

PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE
EQUIPMENT

SAFETY
ENGINEERING STANDARD

ISSUED JAN 1984
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REVISED DEC 1978
STANDARD
REAFFIRMED DEC 1978

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This standard includes requirements of the Occupational Safety and Health Act of 1970 (OSHA) as published in the Federal Register. OSHA information is printed in red.

1. SCOPE

This standard provides information for the selection, use, and care of respiratory protective equipment (respirators). The term "respirator" in this standard is used inclusively and applies to atmosphere-supplying and air-purifying devices that provide breathable air to the wearer within the limits of the equipment, whatever the source of air. This standard does not apply for exposure to airborne radioactive contamination for which special consideration may be necessary.

2. GENERAL

2.1 Respirators should not be used as a substitute for adequate exhaust ventilation or other engineering control methods.

2.2 Respirators shall be worn at all times where the atmosphere may be harmful to employees due to unusual conditions, and where work is necessary in contaminated or oxygen-deficient, confined areas.

2.2.1 When the air is deficient in oxygen, the symptoms range from increased volume of breathing and acceleration of pulse rate to unconsciousness and death, depending upon oxygen content and the degree of a person's activity. Unconsciousness is immediate when a man breathes pure nitrogen and death may follow in a few minutes.

2.2.2 An oxygen deficiency may indicate a hazard other than inert gas; e.g., flammability (see 4.4), skin toxicity, or absorption through the skin, particularly hydrogen cyanide. Threshold limit values (TLV's) of air contaminants are given in S2T. Portable oxygen and toxic-gas detectors are covered in S3T.

2.3 Pure oxygen shall not be used in atmosphere-supplying respirators.

3. APPROVED RESPIRATORS

3.1 Where schedules for a particular type of equipment have been established, only equipment listed and approved by the Bureau of Mines and the National Institute for Occupational Safety and Health shall be used.

3.1.1 Respirators purchased on or before September 30, 1974 and meeting the following Bureau of Mines Schedules are approved for use until the following dates:

Type of Respirator	Bureau of Mines Approval Schedule	Terminal Use Date
Self contained	13 thru 13E	March 31, 1979*
Gas masks	14F	**
Supplied air	19B	March 31, 1980
Dust, fume, mist	21B	March 31, 1976
Chemical cartridge	23B	March 31, 1976

* Certain self-contained breathing apparatus may be upgraded to meet the requirements of 30 CFR, Part 11 and related. Refer to manufacturer. Terminal use dates are being reconsidered by OSHA. Check current status with Departmental OSHA Coordinators.

** Terminal use date has been withdrawn and is indefinite.

3.1.2 Respirators purchased after September 30, 1974 shall be manufactured per quality control plan approved under Title 30, Code of Federal Regulations, Part 11 and shall meet the requirements of the Bureau of Mines Schedules shown in 3.1.1. Such equipment will bear an approval label bearing the letters "TC" instead of "BM".

3.1.2.1 Exception, approved respirators purchased after September 30, 1974 and on or before June 30, 1975 may be marked "BM" if NIOSH has approved the vendor's quality control plan under which the respirator was manufactured.

3.1.3 Respirators purchased after June 30, 1975 shall meet the requirements of Chapter 1, Title 30, Code of Federal Regulations, Part 11 - Respiratory Protective Devices; Tests for Permeability.

3.2 A list of the respirators and their manufacturers, certified by the National Institute for Occupational Safety and Health (NIOSH) per 3.1.3, may be obtained on request for HEW Publication No. (NIOSH) 75-119 plus cumulative supplements from:

NIOSH Testing and Certification Laboratory
944 Chestnut Ridge Rd
Morgantown, WV 26505

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Vendors and merchandise designations are given to describe materials and may not include all acceptable products. Substitutions by suppliers are to be made only on approval of the local authority initiating the use of this standard.



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NIOSH Office of Technical Publications
Post Office Building
Cincinnati, OH 45202

U. S. Bureau of Mines
Health and Safety Research and Testing Center
1800 Forbes Ave
Pittsburgh, PA 15213

3.3 At the present time, there are no approval schedules for aerosupplied suits.

3.4 A list of the several types of respiratory protective equipment, method of operation, use, limitations, and remarks is given in Table 1. For additional information in this regard, reference should be made to:

Practices for Respiratory Protection, ANSI Z88.2,
American National Standards Institute, Inc. 1430
Broadway, New York, NY 10018

Respiratory Protective Equipment, Data Sheet
D-441 National Safety Council, 425 North Michigan
Avenue, Chicago, IL 60611

Respiratory Protective Devices Manual published by
American Industrial Hygiene Association and
American Conference of Governmental Industrial
Hygienists (copies are available from Braun and
Bramfield Inc, Box 1203, Ann Arbor, MI 48106)

4. USES AND LIMITATIONS

4.1 Users of respiratory protective equipment shall have medical approval.

4.2 The air-purifying respirators; i.e., canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 1C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators do not supply oxygen and therefore do not protect against possible oxygen deficiencies. Other reasons for this requirement are that:

a. Gas masks are intended for use with no more than 2 percent by volume of most toxic gases.

b. Chemical cartridge respirators are intended for use in significantly lower toxic gas concentrations than canister gas masks. Limits vary from 0.05 percent maximum to 0.1 percent maximum.

4.3 The following warning signs require immediate return to fresh air:

a. 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.)

b. If nausea, dizziness or signs of distress develop.

c. If the canister has a window indicator which shows the specified color change.

d. If any leakage is detected by smell, taste, eyes, nose or throat irritation.

e. If high breathing resistance develops.

4.4 Air purifying respirators should not be used in atmospheres immediately dangerous to life and health or when the contaminant has poor warning properties, except for escape.

