resistance at 85 liters per minute shall not exceed one (1) inch of water.

For those conditions where the possible inward leakage caused by the negative pressure during inhalation always present in demand systems is unacceptable and there can't be the relatively high air consumption of the constant flow units, a pressure demand air-line respirator (Figure 18) may be the best choice. It provides a positive pressure during both inhalation and exhalation and must meet the same requirements for demand systems except that the static pressure in the facepiece shall not exceed 1.5 inches of water, the exhalation resistance at 85 liters per minute shall not exceed the static pressure in the facepiece by more than 2.0 inches of water and that there be at least 4 CFM air flow during inhalation before a negative pressure is developed in the facepiece.

The air supply is the responsibility of the user, and the air-line respirator is approved for use only when it supplies respirable air at the correct pressure and flow. The compressed air shall meet the most recent requirements of Compressed Gas Association Specification G7.1 (ANSI Z86.1-1973) for Type I, Class D gaseous air. This currently requires that the carbon monoxide level not exceed 20 parts per million (ppm), the carbon dioxide content not exceed 1000 ppm, and condensed hydrocarbons not exceed 5 milligrams per cubic meter.

With internally lubricated piston-type compressors, overheating may produce carbon monoxide, so routine testing for carbon monoxide or the installation of a constant monitoring analyzer is desirable.

Some air compressors are manufactured specifically to provide respirable air. They use compression seal liquids such as water or diaphragms for delivering the air.

The air supply hose for which approval is granted must be used for the approval to be maintained.

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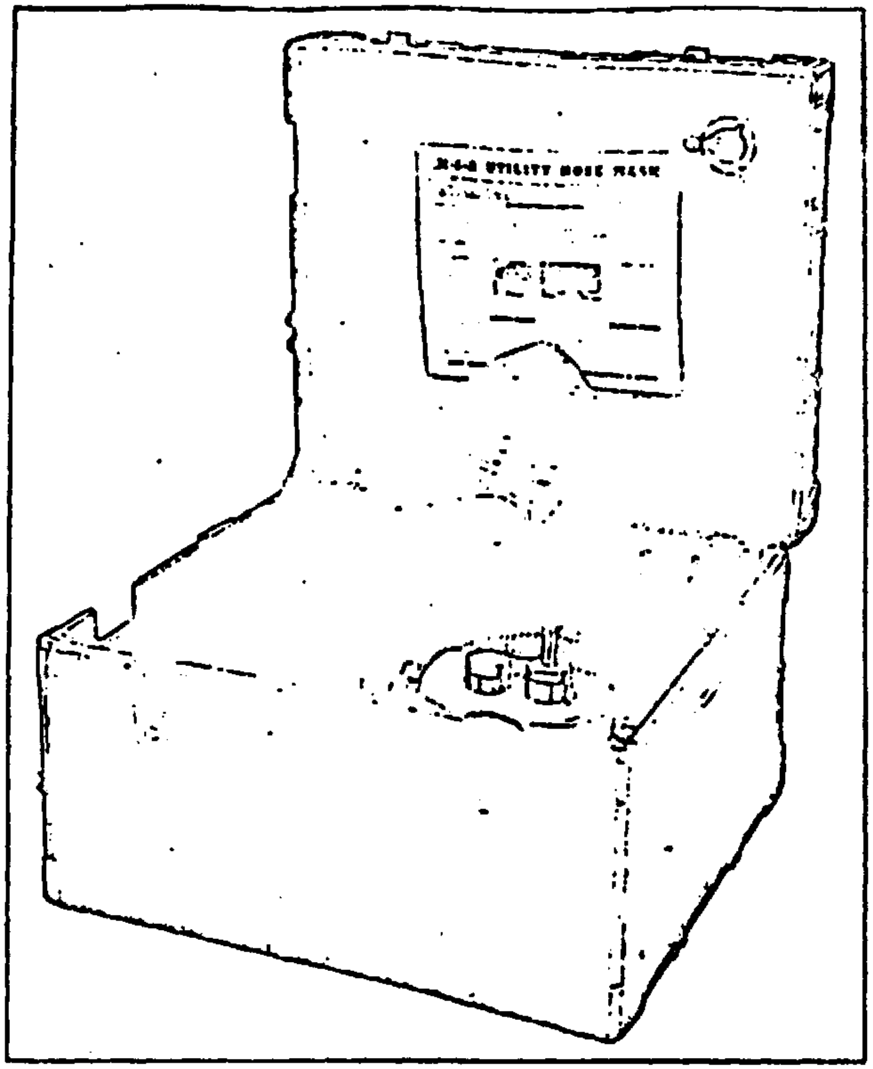

Figure 19—MSA Utility Hose Mask.

