4. *Powered Air-Purifying Respirators*

One advantage of powered air-purifying respirators is that they provide an airstream to the wearer. This airstream has the advantage of providing a cooling effect in warm temperatures, but can present a problem in cold temperatures. The decreased inhalation resistance makes the respirator possibly more comfortable to wear. Powered air-purifying respirators with loose fitting hoods or helmets have the advantage that since there are no large sealing surfaces on the face, some people who cannot wear a tight-fitting facepiece for such a reason as facial scars or facial hair can wear them.

Powered air-purifying respirators normally do not restrict mobility. In addition, these respirators offer minimal breathing resistance since the blower supplies the filtered air to the breathing zone of the wearer. Powered air-purifying respirators have limitations in addition to those imposed by respiratory inlet coverings, particulate filter elements and cartridges containing sorbents. A powered respirator's battery should be recharged periodically to ensure that the blower will deliver enough respirable air to the respiratory inlet covering. A battery has a limited useful life and cannot be recharged indefinitely. Battery replacement can be expensive.

The blower in most powered respirators has a high speed motor which will eventually wear out. Therefore, the blower will have to be replaced periodically. If the blower fails, the wearer of a powered respirator should go to the nearest safe area.

Other disadvantages include weight, bulk, complex design, the need for continual maintenance, at least daily replacement of air-purifying elements, and periodic replacement of batteries and blowers. Out-of-doors use presents special problems if hot or very cold air is supplied to the respiratory inlet covering.

Until recently, powered air-purifying respirators were considered positive pressure devices. Field studies by NIOSH as well as others, have indicated that these devices are not positive pressure, and that their assigned protection factors are inappropriately high.

III. Atmosphere-Supplying Respirators

Examples of respirators that provide breathing gas from a source independent of the surrounding atmosphere instead of purifying the atmosphere are shown in Figures 2-4 thru 2-6. The different types are classified according to the method by which the breathing gas is supplied and used and the method used to regulate the gas supply.

A. Self-Contained Breathing Apparatus

The distinguishing feature of all self-contained breathing apparatus (SCBA) is that the wearer need not be connected to a stationary breathing gas source, such as an air compressor. Instead, enough air or oxygen for up to 4 hours, depending on the design, is carried by the wearer. As Fig. 2-4 shows, SCBAs are classified as "closed circuit" or "open circuit."

1. Closed Circuit

Another name for closed-circuit SCBAs is "rebreather" device, indicative of the mode of operation. The breathing gas is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored by a compressed or liquid oxygen source or an oxygen generating solid. Descriptions and certification tests for the closed-circuit apparatus are given in Subpart H of 30 CFR 11.

These devices are designed primarily for 1 to 4 hour use in oxygen deficient and/or IDLH atmospheres such as might be encountered during mine rescues or in confined spaces. They have been used since the early 1900's when the Gibbs and McCaa devices were developed. Few major design changes have been made since then, a significant commentary on their acceptance and good performance. [NOTE: 30 CFR 11 prescribes certification for mine rescue only devices that give 1-hour or more performance. Devices that give 30-minute or longer performance may be certified for auxiliary mine rescue service.]

Because negative pressure is created in the facepiece of non-positive pressure apparatus during inhalation, there is increased leakage potential. Therefore, negative pressure closed-circuit SCBA should be used in atmospheres immediately dangerous to life or health (IDLH) only where their long term use capability is necessary, as in mine rescue. For use in oxygen deficient atmospheres over long periods, closed-circuit SCBA are satisfactory. Positive pressure closed-circuit SCBA are a significant new respirator development and are described in Chapter 6, **New Developments at NIOSH.**

Two basic types of closed-circuit SCBA are presently available. One uses a cylinder of compressed oxygen and the other a solid oxygen generating substance. Figure 2-41 shows a typical closed-circuit SCBA with a small cylinder of compressed oxygen. Breathable air is supplied from an inflatable bag. The exhaled air passes through a granular solid adsorbent that removes the carbon dioxide, thereby reducing the flow back into the breathing bag. The bag collapses so that a pressure plate bears against the admission valve, which opens and admits more pure oxygen that reinflates the bag. Thus, the consumed oxygen is replaced. The advantage of the rebreathing process is that only the oxygen supply need be provided, as all the other air constituents except the waste carbon dioxide are recirculated. The advantage of this type of device is its long term (1- to 4-hour) protection. Disadvantages include the bulk of the SCBA and the negative pressure created in the facepiece during inhalation from some closed-circuit SCBA. As previously discussed, it is now possible for certification of positive pressure devices which offer a higher level of protection. Figure 2-42 shows a closed-circuit SCBA in use.

The second type of closed-circuit SCBA (Fig. 2-43) uses an oxygen-generating solid, usually potassium superoxide (KO_2). The H_2O and CO_2 in the exhaled breath react with the KO_2 to release O_2.

$$2\ KO_2 + CO_2 + H_2O \dashrightarrow K_2CO_3 + 1.5\ O_2 + H_2O,$$
$$2\ KO_2 + 2CO_2 + H_2O \dashrightarrow 2KH\ CO_3 + 1.5\ O_2.$$

The O_2 is not released until the wearer's exhaled breath reaches the canister. Thus, there is a short time lag between when the canister is initiated and O_2 flow begins. This has been overcome in some devices by providing a "quick start" feature known as a chlorate candle, a canister section filled with mixed sodium chlorate and iron. Oxygen flow is started by striking the device, somewhat like lighting a match. This is designed to provide enough oxygen until the potassium superoxide in the canister begins to function.

Oxygen is continually released at a high flow rate into the breathing bag(s) which acts as a reservoir to accommodate breathing fluctuations. A pressure relief valve and saliva trap release the excess pressure created in the facepiece by oxygen flow and nitrogen buildup.

This closed-circuit apparatus is lighter and simpler than the cylinder type. However, it is useful for only about one hour and, once initiated, cannot be turned off. The precautions are the same as for the compressed oxygen unit.

Recently, as a result of regulations promulgated by MSHA under the Coal Mine Health and Safety Act, a new device of closed-circuit SCBA, known as a self-contained self-rescuer (SCSR) was certified for use in underground mines in emergency situations. These devices are similar in design and operation as those already described. They include both compressed-oxygen and oxygen-generating types and offer a duration of one hour.