4.5 Users should select canisters and cartridges specifically approved for the toxic gas and concentration to be encountered. Canister masks that bear the label "All-Service," "All-Purpose," or "Universal" should not be used for a specific gas or vapor if a canister is available for that specific gas or vapor.

4.6 Although self-contained breathing apparatus or combination air-line and self-contained breathing apparatus have no concentration limit in regard to toxicity, many toxic gases and vapors are flammable and the user could be exposed to a potential fire or explosion. The 2-percent concentration limits approved for toxic gas removal with canister-type masks is within the flammable range for many gases. Work in atmospheres in or near the flammable range is prohibited. When the possibility of flammable atmospheres exists, a check should be made with an explosimeter and permissible concentrations confirmed prior to entry. Standard F6J provides information and instructions for use of portable flammable vapor and gas detectors.

4.7 Respiratory protection is required for cancer suspect agents. Refer to OSHA regulations for specific requirements, Section 1910.1000 series and to S2T.

4.8 An uncontaminated supply of air must be assured when using a hose mask with blower.

5. SELECTION

5.1 In selecting a respirator, the following factors (5.1 - 5.1.6.1) and Tables 1 and 2 should be considered. Engineering Dept Report, Accession No. 15167 "Respirator Selection," also will provide guidance.

- a. Nature of the hazard
- b. Severity of the hazard
- c. Type of contaminant

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- d. Concentration of the contaminant
- e. Period protection is required
- f. Location of the contaminated area with respect to a source of respirable air
- g. Expected activity of the wearer
- h. Operating characteristics and limitations of the available respirators
- i. Safety regulations of state or local governments

5.1.1 Self-contained breathing apparatus rated for at least 30-minute service time should be used for entry into an irrespirable atmosphere.

5.1.2 Self-contained breathing apparatus with less than a 30-minute air supply shall be used only for emergency egress and not for rescue work or reentry.

5.1.3 Operating time for self-contained apparatus is based on moderate work rates. Operating time is reduced by increased respiration required by heavy exertion.

5.1.4 Only self-contained breathing apparatus, or combination air-line respirator and self-contained breathing apparatus, shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life. The air in the self-contained unit of the combination air-line respirator and self-contained breathing apparatus shall be used only for egress in event the hose-line supply of air is interrupted. The volume of this exit supply may vary for different applications, but shall be ample to allow the worker sufficient air to escape from the contaminated area. In any case, this supply shall not be less than 3 minutes. Consideration should be given to using only positive pressure units.

5.1.5 Escape masks are used only while the wearer leaves a contaminated area. They are approved under Subpart I, 30 CFR Part 11 and have a half mask facepiece, or a mouthpiece. Where eye irritation is a consideration, a full facepiece should be used. For escape or emergency purposes from unknown concentrations of extremely hazardous atmospheres (any gas or vapor having a rated lethal concentration LC 50 of less than 10 ppm), a pressure demand self-contained breathing apparatus or combination pressure demand supplied air respirator with pressure demand self-contained breathing apparatus shall be used.

5.1.6 Entry Masks. Use self-contained breathing apparatus with at least a 30-minute air supply or a combination supplied air respirator with self-contained breathing air apparatus. Unit shall be of the pressure demand type. The entry masks should be located outside of the potentially affected area in a noncontaminated area and properly identified and protected.

5.1.7 Fire Fighting. Use self-contained breathing apparatus with at least a 30-minute air supply. Unit shall be the pressure demand type.

5.1.8 Schedule 13E of the U. S. Bureau of Mines on self-contained breathing apparatus requires a remaining service-life indicator or warning for compressed breathing air (except for self-rescue). Some equipment now on plants may not have these alarms. These can and should be obtained from equipment suppliers for apparatus not so equipped.

5.1.8.1 When the device is a combination self-contained breathing apparatus and air-line respirator (supplied-air respirator), either a manual or automatic valve(s) shall be provided to change to the self-contained air supply if the air-line supply fails, and to prevent the wearer breathing contaminated air from the outside atmosphere. If a manual valve is provided, it shall be easily operable and located in a position which is convenient to the wearer. If an automatic valve is provided, a warning also shall be provided to alert the wearer that he is breathing from the self-contained air supply, (1) when his normal air-line supply fails, or (2) when the self-contained air supply falls below 95 percent of its full container pressure. A quick disconnect and check valve shall be provided between the apparatus and the air-line supply hose to permit ready escape from the area, and to prevent loss of breathing air from the device or inhaling the surrounding atmosphere, respectively.

6. BREATHING AIR

6.1 Both purchased and manufactured breathing air shall meet or exceed the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966*. See table below for Grade D analysis summary, and G-7.1 for details including sampling and analytical procedures.

Gas	Breathing Air Analysis
O ₂	19 percent min to 23 percent max†
CO	20 ppm max
CO ₂	1,000 ppm max
Hydrocarbons (condensed)	5 mg/m ³
H ₂ O	Dew point less than the lowest probable temperature to be encountered†
N ₂	Balances
Odor	Free of pronounced odors

† See S&T for data on direct reading portable oxygen analyzers.

‡ This is necessary to prevent freeze-up and stoppage of air flow to the mask. For tables refer to "Handbook of Compressed Gases."

* Available from Compressed Gas Association Inc., 500 Fifth Ave., New York, NY 10036
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6.2 A reliable supplier should be chosen. Visit his facilities to determine his degree of control over the operation. If an air compressor is used, it should be nonlubricated. If a lubricated compressor is used, it must have a carbon monoxide or high temperature (or both) alarm. Annual contacts should be made to assure equipment and procedures have not changed.