Hose Masks

Hose masks, which supply outside air to the wearer through a length of hose, are available either with or without blowers. Those with blowers may be approved by NIOSH/MESA for respiratory protection in any atmosphere regardless of the degree of contamination or oxygen deficiency, providing clean, breathable air can be reached within the distance of the permissible hose length. (Up to 300 feet of hose can be used on this type of equipment.) The blower should always be used with such units.

NIOSH/MESA will approve either hand-driven or motor/hand-driven blowers.

The air hose must have a large inside diameter, approximately one inch, so, in case of blower failure, the wearer can breathe through the hose while escaping from the contaminated area; and it must be highly resistant to petroleum vapors as well as be able to withstand crushing weight. That accounts for the heavy wire-reinforced construction of hose-mask hoses.

The entire hose-mask assembly, including facepieces, harness, air hose, and blower, is usually packaged in a portable trunk (Figure 19). The blower operator serves also as a standby or guard, ready to aid the workman in case of mishap.

Hose masks without blowers are used when uncontaminated air can be reached within a distance of 75 feet. Those units, however, carry only limited approval and cannot be used in atmospheres immediately dangerous to life or health. 30 CFR Part 11, Subpart J, covers this class of equipment.

Self-Contained Apparatus

Self-contained breathing apparatus provide complete respiratory protection in toxic gases and where there is oxygen deficiency. The wearer is independent of the surrounding atmosphere because he is breathing with a system admitting no outside air. The oxygen or air supply of the apparatus itself takes care of respiratory requirements.

Self-contained breathing apparatus are divided into three basic types: oxygen cylinder rebreathing, demand or pressure demand, and self-generating.

Special forms of self-contained breathing apparatus are available for use underwater. Such apparatus are generally referred to as SCUBA (Self-Contained Underwater Breathing Ap-

Figure 20—McCaa® Oxygen Rebreathing-Type Apparatus.

paratus). The self-contained breathing apparatus described in this booklet should never be used underwater.

Oxygen Cylinder Rebreathing Type

The oxygen cylinder rebreathing types in use today are constant flow, "lung-governed" type which automatically compensates for the varying breathing demand of the user, or a combination of the two. It consists of a relatively small cylinder of compressed oxygen, reducing and regulating valves, a breathing bag, facepiece or mouthpiece plus noseclip, and a chemical container to remove carbon dioxide from the exhaled breath.

The self-generating type uses the principle of rebreathing; but it has no mechanical operating components. The types of cylinder rebreathing units now manufactured are approved by the Bureau of Mines or NIOSH/MESA for 45-minute, two- (Figure 20), three- or four-hour duration. They function in the same manner and will be discussed together.

The high-pressure oxygen from the cylinder is reduced in pressure to a breathing level by means of a reducing and regulating valve. In some units there is a constant flow plus a lung-controlled valve which adds any required additional flow. Other apparatus have only an admission valve which delivers the oxygen from the breathing bag to the wearer's face.

Exhaled breath passes down another tube into the container holding the carbon dioxide-removing chemical and then through a cooler. Finally, the purified exhalation flows into the breathing bag where it mixes with the incoming oxygen from the cylinder.

The rebreathing principle permits the most efficient utilization of the oxygen supply. The exhaled breath contains both oxygen and carbon dioxide as the human body extracts only a small part of the oxygen inhaled.

As the user exhales into the container, the carbon dioxide is removed by the chemical and the oxygen which is left reused. That method of operation applies to all oxygen cylinder rebreathing-type apparatus as well as to the self-generating type.

The oxygen cylinder must be refilled and the carbon dioxide-removing chemical replaced after each use. As is true of all respiratory protective equipment, training in proper use and maintenance is essential for the most efficient operation.