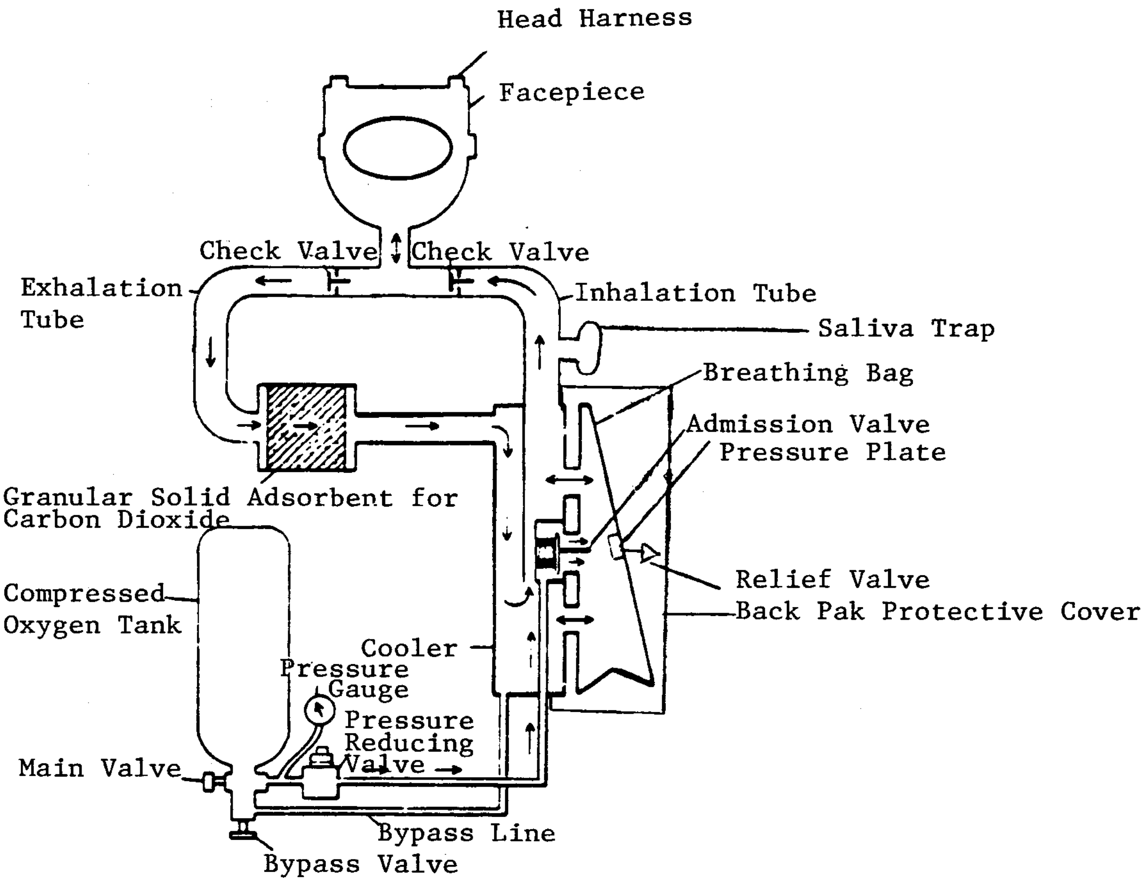
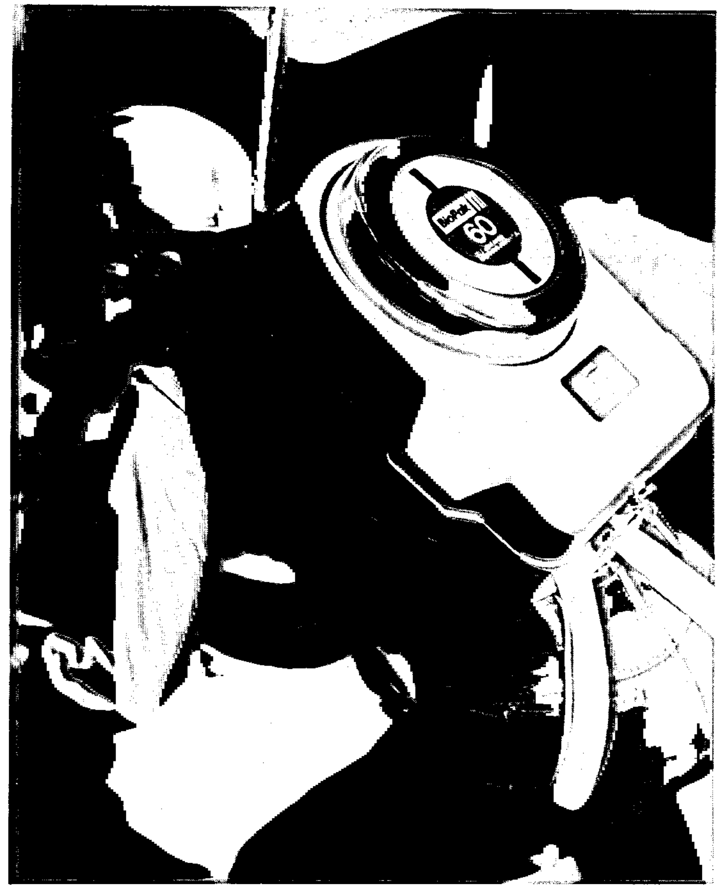