6.3 Preferably, certified breathing air should be purchased from a reliable supplier. If a choice has to be made between certified air from a questionable supplier and uncertified air from a reliable supply, the latter would be the recommended choice.

6.4 Determine if the air is provided by compression or reconstitution (mixing nitrogen and oxygen) and analyze as follows:

Method of Preparation	Analysis Recommend
Compression - supplier does not fill cylinders with any gases other than air.	Check 10 percent of cylinders from each lot for percent CO and odor.
Compression - supplier fills cylinders with gases other than air.	Analyze all cylinders for percent O ₂ . Check 10 percent of cylinders from each lot for percent CO and odor.
Reconstitution	Analyze all cylinders for percent O ₂ . Check 10 percent of cylinders from each lot for percent CO and odor.

6.5 In addition a complete analysis should be conducted periodically to assure compliance with table in 6.1.

7. PRECAUTIONS

7.1 An extensive list of instructions in use and precautions for each type of respirator is given in ANSI Z88.2. Some precautions are given in Table 1 under headings of Limitations and Remarks.

7.2 The manufacturer's instructions or precautions of the ANSI standard should be posted with the respiratory device.

7.3 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use. Also, in execution of plant disaster plans, proper training in use of respiratory protective equipment will aid in the performance of smooth and safe rescue or repair operations.

7.4 A slight negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 1C). Care must be taken to obtain an effective seal between the facepiece and face to prevent inward contaminant leakage.

Also, demand-type air-supplied respirators and demand-type self-contained respirators operate under negative pressure when the wearer inhales. Since some inward leakage of contaminant may be possible, these types provide much less protection. When purchasing new air-supplied, self-contained or combination type, pressure-demand should be specified.

7.4.1 A pressure-demand type self-contained respirator or air-supplied combination self-contained should be used in atmospheres containing contaminants which cannot be detected by smell or where special precautions must be taken to prevent the wearer from inhaling any trace of contaminant. In this type equipment a small positive pressure is maintained inside the facepiece at all times, such that if a leak should develop, there would be no leakage of contaminant into the facepiece.

7.5 A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of full-face masks.

7.6 Contact lenses shall not be worn with full-face masks. See S4H.

7.7 All eyepieces in full-face masks approved by the Bureau of Mines will pass the ball drop test, but some plastic eyepieces may not pass the needle drop test (S4H). Current schedules of the Bureau of Mines, however, require that eyepieces shall meet the pertinent requirements for impact and penetration specified in the most recent ANSI Z87.1 Safety Code for Eye Protection.

7.7.1 Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece. Contact the manufacturers for assistance.

7.8 Major problems in the use of full-face masks at low temperatures are poor visibility and freezing of exhalation valves. Antifog compounds can be used to coat the inside and outside of the eyepiece to prevent its fogging down to about 32°F. Below 0°F, however, antifog compound will not prevent severe fogging. Antifog compounds break down and require reapplication periodically.

7.9 A half-mask facepiece should not interfere with the wearer's use of spectacles or goggles. Proper selection of equipment normally will eliminate any problem of proper fit when using a combination of half-mask facepiece and spectacles or goggles.

7.10 Persons required to wear respirators must be clean shaven in the area of the respirator seal.

7.11 Conventional respirators do not constitute an absolute barrier to transmission of speech. The respirator exhalation valve usually provides a satisfactory pathway for speech transmission over short distances in relatively

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quiet areas. Speech transmission devices are available. (Caution: check for acceptability of electrical classification for use in hazardous areas, and NIOSH approval when mounted on respirator).

7.12 Hoses for air supply should be selected to resist chemicals to which they may be exposed.

8. CARE

8.1 General. A centralized maintenance, cleaning, and storage station should be used to care for respiratory protective equipment.

8.1.1 Procedures Applicable to All Respirators

8.2.1 Inspection. All respirators shall be inspected routinely before and after each use. Those held ready for emergency use shall be inspected at least monthly and after each use.

8.2.1.1 Self-contained breathing apparatus shall be inspected monthly.

8.2.2 Maintenance. When it is necessary to replace worn or deteriorated parts, only those made specifically for the device shall be used; and the repair work shall be accomplished by trained personnel. For most plants, it is preferable that parts of this type (subassemblies) be replaced as a unit or returned to the manufacturer or factory trained personnel for repair.

8.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals, when they shall be cleaned as necessary to assure a sanitary and properly functioning mask.

8.2.4 Storage. All respiratory protective equipment shall be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature. They should be located for easy accessibility and the location adequately labeled if necessary. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or boxes.

8.3 Special Procedures for Maintaining, Cleaning, Disinfecting, and Storing Respirators

8.3.1 Self-Contained Breathing Apparatus. In demand-type (Table 1B), the cylinder pressure shall be checked monthly and recharged if below rated pressure (corrected to 70°F). Recharge after each use, following manufacturer's instructions. Follow manufacturer's instructions on tightness tests for self-contained respirators and hydrostatic testing of compressed-air cylinders. Assure that regulator and low-pressure alarms are functioning.

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8.3.2 Cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR, Part 173).

8.3.3 Hose Masks. Check the blower periodically for proper operation. Check hose for wear and tear after each use and clean when necessary. Keep hose capped when not in use to prevent entrance of dust or other contaminants.

8.3.4 Air-Line Respirators. The facepiece should be serviced after each use, as for all other respirators. The flow control valves should be inspected after each use and cleaned and repaired, if necessary. Air-line hose should be checked for wear and tear after each use and be cleaned when necessary. See SIH on air-supply system.

8.3.5 Self-Rescuers. Monthly inspection is the most important phase of the maintenance program with this type of equipment because the equipment is seldom used but must always be ready.