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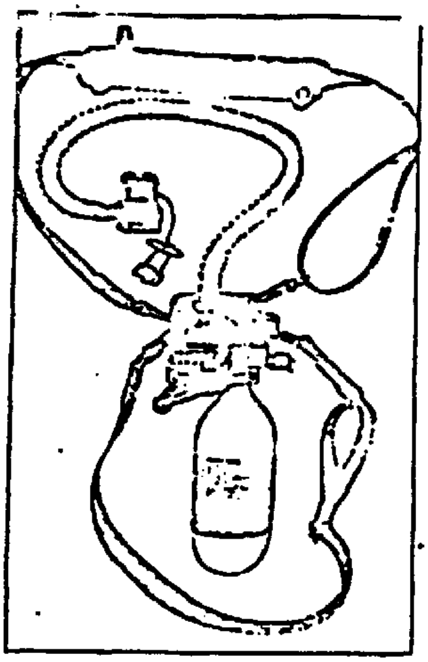

Figure 21—MSA Air Escape Mask.

Figure 22—MSA Sling Mask.

Figure 23—MSA Demand Work Mask.

Demand-Type Apparatus

Demand-type apparatus are available in different models for specific applications. All consist of a high-pressure cylinder, a demand regulator connected either directly or by a high-pressure hose to the cylinder, a facepiece and breathing tube assembly with exhalation valve, and a method of mounting the complete apparatus on the body. In use, the wearer turns on the cylinder valve after putting on the facepiece, inhales to obtain desired air flow through the demand regulator to the facepiece, and then exhales through a valve in the facepiece to the surrounding atmosphere.

The term "demand regulator" means that the air flow is on inhalation demand, automatically regulating itself to the desired level to compensate for variations in breathing needs.

All demand apparatus are relatively inefficient when compared with the rebreathing type, because the exhaled oxygen is released to the atmosphere instead of being reused.

Of particular application to some industries is a short-duration unit known as an "escape mask" (Figure 21). It is normally worn by a worker at times when he is in an area where a potentially toxic atmosphere, above the capacity of a gas mask, exists. Areas to which high-pressure gases are piped fall into this category. Another type of short-duration unit (Figure 22) is put on at the time escape is necessary.

A work mask type of apparatus (Figure 23) is used for planned maintenance work. It is not an emergency apparatus as it requires setting up some auxiliary equipment for use. It has a connecting hose which limits the free movement of the wearer to the length of the hose. The apparatus is actually a two-fold unit:

1. A self-contained apparatus with which the wearer can move freely about by using a small cylinder to leave the toxic atmosphere—either routinely or in the failure of the main breathing supply.

2. There is a provision for connecting a hose to the demand regulator so that the wearer can breathe during the work period from a large cylinder which has a pressure regulator attached to provide low pressure for the connecting hose. Manifold assemblies can be provided to permit more than one worker to work from a common breathing source. It is imperative that the emergency cylinder be used with this type of apparatus; otherwise, a failure of the supply from the large cylinder would expose the wearer to the toxic atmosphere.

Warning Device

Demand-type apparatus depend upon watching a pressure gauge to

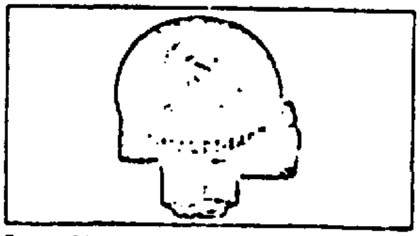

Figure 24—Audi-Larm'® warning device.

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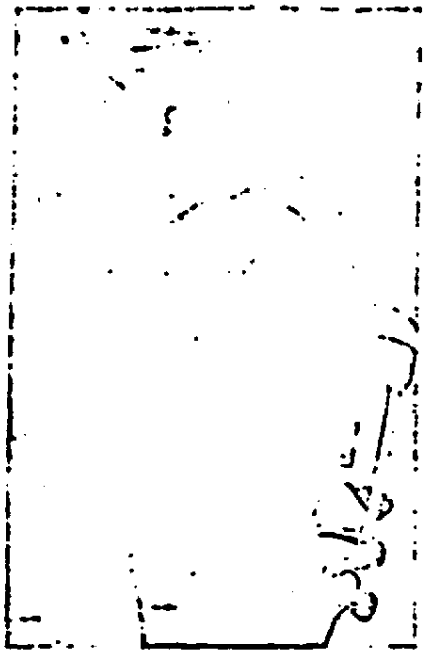

Figure 25—Air Cub[TM] 15-minute unit.

Figure 26—Air Mask[TM] 30-minute unit.

Figure 27—MSA Pressure Demand Apparatus.

learn when the breathing supply has dropped to a point where the user must return to fresh air. Except for escape-type or work mask-type units, a self-actuating warning device is required for NIOSH/MESA approval. The warning device can either be audible (Figure 24) or use increased breathing resistance to alert the wearer to return to fresh air, but it must be self-actuating.