FIGURE 2-41. **Closed-circuit SCBA**

Photograph Courtesy of Draegerwerk



Photograph Courtesy of Rexnord

FIGURE 2-42. **Closed-circuit SCBA**

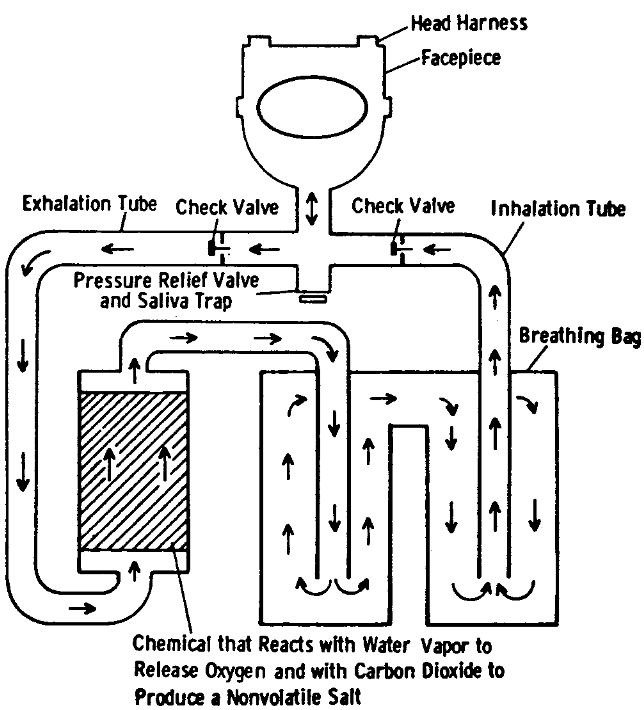


FIGURE 2-43. **Oxygen-generating closed-circuit SCBA**

SCSR are much smaller and weigh considerably less than closed-circuit SCBA for entry. Their weights range between 7 and 16 pounds. The SCSR are escape only apparatus and need not meet all the entry unit requirements of 30 CFR 11. Factors contributing to size and weight reduction include: a mouthpiece in place of a facepiece; the elimination of structural breathing bag protection; filament wound pressure gas vessels; smaller candles; lighter breathing bag material; single pendulum flow breathing tube; the elimination of bypass valve and warning whistle requirements; a more efficient utilization of carbon dioxide sorbent and/or oxygen-generating chemicals; lighter weight packaging material; and others. Figure 2-44 shows an oxygen-generating SCSR. These devices are not usually worn by the miner during mining operations as were the former filter self-rescuers (CO scrubbing only or air-purifying respirators), because they are larger and heavier than the filter self-rescuer. MSHA has strict enforceable storage and location requirements for SCSR. Since they are sealed and may not be opened except for emergency use, there are specific daily and 90 day required SCSR inspection periods and inspection procedures. SCSR with pressure vessels use active pressure gauge indicators. The chemical SCSR use passive storage life color indicators and inspection criteria.

2. Open Circuit

An open-circuit SCBA exhausts the exhaled air to the atmosphere instead of recirculating it. 30 CFR 11 does not specify which breathing gas must be used for these devices, but it is almost always compressed air. Compressed oxygen cannot be used in a device designed for compressed air because minute amounts of oil or other foreign matter in the device components can cause an explosion. In fact, 30 CFR 11 prohibits certification of any device designed to permit interchangeable use of oxygen and air. It is an accepted safety rule that :

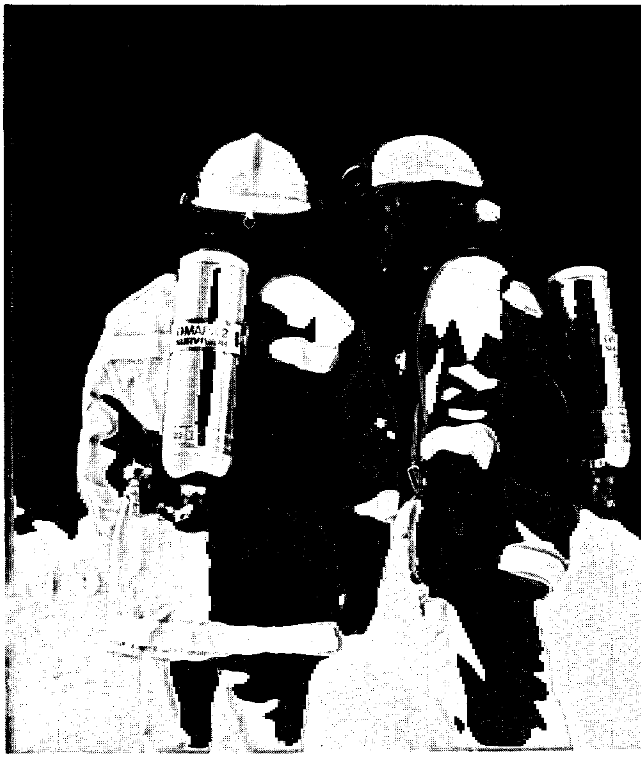
OXYGEN NEVER BE USED IN A DEVICE UNLESS IT IS SPECIFICALLY DESIGNED FOR THAT PURPOSE.

Figure 2-45 shows typical open-circuit SCBA. A cylinder of high pressure (2000-4500 psi) compressed air supplies air to a regulator that reduces the pressure for delivery to the facepiece. This regulator also serves as a flow regulator by passing air to the facepiece on demand. The regulator is either mounted directly to the facepiece or a flexible corrugated hose connects the regulator to the respiratory inlet covering, usually a full-facepiece.

Photograph Courtesy of Draegerwerk

FIGURE 2-44. **Oxygen-generating self-contained self-rescuer**

Photograph Courtesy of Scott Aviation



Photograph Courtesy of Survivair

FIGURE 2-45. **Open-circuit SCBA**

Because it has to provide the total breathing volume requirements, since there is no recirculation, the service life of the open-circuit SCBA is usually shorter than the closed-circuit SCBA. Most open-circuit SCBA have a service life of 30 minutes to 60 minutes based on NIOSH breathing machine tests as prescribed in 30 CFR 11 (11.85-10). NIOSH certifies units with less than 1 hour, but not less than 30 minutes service for auxiliary mine rescue. Open-circuit SCBA are widely used in fire fighting and for industrial emergencies. SCBA with less than 30 minutes service time are certified, generally for escape use only. Escape SCBAs are also certified in combination with supplied-air, airline respirators.

Two types of open-circuit SCBA are available, "demand" or "pressure demand." The difference is very important and best explained by describing the operation of a typical open-circuit SCBA regulator. In a "demand" or negative pressure type regulator, air at approximately 2000 psi is supplied to the regulator through the main valve (Fig. 2-46). A bypass valve passes air to the facepiece in case of regulator failure. Downstream from the main valve, a two-stage regulator reduces the pressure to approximately 50-100 psi at the admission valve, which is actuated by movement of a diaphragm and its associated levers. The admission valve stays closed as long as positive pressure in the facepiece (during exhalation) forces the diaphragm away from the valve assembly. Inhalation creates negative pressure in the facepiece, and the diaphragm contracts, opening the admission valve and allowing air into the facepiece. In other words, air flows into the facepiece only on "demand" by the wearer, hence the name.

Recent studies indicate that a demand-type SCBA is no more protective than an air-purifying respirator with the same facepiece. Therefore, a demand-type open-circuit SCBA should not be used in IDLH atmospheres. Like closed-circuit SCBA, however, they may be adequate against oxygen-deficient atmospheres.

A pressure-demand or positive pressure regulator is very similar to a demand type except that there is usually a spring between the diaphragm and the outside case of the regulator. This spring tends to hold the admission valve slightly open, theoretically allowing continual air flow into the facepiece. This would be true except that all pressure-demand devices have a special exhalation valve that maintains about 1.5-3 inches H_2O positive back pressure in the facepiece, and opens only when the pressure exceeds that value. This combination of modified regulator and special exhalation valve is designed to maintain positive pressure in the facepiece at all times. Under certain conditions of work a momentary negative pressure may occur in the wearer's breathing zone, although the regulator still supplies additional air on