8.3.6 Chemical Cartridge Respirators

8.3.6.1 In plants with centralized maintenance stations, cartridges sometimes are discarded after a predetermined period of use. Masket Laboratory will establish chemical cartridge breakthrough times for specific toxic atmospheres on request to assist plants in establishing use period criteria.

8.3.6.2 Replacement should be incorporated into the maintenance and cleaning program. In most cases, the wearer should not be responsible for scheduling replacement cartridges in his respirator. However, chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant.

8.3.6.3 Where the expected contaminant has no odor or irritating effect, chemical cartridge respirators shall not be used.

8.3.6.4 Mouthpiece respirators shall not be used for routine protection, because breathing through the mouth may bypass the odor or irritation warning of an expended cartridge. These do not have NIOSH approval.

8.3.6.5 Particular care should be exercised in the storage of chemical cartridges because they deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where the workmen use them.

8.3.7 Mechanical Filter Respirators. Mechanical filters of the "throw-away" type should be discarded when the breathing resistance becomes bothersome to the wearer. Some mechanical filter respirators use recleanable filters, in which case the filters are cleaned when the respirator is being serviced.



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RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY ENGINEERING STANDARD

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This standard includes requirements of the Occupational Safety and Health Act of 1970 (OSHA) as published in the Federal Register. OSHA information is printed in red.

1. SCOPE

This standard provides information for the selection, use, and care of respiratory protective equipment (respirators). The term "respirator" in this standard is used inclusively and applies to atmosphere-supplying and air purifying devices that provide breathable air to the wearer within the limits of the equipment, whatever the source of air. This standard does not apply for exposure to airborne radioactive contamination for which special consideration may be necessary.

2. GENERAL

2.1 Respirators should not be used as a substitute for adequate exhaust ventilation or other engineering control methods.

2.2 Respirators shall be worn at all times where the atmosphere may be harmful to employees due to unusual conditions, and where work is necessary in contaminated or oxygen-deficient, confined areas.

2.2.1 When the air is deficient in oxygen, the symptoms range from increased volume of breathing and acceleration of pulse rate to unconsciousness and death, depending upon oxygen content and the degree of a person's activity. Unconsciousness is immediate when a man breathes pure nitrogen and death may follow in a few minutes.

2.2.2 An oxygen deficiency may indicate a hazard other than inert gas; e.g., flammability (see 4.6), skin toxicity, or absorption through the skin, particularly hydrogen cyanide. Threshold limit values (TLV's) of air contaminants are given in SST. Portable oxygen and toxic-gas detectors are covered in SST.

2.3 Pure oxygen shall not be used in open circuit, self-contained, atmosphere-supplying respirators, or in air-line type respirators.

2.4 A closed circuit (rebreathing) system recirculates exhaled air, makes up oxygen and removes undesirable gases such as carbon dioxide. Pure oxygen must be used with these systems. Systems approved by the National

Institute for Occupational Safety and Health (NIOSH) which utilize a high-pressure cylinder for oxygen may be used. Closed circuit oxygen generating type equipment shall not be used.

2.5 Each location shall develop written procedures covering the selection, use, and maintenance of respirators.

3. APPROVED RESPIRATORS

3.1 Only equipment approved by the National Institute for Occupational Safety and Health/Mine Safety Health Administration (NIOSH/MSHA) shall be used.

3.1.1 Respirators purchased after September 30, 1974 shall be manufactured per quality control plan approved under Title 30, Code of Federal Regulations, Part 11. Such equipment will bear an approval label bearing the letters "TC" instead of "BM."

3.1.1.1 Exceptions. Self-contained breathing apparatus approved by Bureau of Mines under Schedule 13 through 13-E equipped with an audible end-of-service life indicator and gas masks approved by Bureau of Mines under Schedule 14F are approved for use until further notice provided they (1) were fabricated, assembled, or built under an approval or any modification thereof issued by the U. S. Bureau of Mines, Department of the Interior, (2) were purchased on or before June 30, 1975, and (3) are maintained in an approved condition.

3.2 A list of the respirators and their manufacturers, certified by NIOSH may be obtained by requesting HEW Publication No. NIOSH 75-119 plus cumulative supplements from:

NIOSH Testing and Certification Laboratory
944 Chestnut Ridge Road
Morgantown, WV 26505

Division of Technical Services
NIOSH
Robert A. Taft Laboratories
4616 Columbia Parkway
Cincinnati, OH 45226

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Vendors and merchandise designations are given to describe materials and may not include all acceptable products. Substitutions by suppliers are to be made only on approval of the local authority initiating the use of this standard.

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3.3 At the present time, there are no approval schedules for air-supplied suits.

3.4 A list of the several types of respiratory protective equipment, method of operation, use, limitations, and remarks is given in Table 1. For additional information in this regard, reference should be made to:

"Practices for Respiratory Protection," ANSI Z88.2, American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018

Respiratory Protective Equipment, Data Sheet D-444, National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611

"Respiratory Protection Program, A Manual and Guideline," American Industrial Hygiene Association, 475 Wolf Ledges Parkway, Akron, OH 44311

4. USES AND LIMITATIONS

4.1 Users of respiratory protective equipment shall have medical approval.

4.2 The air-purifying respirators; i.e., canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 1C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators do not supply oxygen and therefore do not protect against possible oxygen deficiencies. Other reasons for this requirement are that:

a. Gas masks are intended for use with no more than 2 percent by volume of most toxic gases.

b. Chemical cartridge respirators are intended for use in significantly lower toxic gas concentrations than canister gas masks. Limits vary from 0.05 percent maximum to 0.1 percent maximum.