The apparatus shown in Figure 25 is approved by NIOSH/MESA for 15 minutes and that shown in Figure 26 is approved for 30 minutes under 30 CFR Part 11, Subpart H, for entry into and escape from irrespirable atmospheres. These service life ratings are based on tests on men performing moderate to heavy work in each of the different types of work tests or breathing machine tests at a rate of 40 liters per minute. The user should not expect to obtain the exact rated service life on each use. The work being performed may be more or less strenuous than that used in the tests. Where work is more strenuous, the duration may be shorter. The duration of the apparatus will depend upon factors such as:

(a) the degree of physical activity of the user;
(b) the physical condition of the user;
(c) the degree to which the user's breathing is increased by excitement, fear, or other emotional factors;
(d) the degree of training or experience which the user has had with this or similar equipment;
(e) whether or not the cylinder is fully charged at the start of the work period;
(f) the possible presence in the compressed air of carbon dioxide concentrations greater than the 0.04 percent normally found in atmospheric air;
(g) the atmospheric pressure; if used in a pressurized tunnel or caisson at 2 atmospheres (15-psi gauge), the duration will be one-half as long as when used at 1 atmosphere, and 3 atmospheres will be one-third as long;
(h) the condition of the apparatus.

Three-, five-, or ten-minute-duration units can be approved for escape only. Combination apparatus, combining an escape unit with an air-line respirator, are approved also.

Pressure demand apparatus (Figure 27) using the same principle as described previously under pressure demand air-line respirators are approved and used where the toxicity is such that the potential back leak of demand apparatus is not tolerable. Under Subpart H all demand-type apparatus have met tests conducted at −25°F, although low-temperature components such as nosecups to reduce fogging may be added if needed. Under the latest approval requirements, the manufacturer selects the minimum temperature for which he seeks approval.

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Figure 28—MSA Cascade Recharging System.

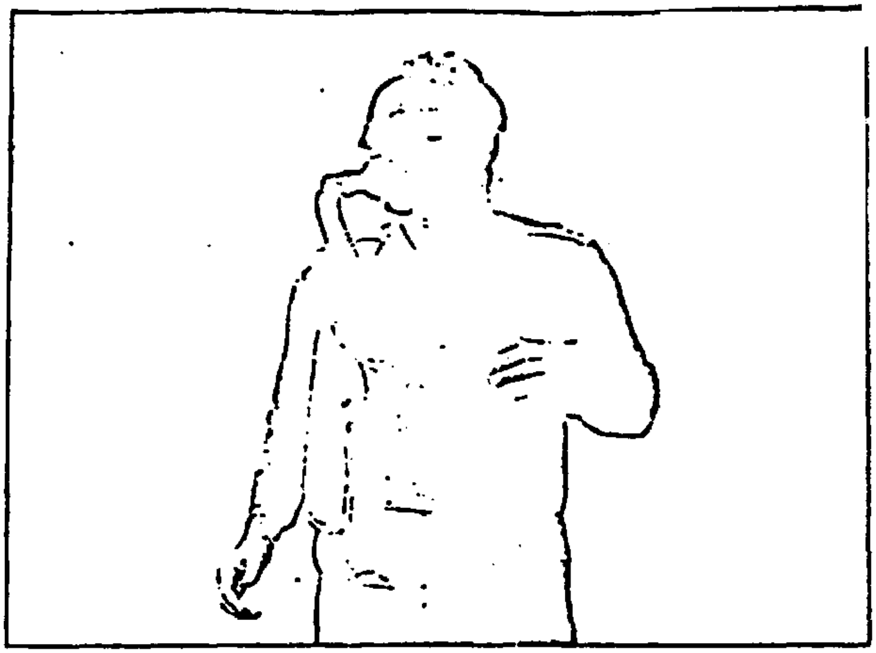

Figure 29—Chemox[9] self-generating-type apparatus.

Recharging Cylinders

There are several methods for refilling or recharging high pressure air or oxygen cylinders. Compressors are sometimes used, but the simplest and most convenient method is to cascade from large supply to small apparatus cylinders. Such a system is shown in Figure 28.

Self-Generating Apparatus

The self-generating type apparatus has a nominal service life of one hour (Figure 29). This one hour service life is based on specific test procedures and in use a lesser or longer protection period may result based on the user and his level of exertion.