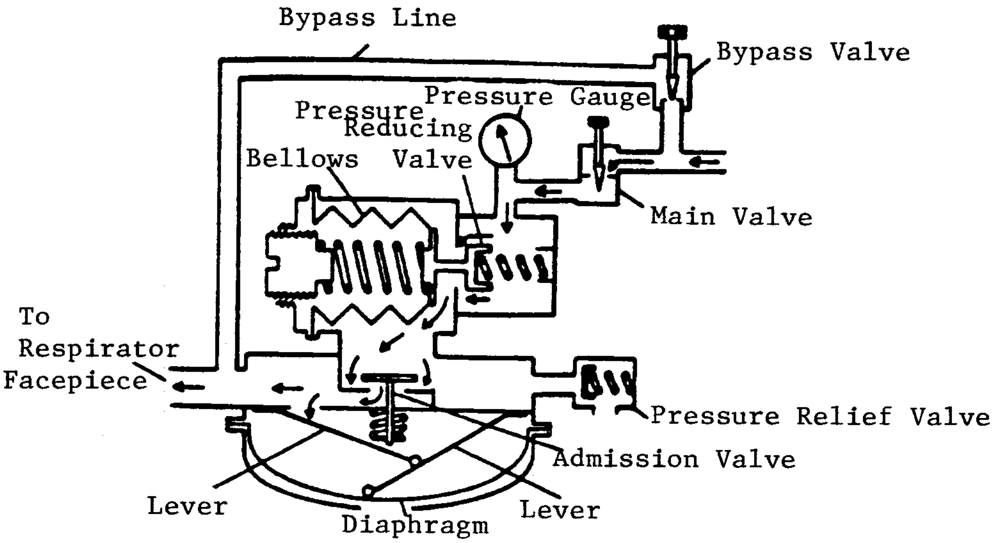


FIGURE 2-46. **Open-circuit demand SCBA regulator**

"demand." Because of the positive pressure, any leakage should be outward; therefore, a pressure-demand SCBA provides very good protection. Contrary to common belief, the pressure-demand SCBA has the same service time as a demand version of the same device, if it seals well on the wearer's face. Any leakage increases air consumption and decreases service time.

A FACEPIECE WHOSE EXHALATION VALVE IS DESIGNED FOR DEMAND OPERATION CANNOT BE USED WITH A PRESSURE-DEMAND REGULATOR, AS AIR WILL FLOW CONTINUALLY AND QUICKLY EXHAUST THE AIR SUPPLY.

Some open-circuit SCBA can be switched from demand to pressure-demand operation. The demand mode should be used **only** for donning and adjusting the apparatus in order to conserve air and should be switched to "pressure demand" for actual use.

Several required safety features on all certified entry (both closed and open circuit) SCBA provide additional protection. Among these are:

- o pressure gauges or liquid level gauges visible to the wearer which indicate the quantity of gas or liquid (air or oxygen) remaining in the cylinder

- o remaining service life indicators or warning devices that signal alarm when only 20-25% of service time or service volume remains

- o bypass valves, in case the first and second stage reducer or regulator fails and it is necessary to conserve or provide respirable air

- o fittings on devices that use compressed or liquid oxygen which are incompatible with compressed or liquid air fittings.

The choice of demand or pressure-demand open-circuit SCBA should be based on thorough evaluation of the respiratory hazards. MSHA and NIOSH continue to issue certifications for both types since the demand type is still used in many industrial applications. In a potentially IDLH atmosphere, a pressure-demand SCBA should most certainly be used.

In addition to entry, SCBA are also certified for escape from IDLH. These escape-only SCBA are generally of short duration, that is, 3, 5 or 10 minutes, and are small in both size and weight. The compressed-air container is usually hip- or back-mounted with the air valve in a readily accessible position for immediate activation. The facepiece may be donned quickly by simply tightening the headband straps or a hood may be furnished for quick donning of the escape SCBA. Figure 2-47 shows two hood-type, escape-only SCBA.

B. Supplied-Air Respirators

1. *Airline respirators (Types C and CE)*

Airline respirators as described in 30 CFR 11, Subpart J use compressed air from a stationary source delivered through a hose under pressure. 30 CFR 11 specifies that the pressure shall not exceed 125 psi at the point where the hose attaches to the air supply. A manufacturer submitting an airline respirator for certification must specify the operating pressure and the hose length, from 25 to 300 feet. At the lowest pressure and longest hose length, the device must deliver at least 170 Lpm to a helmet or hood. At the highest pressure and shortest hose length the flowrate must not exceed 425 Lpm to a helmet or hood. The equivalent airflows to a tight-fitting facepiece are 115 Lpm and 425 Lpm, respectively.

Airline respirators are available in demand, pressure-demand, and continuous-flow configurations (see Figure 2-5). The respiratory inlet covering may be a facepiece, helmet, hood, or complete suit, although there are presently no approval tests for suits.

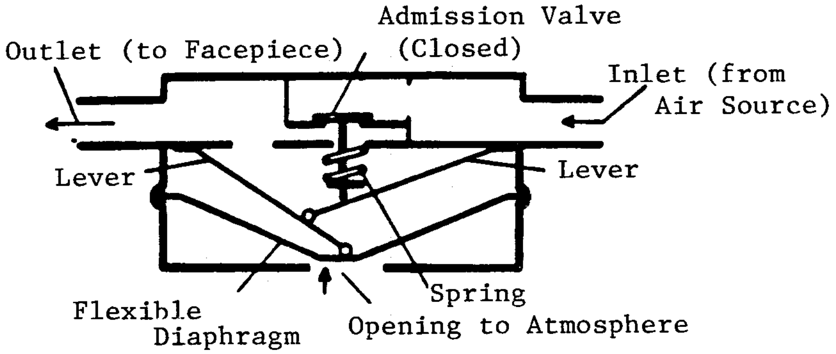
A demand or pressure-demand airline respirator is very similar in basic operation to a demand or pressure-demand open circuit SCBA, except that the air is supplied through a small diameter hose from a stationary source of compressed air rather than from a portable air source. Because the air pressure is limited to 125 psi, regulators for demand and pressure-demand airline respirators need only single stage reduction. Otherwise, the demand and pressure-demand airline regulators are similar in operation to the demand and pressure-demand SCBA regulators respectively. Figure 2-48 shows a typical demand type regulator. Figure 2-49 shows a typical pressure-demand airline respirator with a tight-fitting facepiece. Note that the regulator sometimes is mounted on the facepiece or worn on the wearer's chest.

Continuous-flow airline respirators maintain air flow at all times, rather than only on demand. In place of a demand or pressure-demand regulator, an air flow control valve or orifice partially controls the air flow. According to 30 CFR 11, a flow of at least 115 Lpm to a tight fitting facepiece and 170 Lpm to

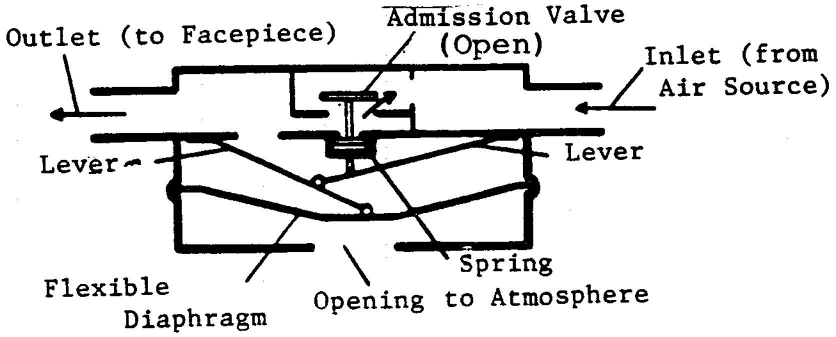
Photograph Courtesy of ISI

Photograph Courtesy of North

FIGURE 2-47. **Typical escape-only ESCBA**



EXHALATION. High pressure of exhaled air stretches diaphragm. Resulting lever movement and spring action close admission valve, and air flow ceases.