4.3 The following warning signs require immediate return to fresh air:

a. 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.)

b. If nausea, dizziness or signs of distress develop.

c. If the canister has a window indicator which shows the specified color change.

d. If any leakage is detected by smell, taste, eyes, nose or throat irritation.

e. If high breathing resistance develops.

4.4 Air purifying respirators should not be used in atmospheres immediately dangerous to life and health or when the contaminant has poor warning properties, except for escape.

4.5 Users should select canisters and cartridges specifically approved for the toxic gas and concentration to be encountered. Canister masks that bear the label "All-Service," "All-Purpose," or "Universal" should not be used for a specific gas or vapor if a canister is available for that specific gas or vapor.

4.6 Although self-contained breathing apparatus or combination air-line and self-contained breathing apparatus have no concentration limit in regard to toxicity, many toxic gases and vapors are flammable and the user could be exposed to a potential fire or explosion. The 2-percent concentration limits approved for toxic gas removal with canister-type masks is within the flammable range for some gases. Work in atmospheres in or near the flammable range is prohibited. When the possibility of flammable atmospheres exists, a check should be made with an explosimeter and permissible concentrations confirmed prior to entry. Standard F6J provides information and instructions for use of portable flammable vapor and gas detectors.

4.7 Respiratory protection is required for cancer suspect agents. Refer to OSHA regulations for specific requirements, Section 1910.1000 series, and to 52T.

4.8 An uncontaminated supply of air must be assured when using a hose mask with blower.

5. SELECTION

5.1 In selecting a respirator, the following factors (5.1 - 5.1.8.1) and Tables 1 and 2 should be considered. Engineering Dept Report, Accession No. 15167 "Respirator Selection," also will provide guidance.

- a. Nature of the hazard
- b. Severity of the hazard
- c. Type of contaminant
- d. Concentration of the contaminant
- e. Period protection is required
- f. Location of the contaminated area with respect to a source of respirable air

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g. Expected activity of the wearer

h. Operating characteristics and limitations of the available respirators

i. Safety regulations of state or local governments

5.1.1 Self-contained breathing apparatus rated for at least 30-minute service time should be used for entry into an irreparable atmosphere.

5.1.2 Self-contained breathing apparatus with less than a 30-minute air supply shall be used only for emergency egress and not for rescue work or reentry.

5.1.3 Operating time for self-contained apparatus is based on moderate work rates. Operating time is reduced by increased respiration required by heavy exertion.

5.1.4 Only self-contained breathing apparatus, or combination air-line respirator and self-contained breathing apparatus, shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life. The air in the self-contained unit of the combination air-line respirator and self-contained breathing apparatus shall be used only for egress in event the hose-line supply of air is interrupted. The volume of this exit supply may vary for different applications, but shall be ample to allow the worker sufficient air to escape from the contaminated area. In any case, this supply shall not be less than 3 minutes. Consideration should be given to using only positive pressure units.

5.1.5 Escape masks are used only while the wearer leaves a contaminated area. They are approved under Subpart I, 30 CFR Part 11 and have a half mask facepiece, or a mouthpiece. Where eye irritation is a consideration, a full facepiece should be used. For escape or emergency purposes from unknown concentrations of extremely hazardous atmospheres (any gas or vapor having a rated lethal concentration LC 50 of less than 10 ppm), a pressure demand self-contained breathing apparatus or combination pressure demand supplied air respirator with pressure demand self-contained breathing apparatus shall be used.

5.1.6 Entry Masks. Use self-contained breathing apparatus with at least a 30-minute air supply or a combination supplied air respirator with self-contained breathing air apparatus. Unit shall be of the pressure demand type. The entry masks should be located outside of the potentially affected area in a noncontaminated area and properly identified and protected.

5.1.7 Fire Fighting. Use self-contained breathing apparatus with at least a 30-minute air supply. Unit shall be the pressure demand type.

5.1.8 Schedule 13E of the U. S. Bureau of Mines on self-contained breathing apparatus requires a remaining service-life indicator or warning for compressed breathing air (except for self-rescue). Some equipment now on plants may not have these alarms. These can and should be obtained from equipment suppliers for apparatus not so equipped.

5.1.8.1 When the device is a combination self-contained breathing apparatus and air-line respirator (supplied-air respirator), either a manual or automatic valve(s) shall be provided to change to the self-contained air supply if the air-line supply fails, and to prevent the wearer breathing contaminated air from the outside atmosphere. If a manual valve is provided, it shall be easily operable and located in a position which is convenient to the wearer. If an automatic valve is provided, a warning also shall be provided to alert the wearer that he is breathing from the self-contained air supply. (1) when his normal air-line supply fails, or (2) when the self-contained air supply falls below 95 percent of its full container pressure. A quick disconnect and check valve shall be provided between the apparatus and the air-line supply hose to permit ready escape from the area, and to prevent loss of breathing air from the device or inhaling the surrounding atmosphere, respectively.

6. BREATHING AIR

6.1 Both purchased and manufactured breathing air shall meet or exceed the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1. See table below for Grade D analysis summary, and G-7.1 for details including sampling and analytical procedures.

Gas	Breathing Air Analysis
O ₂	19.5 percent min to 23.5 percent max†
CO	20 ppm max
CO ₂	1,000 ppm max
Hydrocarbons (condensed)	5 mg/m ³
H ₂ O	Dew point less than the lowest probable temperature to be encountered
N ₂	Balance
Odor	Free of pronounced odors

† See S&T for data on direct reading portable oxygen analyzers. This is necessary to prevent freeze-up and stoppage of air flow to the mask. For tables refer to "Handbook of Compressed Gases."

Available from Compressed Gas Association Inc., 300 Fifth Ave., New York, NY 10036
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6.2 A reliable supplier should be chosen. Visit his facilities to determine his degree of control over the operation. If an air compressor is used, it should be nonlubricated. If a lubricated compressor is used, it must have a carbon monoxide or high temperature (or both) alarm. Annual contacts should be made to assure equipment and procedures have not changed.