This apparatus differs from conventional cylinder rebreathing apparatus in that it utilizes a chemical canister which evolves oxygen and removes the exhaled carbon dioxide in accordance with breathing requirements. It eliminates high pressure cylinders, regulating valves, and other mechanical components.

The canister, which contains potassium superoxide, evolves oxygen when contacted by the moisture and carbon dioxide in the exhaled breath, and retains the carbon dioxide and moisture. Retaining moisture is important as it aids in preventing lens fogging.

In use, the self-generating unit operates as other rebreathing apparatus except that the wearer, using the canister, makes his own oxygen instead of drawing from a compressed gas cylinder. The outstanding features of this type are its simplicity of construction and use, and lesser need for maintenance when compared with high pressure apparatus.

NIOSH/MESA 30 CFR Part 11, Subpart H, covers self-contained breathing apparatus. Except for some special application equipment not covered by the Approval Schedule, all self-contained breathing apparatus should bear Bureau of Mines or NIOSH/MESA approval.

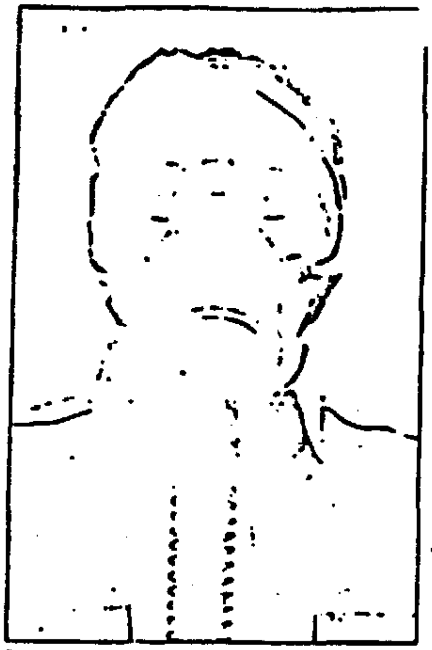

Figure 30—Ultravue† Facepiece with provision for prescription spectacles.

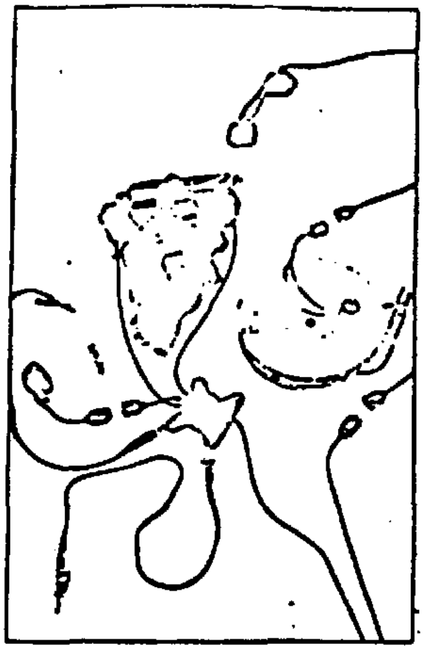

Figure 31—Maskfone™ Sound Powered Communication.

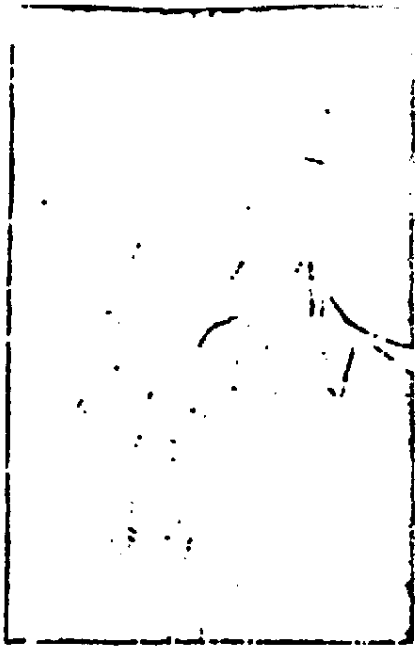

Figure 32—ClearCom™ Voice Amplifying Unit.

Use of Spectacles and Audible Communications

Certain facepieces enable the wearer to also wear prescription spectacles without disturbing the facepiece seal (Figure 30).

Most respiratory protective equipment can be furnished with a speaking diaphragm mounted in the facepiece. Without such a speaking diaphragm, audible communication between wearers of respiratory protective equipment is inadequate at best and at times may be impossible. Facepieces with an exhalation valve provide some measure of voice transmission through this valve, and even those without exhalation valves permit an extremely limited transmission through the facepiece. However, a much greater degree of audible transmission is provided by the modern, scientifically designed speaking diaphragm, thus enabling voice communication between wearers of such equipment where otherwise visible communication might be the only method possible.