INHALATION. Low pressure created by inhalation pulls diaphragm inward. Resulting lever movement compresses spring and opens admission valve. Air flows through valve.

FIGURE 2-48. **Typical demand-type air flow regulator**

Photograph Courtesy of ISI

FIGURE 2-49. **Pressure-demand airline respirator** a loose-fitting hood or helmet must be maintained at lowest air pressure and longest hose length specified. This means that by design, either the control valve cannot be closed completely, or a continually open bypass is provided to allow air to flow around the valve and maintain the required minimum rates.

Some special valves known as vortex tubes are available with some certified airline respirators. These valves fractionate the airstream into two high speed airflow components. One component becomes cool from adiabatic expansion while the other component becomes warm from adiabatic compression. Either component can be utilized in valve design to cool or heat the respirable air provided to the user for comfort and physiological support.

Figure 2-50 depicts a typical continuous-flow airline respirator with a tight-fitting facepiece. Notice the air-purifying element on the air-supply line. Figure 2-51 shows typical airline respirators, which may be obtained with half masks and full-facepieces. Figure 2-52 shows continuous-flow airline respirators with hoods.

Although addition of an air-purifying element in the supply line upstream of the air-supply hose attachment can help clean the air, other precautions also should be taken to ensure breathing air quality. The air supply to airline respirators is required to meet the requirements for Type I gaseous air (Grade D or higher quality) set forth by the Compressed Gas Association Commodity Specification for Air, G-7.1. Furthermore, OSHA requires that a breathing air compressor have certain safety devices to protect the air quality (see Chapter 3).

Airline respirators with special items to protect the wearer's head and neck from rebounding abrasive material may have facepieces, helmets, or hoods. Plastic, glass, and metal wire screen are used to protect the lenses of facepieces and the windows of helmets and hoods against the rebounding material. These respirators are known as abrasive-blasting airline respirators or Type "CE" supplied-air respirators.

Figure 2-53 shows Type "CE" respirators in use. Note the protective screen over the lens and the heavy apron on the abrasive- blasting hood.

Full suit airline respirators are available. They provide air not only for breathing but also to isolate the whole body from the surrounding atmosphere. They are used against substances that irritate or corrode the skin or which may penetrate the