6.3 Preferably, certified breathing air should be purchased from a reliable supplier. If a choice has to be made between certified air from a questionable supplier and uncertified air from a reliable supply, the latter would be the recommended choice.

6.4 Determine if the air is provided by compression or reconstitution (mixing nitrogen and oxygen) and analyze as follows:

Method of Preparation	Analysis Recommendation
Compression - supplier does not fill cylinders with any gases other than air.	Check 10 percent of cylinders from each lot for ppm CO and odor.
Compression - supplier fills cylinders with gases other than air	Analyze all cylinders for percent O ₂ . Check 10 percent of cylinders from each lot for ppm CO and odor.
Reconstitution	Analyze all cylinders for percent O ₂ . Check 10 percent of cylinders from each lot for ppm CO and odor.

6.5 In addition a complete analysis should be conducted periodically to assure compliance with table in 6.1.

7. PRECAUTIONS

7.1 An extensive list of instructions in use and precautions for each type of respirator is given in ANSI Z88.2. Some precautions are given in Table 1 under headings of Limitations and Remarks.

7.2 The manufacturer's instructions or precautions of the ANSI standard should be posted with the respiratory device.

7.3 All persons who may have occasion to use respiratory devices, or cause them to be used, shall be properly trained in their use. Also, in execution of plant disaster plans, proper training in use of respiratory protective equipment will aid in the performance of smooth and safe rescue or repair operations.

7.4 A slight negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 1C). Care must be taken to obtain an effective seal between the facepiece and face to prevent inward contaminant leakage.

Also, demand-type air-supplied respirators and demand-type self-contained respirators operate under negative pressure when the wearer inhales. Since some inward leakage of contaminant may be possible, these types provide much less protection. When purchasing new air-supplied, self-contained or combination type, pressure-demand should be specified.

7.4.1 A pressure-demand type self-contained respirator or air-supplied combination self-contained should be used in atmospheres containing contaminants which cannot be detected by smell or where special precautions must be taken to prevent the wearer from inhaling any trace of contaminant. In this type equipment, a small positive pressure is maintained inside the facepiece at all times, such that if a leak should develop, there would be no leakage of contaminant into the facepiece.

7.5 A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of full-face masks.

7.6 Contact lenses shall not be worn with full-face masks. See S4H.

7.7 All eyepieces in full-face masks approved by the Bureau of Mines will pass the ball drop test, but some plastic eyepieces may not pass the needle drop test (S4H). Current schedules of the Bureau of Mines, however, require that eyepieces shall meet the pertinent requirements for impact and penetration specified in the most recent ANSI Z87.1, "Safety Code for Eye Protection."

7.7.1 Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece. Contact the manufacturers for assistance.

7.8 Problems in the use of self-contained breathing apparatus (SCBA) at low temperatures include failure of exhalation valves due to frozen exhaled moisture and failure of the regulator or low air pressure alarm. These problems can be minimized by:

- Using only air with low moisture content
- Installing a nosecup in the mask
- Thoroughly drying masks after cleaning
- Keeping SCBA's in a warm location between uses (if practical)
- Visually checking pressure gages for low air supply
- Following manufacturer's instructions for use in subfreezing environments

Antifog compounds can be used to coat the inside and outside of the facepiece to prevent its fogging, down to about 32°F (0°C). Below 0°F (-1°C), however, antifog

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contaminants will not prevent severe fogging. Antifog compounds break down and require reapplication periodically.

2.9 A half-mask facepiece should not interfere with the wearer's use of spectacles or goggles. Proper selection of equipment normally will eliminate any problem of proper fit when using a combination of half-mask facepiece and spectacles or goggles.

2.10 Persons required to wear respirators must be clean shaven in the area of the respirator seal.

2.11 Conventional respirators do not constitute an absolute barrier to transmission of speech. The respirator exhalation valve usually provides a satisfactory pathway for speech transmission over short distances in relatively quiet areas. Speech transmission devices are available.

Caution: check for acceptability of electrical classification for use in hazardous areas, and NIOSH approval when mounted on respirator).

2.12 Hoses for air supply should be selected to resist materials to which they may be exposed.

3. CARE

3.1 General. A centralized maintenance, cleaning, and storage station should be used to care for respiratory protective equipment.

3.2 Procedures Applicable to All Respirators

3.2.1 Inspection. All respirators shall be inspected carefully before and after each use. Those held ready for emergency use shall be inspected at least monthly and after each use.

3.2.1.1 Self-contained breathing apparatus shall be inspected monthly.

3.2.2 Maintenance. When it is necessary to replace worn or deteriorated parts, only those made specifically for the device shall be used; and the repair work shall be accomplished by trained personnel. For most plants, it is preferable that parts of this type (subassemblies) be replaced as a unit or returned to the manufacturer or factory-trained personnel for repair.

3.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals, when they shall be cleaned as necessary to assure a sanitary and properly functioning mask.

3.2.4 Storage. All respiratory protective equipment shall be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature. They should be located for easy accessibility and the location adequately labeled if necessary. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or boxes.

3.3 Special Procedures for Maintaining, Cleaning, Disinfecting, and Storing Respirators

3.3.1 Self-Contained Breathing Apparatus. In demand-type (Table 1B), the cylinder pressure shall be checked monthly and recharged if below rated pressure.

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(corrected to 70°F (21°C)). Recharge after each use, following manufacturer's instructions. Follow manufacturer's instructions on tightness tests for self-contained respirators and hydrostatic testing of compressed-air cylinders. Assure that regulator and low-pressure alarms are functioning.