Also, sound-powered telephone equipment (Figure 31) can be used with facepieces equipped with a speaking diaphragm or in some models built into the facepiece. Such equipment provides audible communication for long distances over a connecting cable but requires no power source other than human voice. The usual installation of these instruments provides a transmitter mounted in the facepiece and earphones mounted in a head harness for each user of respiratory protective equipment who is to be connected to the system.

The person who is to direct the operations of those with respiratory protection is located in fresh air with a handset similar to that used with telephones. The connecting cable is conveniently mounted on a reel to provide rapid winding and unwinding.

Voice Amplification Unit

Another type of voice transmission equipment that can be used with facepieces containing a speaking diaphragm is the battery-powered amplification unit (Figure 32). These devices are particularly effective in overcoming high background noise levels and enable mask wearers to communicate with other workers.

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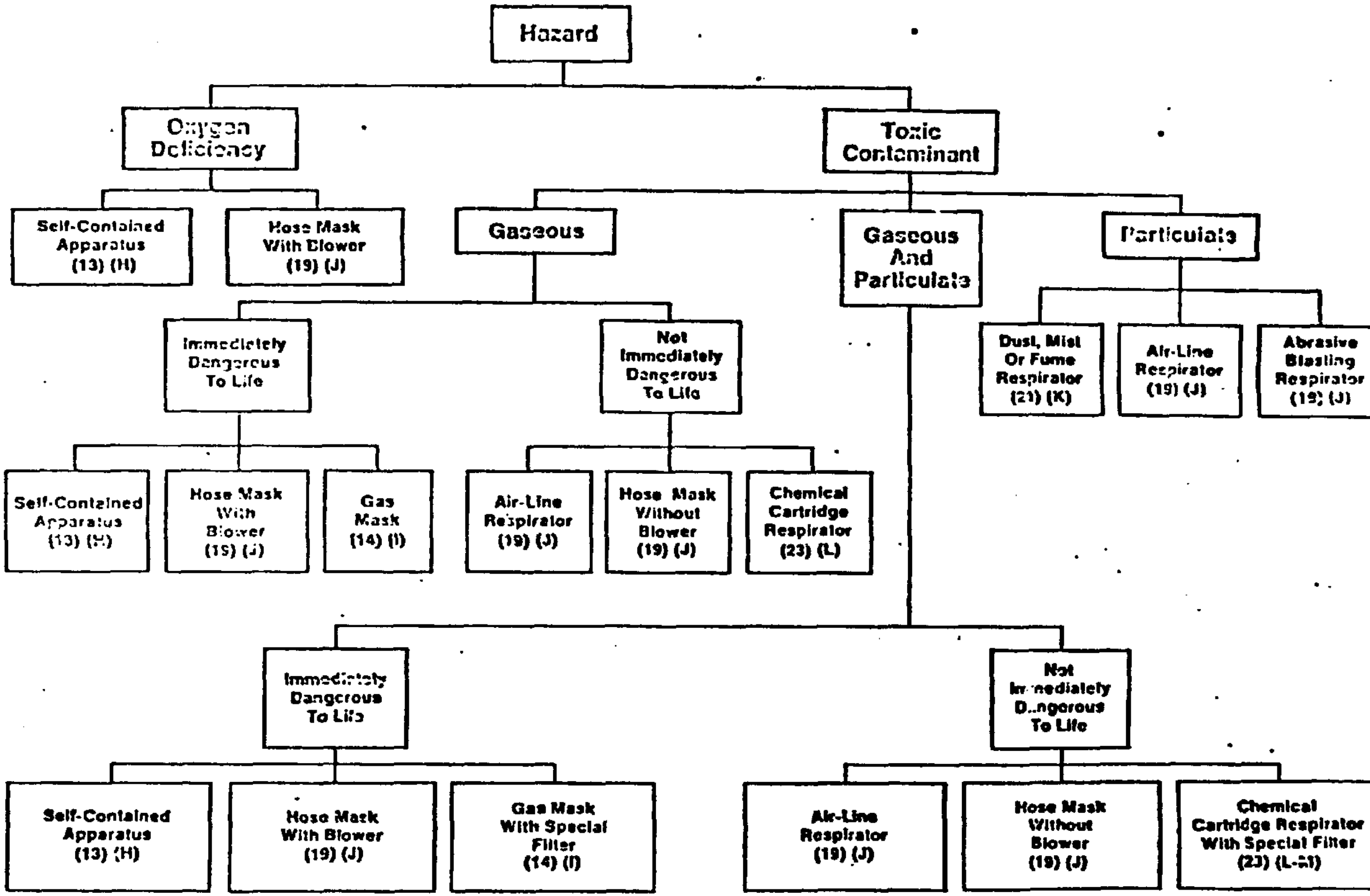