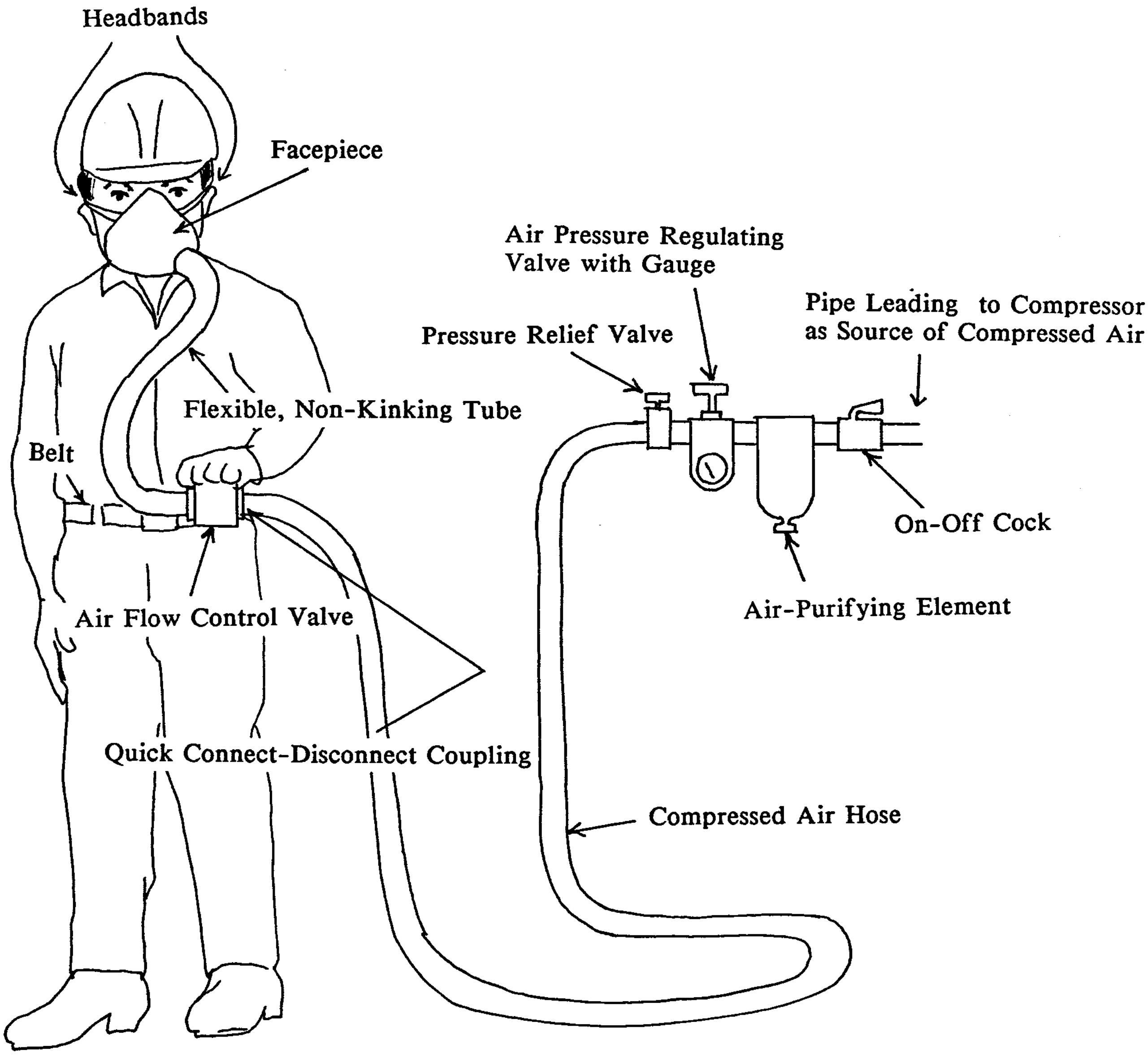


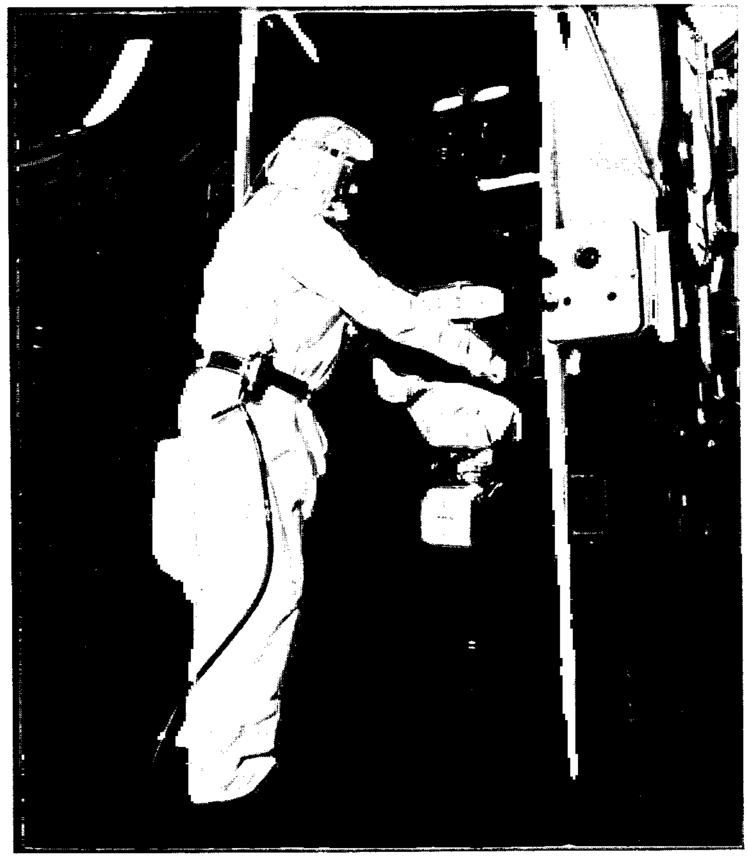
FIGURE 2-50. **Continuous-flow airline respirator**

Photograph Courtesy of
U.S. Safety Service

Photograph Courtesy of
Willson Safety Products

FIGURE 2-51. **Half mask and full-facepiece continous flow airline respirators**

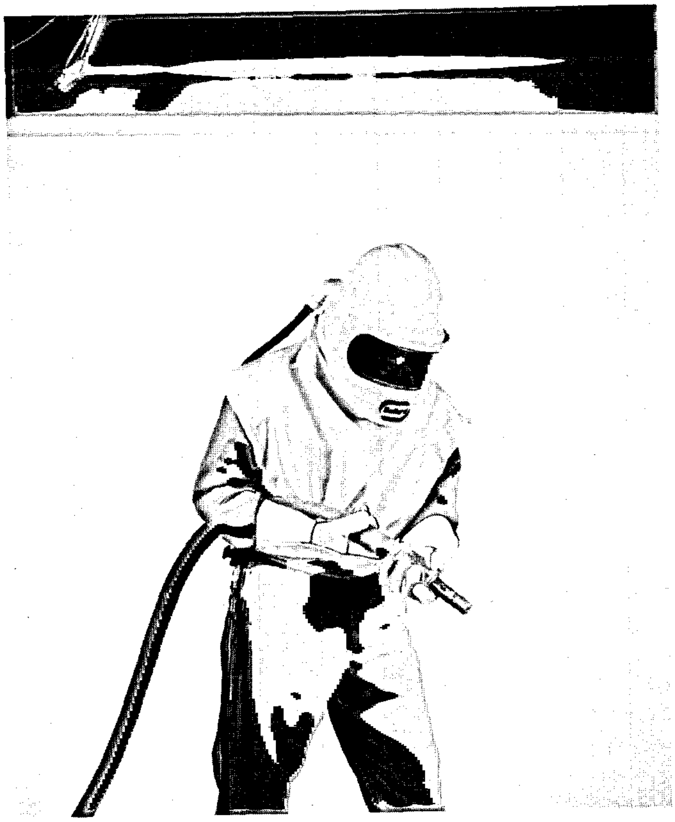
Photograph Courtesy of
Standard Safety Equipment



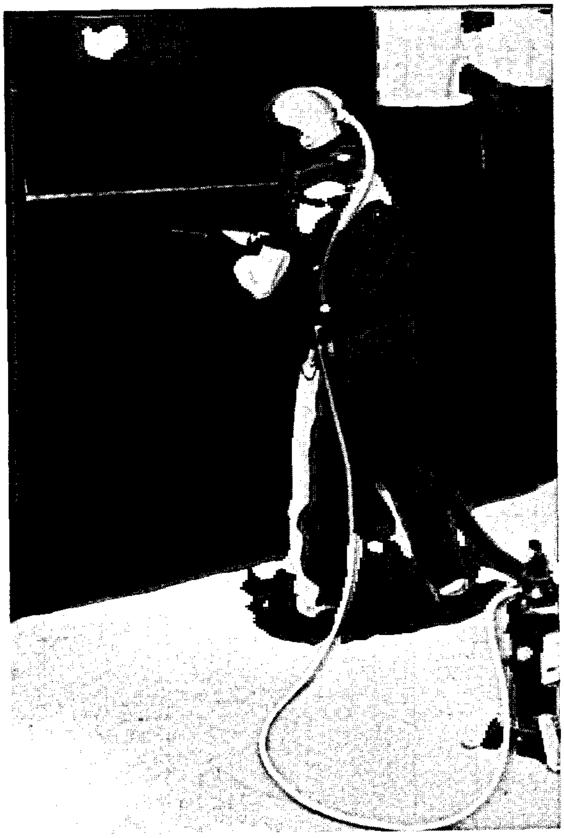
Photograph Courtesy of
Safety Products Limited

Photograph Courtesy of Mohawk Industries

FIGURE 2-52. **Continuous flow airline respirators with hoods**



Photograph Courtesy of Bullard



Photograph Courtesy of Clemco

FIGURE 2-53. **Typical Type CE abrasive-blast airline respirator** skin to produce toxic effects. Presently, 30 CFR 11 does not provide for certification of airline suits.

2. Hose Masks

Hose masks supply air from an uncontaminated source through a strong, large diameter hose to a respiratory inlet covering. Two types are available. One has a hand or motor operated air blower that pushes low pressure air through the hose to the respiratory inlet covering. The blower is designed so that air flows freely through it when it is not in operation. Therefore, if the blower fails, the wearer can still inhale respirable air by normal breathing. The other type of hose mask has no blower and requires the wearer to inhale through the hose.