3.3.2 Cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR, Part 173).

3.3.3 Hose Masks. Check the blower periodically for proper operation. Check hose for wear and tear after each use and clean when necessary. Keep hose capped when not in use to prevent entrance of dust or other contaminants.

3.3.4 Air-Line Respirators. The facepiece should be serviced after each use, as for all other respirators. The flow control valves should be inspected after each use and cleaned and repaired, if necessary. Air-line hose should be checked for wear and tear after each use and be cleaned when necessary. See 5111 on air-supply system.

3.3.5 Self-Rescuers. Monthly inspection is the most important phase of the maintenance program with this type of equipment because the equipment is seldom used but must always be ready.

3.3.6 Chemical Cartridge Respirators

3.3.6.1 In plants with centralized maintenance stations, cartridges sometimes are discarded after a predetermined period of use. Maskell Laboratory will establish chemical cartridge breakthrough times for specific toxic atmospheres on request to assist plants in establishing use period criteria.

3.3.6.2 Replacement should be incorporated in the maintenance and cleaning program. In most cases, the wearer should not be responsible for scheduling replacement cartridges in his respirator. However, chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant.

3.3.6.3 Where the expected contaminant has no odor or irritating effect, chemical cartridge respirators shall not be used.

3.3.6.4 Mouthpiece respirators shall not be used for routine protection, because breathing through the mouth may bypass the odor or irritation warning of an expended cartridge. These do not have NIOSH approval.

3.3.6.5 Particular care should be exercised in the storage of chemical cartridges because they deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where the workmen use them.

3.3.7 Mechanical Filter Respirators. Mechanical filters of the "throw-away" type should be discarded when the breathing resistance becomes burdensome to the wearer. Some mechanical filter respirators use reusable filters, in which case the filters are cleaned when the respirator is being serviced.



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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONT'D ON PAGE 7)

Table 1A - Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See S1H on air-distribution system.
Use	Operating or repair work where there is exposure to substances that are irritating or corrosive to the skin and mucous membranes, but where the atmosphere is not immediately dangerous to life. If immediately dangerous to life, the respiratory equipment should be provided as in S14 and the air-supplied suit should be kept with a slight positive pressure. In any case the air supply should not be less than 18 minutes to allow the worker sufficient air to escape from the contaminated area. A body harness is required to handle the hose line and the life line, which always should be worn as a rescue device. Helper (wearing similar air-supplied suit, body harness, and life line) should be assigned with no other duties than to observe the man in the hazardous area, attend the life line and in emergency, ask for help and be ready to rescue the worker. (See S16G)
Limitations	The wearing of an impervious suit for any extended period is extremely fatiguing and dangerous unless it is well ventilated. The suit must be impervious to the substance encountered. With the longest hose length for which use is intended assembled to the respirator, and the lowest inlet pressure intended for operation introduced to the air-supply hose, constant flow units must deliver at least 4 cfm measured at the facepiece. The exhalation resistance at 85 liters per minute shall not exceed 1 inch of water. When helmets or hoods are used, the same requirements must be met except that the flow rate must be at least 6 cfm. For both types of assemblies with the highest inlet pressure and shortest hose length, the maximum flow shall not exceed 15 cfm.
Remarks	No NIOSH* approval. For additional information, see Fleming, A. J., D'Alonzo, C. A., and Zepp, J. A., "Modern Occupational Medicine," Chapter 7, "Protective Clothing for the Chemical Industry," Lea and Febiger, Philadelphia (1960). A Ranque-Hilsch vortex tube** worn as a portable refrigerator can satisfactorily cool compressed air for personnel wearing industrial protective clothing. The vortex tube is light and small, and can be strapped to the belt where it does not interfere with physical movement. The tube operates on 20 to 25 cfm of compressed air at 80 to 100 psi and delivers 15 to 18 cfm of air cooled 50 to 60°F below the inlet air temperature. The tube can be reversed and used as a heater.

* National Institute for Occupational Safety and Health, U. S. Dept. of Health, Education and Welfare

** Available from:

Encon Manufacturing Company
P. O. Box 9825-TR
Houston, TX 77001

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTO ON PAGE 2)

	Self-Contained Type		With Blower (Type A Supplied-Air Respirator)	Supplied-Air Respirator		
	Recirculating	Demand Type		Without Blower (Type B Supplied-Air Respirator)	Air-Line Respirator (Type C Supplied-Air Respirator)	
Method of operation	Pure oxygen from high pressure cylinders is added to a closure circuit system which continuously exhausts air. CO ₂ is absorbed.	Air from high pressure cylinders (usually 2000 to 2200 psi) supplied to leopaceas. Breath exhaled to atmosphere. Available to both demand and pressure demand models.	Respirable air is forced through a large-diameter Respiro hose by a hand blower to a full leopaceas (M. S. Bureau of Mines has calculated with electric motor as blower.)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.	Pressurized air supplied through a small-diameter hose to full-mask leopaceas, full leopaceas, or a loose fitting helmet or hood.	Source of air attached by seal hose to demand valve actuated by slight negative pressure when wearer inhales.
Use	Required under conditions immediately dangerous to life and at distances over 200 ft from a source of respirable air-protection for limited periods.		Up to 300 ft of hose from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of hose from source of respirable air. Protection provided for an unlimited period.	Usable by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.	Usable to protect head and face from flying particles (abrasive blasting, spraying of materials or paint).
Limitations	No environmental limitation in regard to toxicity or on O ₂ content. Absorption through the skin or skin irritations are possible limitations. Extensive training in use and care is required. Fatiguing due to weight.		Limitation in regard to toxicity or on oxygen content. Absorption through the skin or skin irritations are possible limitations. Worker must return to fresh air by utilizing entry routes. An uncontaminated supply of fresh air must be ensured.	See limitations for Type A at left. Not for emergency situation where inhalation resistance exceeds 2.5 in H ₂ O or where substitution resistance exceeds 1 in H ₂ O. Hose must be fitted with a flow (200) each SST screen, and shall be featured in a zone of clean air.	When used alone, this device is limited to concentrations of gases or vapors that are not immediately dangerous to life, or from which the wearer can escape unharmed without the aid of the respirator. Not to be worn in oxygen deficient atmosphere. Travel is limited by the length of the air-supply hose. Reseals must be replaced. Absorption through the skin or skin irritation are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an inspirable atmosphere. (See 5.1.1).	
Remarks	Approved for 30 min only. Scott Air Pak is an example.	* Pressure demand models maintain the leopaceas under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmospheres.	Wearer must permit free entrance of air when it is not required. Helper should be assigned with no other duties than to observe the wearer in the hazardous atmosphere, stand by the life line and, in emergency, operate the blower. A power operator also should be provided. A body harness is required to handle the hose line and the life line, which always should be worn as a rescue device.	See remarks for Type A at left regarding helper and harness.	Nonleakable hose should be used if operating pressure is greater than 5 psi (see 5.2.1).	Helmet or hood are not used with this respirator. See SH on air-distribution system.