Figure 33—Outline for selecting respiratory protective devices.
(Based on Bureau of Mines Information Circular 7792. Numbers in parentheses refer to Bureau of Mines Schedules; letters in parentheses refer to Subpart of NIOSH/MESA 30 CFR Part 11.)

Training

For safe use of any respiratory protective device, it is essential that the user be properly instructed in its selection, use and maintenance. Both supervisors and workers shall be so instructed by competent persons.

Minimum training shall include the following:

1. Instruction in the nature of the hazard, whether acute, chronic, or both, and an honest appraisal of what may happen if the proper device is not used.
2. Explanation of why more positive control is not immediately feasible. This shall include recognition that every reasonable effort is being made to reduce or eliminate the need for respiratory protection.
3. A discussion of why this is the proper type of unit for the particular purpose.
4. A discussion of the device's capabilities and limitations.
5. Instruction and training in actual use (especially a respiratory protective device for emergency use) and close and frequent supervision to assure that it continues to be properly used.
6. Classroom and field training to recognize and cope with emergency situations.

Training shall provide the men an opportunity to handle the device, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

Respiratory protective devices should never be worn when a satisfactory face seal cannot be obtained. There are many conditions which may prevent a satisfactory face seal such as excessively long sideburns, a beard, temples on glasses, or an unusually structured face.

Inspection, Maintenance and Repair of Respiratory Protective Equipment

Proper inspection, maintenance, and repair of respiratory protective equipment is mandatory to insure success of any respiratory protection program. The precise nature of the program will vary widely based on variables as plant size and the equipment involved. However, the goal is to maintain the equipment in a condition providing the same effectiveness it had when manufactured.

Inspection: All equipment must be inspected periodically before use and after each use. For equipment used only for emergencies the period between inspections can be as individually desired, but should be no more than one month. A record shall be kept of all inspections by date with the results tabulated. There are many differences in the types of equipment used and between the same types of equipment made by different manufacturers. The best rule is to follow precisely the recommendations of the manufacturer.

Maintenance: All respiratory protective equipment shall be cleaned and disinfected after each use. Other maintenance includes replacement of disposable elements such as filters and cartridges whenever such replacement is necessary.

Repair: Replacement of other than disposable parts and any repair shall be done only by personnel with adequate training to insure the equipment is functionally sound after the work is accomplished. Only parts supplied by the manufacturer for the product being repaired shall be used.

Medical Surveillance

Workers should never be assigned to any operations requiring respiratory protection until a physician has determined that they are capable physically and psychologically to perform the work using the respiratory protective equipment. Many plants have preemployment physical examinations which aid in such evaluation, but additional checks may be necessary to determine suitability for a specific assignment.

Should an employee have exposure to certain toxic materials periodic examinations such as a urinalysis or bioassay may be necessary even though the worker wears the proper respiratory protective equipment.

Bureau of Mines Approval Schedules

The Bureau of Mines, U.S. Department of the Interior, prepared a series of Approval Schedules setting forth the minimum requirements that various types of respiratory protective equipment should meet to be considered safe and satisfactory for use in certain hazards or unhealthful conditions.

Provisions were made for testing and approving the following types of respiratory protective devices: Self-Contained Breathing Apparatus (Schedule 13), Supplied-Air Respirators (Schedule 19), Gas Masks (Schedule 14), Mechanical Filter Respirators (Schedule 21), Chemical Cartridge Respirators (Schedule 23). These devices were tested at the Bureau of Mines at Pittsburgh, Pennsylvania.