The hose mask with a blower is categorized by 30 CFR 11 Subpart J as a Type "A" supplied-air respirator and is certified for use in atmospheres not immediately dangerous to life or health. The hose mask without a blower is categorized as Type "B" and is certified for use only in atmospheres not immediately dangerous to life or health. The hose mask with blower may have a facepiece, helmet, or hood, but the hose mask without blower must have a tight fitting facepiece. Hose masks may have special equipment to protect the wearer's head and neck from rebounding material during abrasive blasting. Such a hose mask with blower is classified as a Type "AE" supplied-air respirator, and the one without blower is classified as Type "BE."

A certified hose mask with blower may have up to 300 feet of air supply hose in multiples of 25 feet, but one without blower may have only up to 75 feet in multiples of 25 feet. The hand or motor operated blower must deliver air through the maximum length of hose at not less than 50 Lpm. The motor operated blower of a device with 50 feet of hose must deliver no more than 150 Lpm. However, no maximum air flow rate is specified for the hand operated blower.

Currently there are only three hose masks certified. They are not widely used in industrial applications. They are heavy, cumbersome and offer only a very low protection factor.

C. Combination Respirators

MSHA/NIOSH may certify respirators assembled from two or more types of respirators in combination as prescribed in 30 CFR 11.63(b).

To date MSHA/NIOSH have certified several types of air-purifying units or SCBA in combination with the Type C supplied-air respirator.

1. Combination Supplied-Air/Air-Purifying Respirator

One type of combination respirator that MSHA/NIOSH has certified is the Type C supplied-air and air-purifying respirator as shown in Figure 2-54. These devices are certified under the class of the air-purifying element since it is the component in the combination which provides the least protection to the user. This type of respirator consists of facepiece; regulator or control valve, if necessary; breathing tube, if necessary; belt or harness; supplied-air hose; and air-purifying element. The air-purifying element may be a canister, chemical cartridge, or particulate filter. It is mounted either directly on the facepiece or on an adapter which is worn on the belt.

The supplied-air portion of the respirator can be either Type C continuous-flow or pressure-demand.

An advantage of this type of respirator is that the wearer has respiratory protection while entering (in some cases) and leaving without being connected to an airline. The air-purifying element weighs less than a self-contained breathing apparatus cylinder. The disadvantage is that they have the limitations of the air-purifying element, and therefore, can be used only for specific conditions. Depending upon the specific respirator, the air-purifying element will have one of the following restrictions (consult the certification label of the respirator to determine which applies):

a. no restrictions

b. air-purifying element can be used only to: (1) enter prior to connecting to air supply, (2) egress after disconnecting or loss of air, or (3) to move from one air supply to another

c. escape only after loss of air.

2. Combination Supplied-Air/SCBA Respirator

To be usable in an IDLH atmosphere, an airline respirator must have an auxiliary air supply to protect against potential failure of the primary supply. This is provided by adding a self-contained cylinder of high pressure compressed air to a Type "C" or "CE" airline respirator. The auxiliary air supply may be certified for 3-, 5-, or 10-minute service time, or for 15 minutes or longer (see Figure 2-55). The certification tests for these combination devices are found in 30 CFR 11, Subpart H, "Self-Contained Breathing Apparatus." The devices shown in Figure 2-55 are only representative of this general class; designs vary widely.

Photograph Courtesy of North Safety Products, Inc.

Photograph Courtesy of Racal Airstream

FIGURE 2-54. **Combination supplied-air respirator with escape only high efficiency filter**

Photograph Courtesy of Powermaster, Inc.

Photograph Courtesy of Interspiro

***FIGURE 2-55.* Combination supplied-air/SCBA**

Because of the short service time of the self-contained breathing air supply, combination units generally are used for emergency entry into and escape from IDLH atmospheres. The self-contained portion of the device is used only when the airline portion fails and the wearer must escape, or when it may be necessary to disconnect the air line temporarily while changing locations. A combination airline and SCBA may be used for emergency entry into a hazardous atmosphere (to connect the airline), if the SCBA part is classified for 15 minutes or longer service and not more than 20% of the air supply's rated capacity is used during entry. It is seldom used as a routine means of protection, as the open-circuit SCBA might be.

D. Advantages and Disadvantages of Atmosphere-Supplying Respirators

1. *Airline Respirators*

A great advantage of the airline respirator is that it may be used for long continuous periods. Other advantages are minimal breathing resistance and discomfort, light weight, low bulk, moderate initial cost, and relatively low operating cost.

The biggest disadvantage of supplied-air respirators is that loss of the source of respirable air supplied to the respiratory inlet covering eliminates any protection to the wearer. Such loss may be caused by cutting, burning, kinking, or crushing the supply air hose, by air compressor failure, or by depletion of the respirable air in a storage tank. Possible loss of respirable air supports the NIOSH recommendation against airline respirator use in IDLH atmospheres. However, an airline respirator with an auxiliary self-contained air supply could be used in such atmospheres because the auxiliary self-contained air supply always can be used in escape.

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 move frequently between widely separated work stations. A combination airline and self-contained breathing apparatus may be suitable if the supply of self-contained breathing air is adequate for the time required to move from place to place. A coiled airline hose provided with some MSHA/NIOSH certified devices will further promote wearer mobility at the worksite.

Airline respirators that operate in the demand mode have negative air pressure inside the respiratory inlet covering during inhalation which permits the contaminated atmosphere to leak into the respiratory inlet covering if it fits poorly. However, airline respirators that operate in the pressure-demand mode are designed to have positive air pressure inside the respiratory inlet covering which helps to ensure that contaminated air will not leak in. Thus, an airline respirator operating in the pressure-demand mode provides much better protection than one that operates in the demand mode.

2. *Hose Masks*

Advantages of the hose mask without blower are its theoretically long use periods and its simple construction, low bulk, easy maintenance, and minimal operating cost. An advantage of the hose mask with blower is its minimal resistance to breathing.

Obviously, air pressure inside the respiratory inlet covering of the hose mask with no blower is negative during inhalation, so contaminated air may leak in if the covering fits poorly. Therefore, hose masks, with and without blower, are certified only for use in non-IDLH atmospheres.

The trailing air supply hose of the hose mask also severely limits mobility, so it may be unsuitable for those who move frequently among widely separated work stations.

A severe restriction of the hose mask without blower is that it is limited to a maximum hose length of only 75 ft. 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 strains the wearer and may cause fatigue.

3. *Self-Contained Breathing Apparatus*

Because the SCBA wearer carries his own supply of respirable air, he is independent of the surrounding atmosphere. A great advantage of such apparatus is that it allows comparatively free movement over an unlimited area.