Closed circuit oxygen generating type equipment is not approved for use.

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD FROM PAGE 1)

Table 1C - Air Purifying Respirators

(Not for use in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life)

Method of operation	Chemical Filter Type				Mechanical Filter Type Respirators	Combination Chemical and Mechanical Filter Respirators
	Canister Gas Mask (Full Facepiece Respirator)	Chemical Cartridge Respirator (Full Mask Respirator)	Self Rescuer Mouthpiece Respirator			
	Toxic gases or vapors removed from inspired air by absorption, adsorption, chemical reaction, or catalysis, or a combination of these in a packed sorbent bed of the canister or cartridge. Excluded breath gases to atmosphere.				Respirators remove particulate matter such as dust, fumes, or mists, from inspired air by capture on the filter, which is usually a fibrous pad.	Some gas mask canisters contain special filters which provide respiratory protection against particulate matter, as well as against gases and vapors. Some chemical cartridge respirators contain filters for the same purpose.
Use	Provides respiratory protection against single or combination of 2 or more gases and vapors.			For escape only. Provides limited protection consistent with size of device.	Designed to provide respiratory protection against a single specific dust, fume, or mist, a single class such as toxic dusts or a combination of several classes of particulate matter such as dusts, fumes, and mists. It offers no protection against gases or vapors.	For particulate matter, gases and vapors in concentration within capacity of the device.
Limitations	See Section 4. Cannot be used in atmospheres irritating to the skin. Limited to use in atmospheres containing at least 19.5% oxygen and to the minimum gas concentration for which the specific canister is recommended (generally 5% minimum or less). Cannot be used in atmospheres irritating to the skin or eyes.	See Section 4. Cannot be used in atmospheres irritating to the skin. Limited to use in atmospheres containing at least 19.5% oxygen and to the minimum gas concentration for which the specific canister is recommended (generally 5% minimum or less). Cannot be used in atmospheres irritating to the skin or eyes.			Practical limit of concentration is determined by time required to plug filter, but these respirators should not be used in high concentrations of particulate matter. Not to be used when flying particles may cause injury, for which condition the alternative blating respirator should be used, see Table 1B. Does not protect against oxygen deficiency and toxic vapors or gases.	The limitations of the combination are generally the same as for each type of respirator given on the left. The limitation of dust filters in regard to protection against gases and vapors in mechanical filter type is modified by the protection afforded by the chemical filter respirator against gases and vapors. See Section 4.
Remarks	Canisters are color coded for identification, per ANSI K13.1.	See 8.3.6.			See 8.3.7. Flammability of the particles to be filtered out of the air controls the flammability of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * NIOSH approves mechanical filter respirators according to the following classification: (1) "Protective - Protecting and Nuisance - Dust Respirators (2) "Toxic - Dual Respirators (not significantly more toxic than lead) (3) "Dual Respirators (not significantly more toxic than lead) (4) "Toxic Respirators (not significantly more toxic than lead)	See 8.3.7. Flammability of the particles to be filtered out of the air controls the flammability of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * NIOSH approves mechanical filter respirators according to the following classification: (1) "Protective - Protecting and Nuisance - Dust Respirators (2) "Toxic - Dual Respirators (not significantly more toxic than lead) (3) "Dual Respirators (not significantly more toxic than lead) (4) "Toxic Respirators (not significantly more toxic than lead)

* Dual - Dispersible or particulate matter, smaller than 100 microns, formed when solid materials are disintegrated by such processes as crushing, grinding, and abrading.

Fume - Solid dispersible formed when vapors are condensed from heated metals and other substances.

Mist - Liquid dispersible formed when liquid is disintegrated as in spraying, coating, and atomizing.

** All approved under (1) and (2) are approved for protection of dusts that are not significantly more toxic than lead.

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TABLE 2 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

Hazard	Respirator
Oxygen deficiency	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 3.1.4)	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Air-line respirator Hose mask without blower Chemical-cartridge respirator
Particulate contaminant Immediately dangerous to life (see 3.1.4)	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Ablative-blistering respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 3.1.4)	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Air-line respirator Hose mask without blower Combination chemical and mechanical filter respirators

Note: The self-contained breathing apparatus, combination air-line respirator and self-contained breathing apparatus, would give respiratory protection against any of the hazards listed, but these devices are not included in the list of respirators that could be used in the less hazardous situations.

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