With the exception of certain sections of Schedule 13, Bureau of Mines approvals of respiratory protective devices were based upon performance tests rather than upon specifications as to how the devices must be built. This policy allows manufacturers wide latitude of choice in design and allowed the Bureau to approve changes and improvements in the devices without frequent revision of the Schedules. Each Schedule contains a statement to the effect that: (1) the device must be constructed, in all of its parts, of materials suitable for the purpose they must serve, and (2) the design, mechanical construction, durability, and workmanship must be satisfactory from the standpoint of safety of the wearer, freedom of movement, field and clearness of vision, fit of the facepiece, and comfort under all conditions of use. This statement gave the Bureau of Mines certain discretionary powers that permit the denial of approval of a device that may meet the performance requirements of the specific Schedule yet may be extremely uncomfortable to wear, flimsily built, or constructed of materials that are not suitable for conditions the device will encounter in service.

The submission of respiratory protective devices to the Bureau of Mines was entirely voluntary on the part of the manufacturer. The Bureau had no regulatory power requiring that all respiratory protective equipment be submitted for approval testing. It acted merely as an impartial testing agency that served by making available to the public a list of respiratory protective devices that have met definite performance requirements.

A manufacturer could visit or communicate with the Bureau of Mines at Pittsburgh to obtain criticisms of proposed designs or to discuss test requirements in connection with a device to be submitted. No charge was made for this consultation, and no written report made to the manufacturer.

The Bureau of Mines approval applies only to the device as a unit and not to its integral parts. For instance, suppose that approvals had been granted to four manufacturers, A, B, C, and D, on four entirely different gas masks of the same type. An assembly of A's canister harness, B's canister, C's check valve, and D's facepiece would not constitute an approved assembly, even though these individual items are parts of approved gas masks. This approval of complete devices applies throughout the entire Bureau of Mines approval system and is not peculiar to those Schedules that deal with respiratory protective equipment.

All approved devices must bear the approval label issued to the manufacturers by the Bureau. These labels contain much more information than the bare fact that the device has been approved by the Bureau of Mines. They give the limitations of the approval, list the approval markings on the parts that make up the approved assembly, and have statements regarding special precautions that should be taken in the use of the device. The approval labels should be studied carefully so that the devices may be used in an approved manner. Even though a device is approved, if it is used improperly or under conditions other than those covered by the approval label, the approval is invalidated.

Bureau of Mines approvals were issued with the understanding that the manufacturer would make his device according to drawings, designs and specimens that he submitted to the Bureau and that had been considered and included in the approval. If he desired to make any changes in the design of a permissible device, he had to first obtain the Bureau's approval of the change. The Bureau checked approved equipment that is on the market from time to time to ascertain whether or not it conformed to the approved device in physical makeup and performance.

From the preceding information, it is clear that Bureau of Mines approval is truly significant as a safeguard to the purchaser of respiratory protective equipment and will ensure to him that such equipment is dependable and safe.

NIOSH/MESA Approvals

Recently, testing for approval was transferred from the Bureau of Mines to the Testing and Certification Laboratory (TCL) of the National Institute for Occupational Safety and Health (NIOSH) at Morgantown, West Virginia. The current approval requirements are outlined in Code of Federal Regulations, Title 30, Part 11, usually referred to as 30 CFR Part 11, and are similar to those of the Bureau of Mines. However, additional devices, such as chin-type gas masks, various types of chemical cartridge respirators other than organic vapor types, and pesticide respirators, are covered by the Subparts of 30 CFR Part 11. All approvals are issued jointly by NIOSH and the Mining Enforcement and Safety Administration (MESA).

The Subparts of 30 CFR Part 11 correspond to the Bureau of Mines Approval Schedules. Bureau of Mines Schedule 13 (Breathing Apparatus) is Subpart H; Schedule 14 (Gas Masks) is Subpart I; Schedule 19 (Air-Line Respirators and Hose Masks) is Subpart J; Schedule 21 (Dust, Fume, and Mist Respirators) is Subpart K; and Schedule 23 (Chemical Cartridge Respirators) is Subpart L. A new Subpart M covers pesticide respirators and gas masks with the approvals granted as appropriate under either Subpart I or L. Such devices were previously listed by the Department of Agriculture.

Bureau of Mines approval numbers were BM with the appropriate Approval Schedule Number and the approval number in sequence. For example, a demand-type breathing apparatus would be BM 13E-10, etc. Under the NIOSH/MESA joint approval, the letters "TC" (meaning Testing and Certification) are used rather than "BM" with the balance of the approval number being the same. For example, the breathing apparatus referred to above now bears approval number TC 13F-29.

Since all approvals are now joint NIOSH/MESA, all devices recently approved or approved in the future will be NIOSH/MESA joint approvals with the TC prefix.

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