The bulk and weight of most SCBAs make them unsuitable for strenuous work or use in a constricted space. The limited service life makes them unsuitable for routine use for long continuous periods. The short service life of open-circuit type devices may limit them to use where the wearer can go conveniently and quickly from a hazardous atmosphere to a safe atmosphere to change the tank of supply air.

Open-circuit SCBA are normally less expensive to purchase and use than closed-circuit SCBA. Additionally, the open-circuit SCBA requires less maintenance and fewer inspections.

The demand-type open-circuit SCBA and most closed-circuit SCBA have negative air pressure inside the respiratory inlet covering during inhalation so contaminated air can leak in if they fit poorly. The pressure-demand type open-circuit SCBA and those closed-circuit SCBA that are positive pressure devices provide very good protection because the air inside the respiratory inlet covering is normally at positive pressure which helps to keep the contaminated atmosphere from leaking in.

CHAPTER 3

RESPIRATOR SELECTION

I. Regulatory Requirements

The selection, use, and maintenance of respirators in the United States is presently regulated by several Federal agencies. The agencies, the acts which authorize their activities, and the current regulations relating to selection, use, and maintenance of respirators, are as follows:

Act	Agency	Regulation(s)
Federal Mine Safety and Health Act of 1977	Mine Safety and Health Administration; Department of Labor	Title 30 CFR Parts 11 , 70
	National Institute for Occupational Safety and Health, Centers for Disease Control, Department of Health and Human Services	Title 30 CFR Part 11
Occupational Safety and Health Act of 1970	Occupational Safety and Health Administration, Department of Labor	Title 29 CFR Part 1910
Toxic Substances Control Act	Environmental Protection Agency	Title 40 CFR Part 750
Title II of the Energy Reorganization Act of 1974	Nuclear Regulatory Commission	Title 10 CFR Part 20

The Federal regulations cited above and Guidelines issued in accordance with those regulations, with few exceptions, call for selection and use of respirators that have been certified by MSHA and NIOSH. Exceptions to that principle include the MSHA allowance of use of certain Bureau of Mines-approved mine rescue breathing apparatus, the OSHA acceptance of cylinder interchange and "buddy breathing systems" for use by fire fighters in 29 CFR 1910.156, and the NRC acceptance of supplied-air suits tested by Los Alamos National Laboratory.

Since 1972, with promulgation of Title 30 CFR 11, MSHA and NIOSH have tested and certified various types of respiratory protective devices. The present regulations in Part 11 are the result of amendment of the 1972 regulation. NIOSH currently recognizes that certain requirements of Part 11 are inadequate and incomplete, and a proposed revision of Part 11 has been published for public comment as a Notice of Proposed Rulemaking 42 CFR Part 84. Final publication is expected following a public hearing and further revision of Part 84.

II. General Selection Information

NIOSH recommends that respirators only be used when engineering controls are not feasible or effective, while controls are being installed or repaired, or for emergency and other temporary (intermittent) situations. Respirator selection is very complex and should be performed by an Industrial Hygienist or other professional knowledgeable in respiratory protective devices.

In 1975, NIOSH and the Occupational Safety and Health Administration (OSHA) as part of the Standards Completion Program developed a Respirator Decision Logic. That Logic incorporated fit factor data developed by the Los Alamos National Laboratory (LANL) under contract to NIOSH and incorporated requirements from 30 CFR 11.

The Decision Logic was modified by NIOSH in 1987 to include:

1. the NIOSH respirator carcinogen policy,

2. respiratory protective devices developed since 1975, and

3. a revision of assigned protection factors for those respirators for which valid workplace protection factor studies had been performed.

The selection of a specific respirator should be made by individuals knowledgeable of the limitations associated with each class of respirator (see Chapter 2), and familiar with the actual work environment including job tasks to be performed. For example, mobility of the worker and temperature and humidity of the work environment should all be considered in making an adequate respirator selection.

III. NIOSH Respirator Decision Logic

The NIOSH Respirator Decision Logic is reproduced as part of Appendix E of this document. This Logic contains a set of questions which will lead the user to the proper respirator selection table and identifies the criteria necessary to determine the classes of respirators which will provide adequate protection.

IV. NIOSH Certified Equipment List

The *NIOSH Certified Equipment List* (NCE) is published annually and lists the coal mine dust personal sampler units and respirators certified by NIOSH as well as provides updated information on the products, certifications, respirator complaints and problems, and NIOSH respirator policy.

In 1985, the format of this publication was modified. Respirators are now listed by specific certification class. General cautions and limitations for each certification class are listed (see page 84). However, these limitations are by no means all inclusive. The respirator manufacturer may also identify further limitations or cautions for their respirators. In addition, regulatory agencies may also place a limit on the use of respirators in their standards. An example of the listing for entry into and escape open-circuit SCBA is given on page 85.

Single, complimentary copies of the NCE will be provided by NIOSH while the supply lasts. Multiple copies can be ordered from the Government Printing Office (GPO). Requests for single copies should be sent to:

Publication Dissemination, DSDTT
NIOSH
4676 Columbia Parkway
Cincinnati, Ohio 45226-1998

EXAMPLE OF LISTING FROM NIOSH CERTIFIED EQUIPMENT LIST

A. Self-contained Breathing Apparatus

1. Entry Into and Escape

a. Open circuit pressure demand

Approval

Certified as approved for respiratory protection during entry into or escape from oxygen deficient atmospheres, gases and vapors.

Limitations

Use only for temperatures above the temperature listed on approval label.

Approved only when compressed air reservoir is fully charged with air meeting the requirements of the Compressed Gas Association Specification G-7.1 for Type 1, Grade D air, or equivalent specifications.

The air container shall meet applicable DOT specifications.

Use adequate skin protection when worn in gases or vapors that poison by skin absorption.

Refer to certification label and instruction and maintenance manuals for additional information on use and maintenance of these respirators.

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

Demand mode shall be used only when donning apparatus.

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

Recommendations

NIOSH recommends that SCBA be inspected weekly if stored and immediately before use, if used regularly, for breathing gas pressure.

SCBA ENTRY INTO AND ESCAPE OPEN CIRCUIT PRESSURE DEMAND

Approval Number TC-13-F-	Approval Issued to	Model Number(s)	Service Life (min.)	Facepiece Type	Regulator Position
30	MSA	95069 96338 461696 461704 461946 461947 463814 463815 463831 463833 466209 470444 470445 470448 470449	30	FF	Bm
40	Scott	900014-00 900014-01/05/06/12/30/31/39/50/51 900214-00/01/05/06/50/51	30	FF	Bm
42	Scott	900015-00 900015-01/05/06	15	FF	Bm
45	USD	9038-20* 9038-22*/70*/72* 9838-22/70*/72* 9848-20/22 9849-20*/22* U9038-00 U9838-00/02 M9838-20*	30	FF	Bm
47	MSA	95063 460262 461697 461703	15	FF	Bm