

PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE
EQUIPMENTSAFETY
ENGINEERING STANDARD

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STANDARD REAFFIRMED	SEPT 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 CFM, Part 11 and relabeled. Refer to manufacturers.

** 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 instituting the use of this standard.

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NOTE

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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
3800 Forbes Ave
Pittsburgh, PA 15213

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 Protective Devices Manual published by American Industrial Hygiene Association and American Conference of Governmental Industrial Hygienists (copies are available from Braun and Brumfield 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 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 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.

- Nature of the hazard
- Severity of the hazard
- 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 entry.

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 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 (cuppiece, 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. There 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 gas analysis summary:

Gas	Content Analysis†
O ₂	19 percent min to 23 percent max
CO	20 ppm max
CO ₂	1,000 ppm max
Hydrocarbons	0.020 mg/liter max (as condensables)
H ₂ O	Dew point less than the lowest probable temperature to be encountered‡
N ₂	Balance
Odor	Free of all objectionable odors

† See S&T for data on direct reading portable detectors for oxygen and other gases and vapors.

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

6.2 A reliable supplier should be chosen. Visit his facilities to determine his degree of control over the

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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 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 3 specifications.

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.

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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.

8.2 Procedures Applicable to All Respirators

8.2.1 **Inspection.** All respirators shall be inspected thoroughly 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 should be checked periodically 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. Assume 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. Haskell 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 burdensome 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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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD ON PAGE 7)
Table 1A - Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See 31H 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 5.1.4 and the air-supplied suit should be kept with a slight positive pressure. In any case the air supply should not be less than 1 ¹ / ₂ 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 315G).
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 Zapp, 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 60 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 (CONTD ON PAGE 6)

Table 1B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		Supplied-Air Respirator				
	Not Recommended	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	Continuous Flow Air-Line Resp	Altrative Breathing Resp	Demand Clean Air-Line Resp
In Chemical related vapor reacts with a granular absorbent to remove O ₂ in a canister. CO ₂ also is removed. Purified breath is inhaled through a low lag bag		Air from high pressure cylinders (normally 2000 to 2200 psi) supplied to facepiece. Breath exhaled to atmosphere. Available in both normal and pressure demand modes.*	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facepiece. (U.S. Bureau of Mines has schedule with electric motor on 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-face facepiece, full facepiece, or a loose fitting hood or head.	Source of air at least 10 ft from source of hazard. To demand valve located by slight negative pressure when wearer inhales.	
Not approved	Required under conditions immediately dangerous to life and limb (IDLH) and at distances over 300 ft from a source of respirable air concentration for limited periods	Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Non-emergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Limits set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.	Debatable to protect head and face from flying particles (abrasive blasting, spraying at wet, dry or paint).		
	No environmental limitation in regard to toxicity or an oxygen content. Absorption through the skin or skin irritations are possible limitations. Worker must return to fresh air by retracting entry to fresh air. An unaccompanied supply of fresh air must be assured.	Limitation in regard to toxicity or an oxygen content. Absorption through the skin or skin irritations are possible limitations. Worker must return to fresh air by retracting entry to fresh air. An unaccompanied supply of fresh air must be assured.	See limitations for Type A at left. Not for emergency use. Not approved in any situation where initiation or where initiation resistance exceeds 2.5 in. H ₂ O or where initiation resistance exceeds 1 in. H ₂ O. These limits shall be tested with a line (200) mesh SST screen, and shall be fastened in a time 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 uninjured without the aid of the respirator. Not to be worn in oxygen deficient atmosphere. Tended to be limited by the length of the air-supply hose. There must be reliable Absorption through the skin or skin irritations are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an inoperable atmosphere. (See 3.1.1)	Bulky to wear.		
Not approved	Approved for 30 min only. Scott Air Pak is an example. * Pressure demand masks override the facepiece under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmosphere.	Shower must permit free entrance of air when it is not operating. Worker should be designed with no other duties than to observe the man in the hazardous atmosphere, stand by the line and, in case of emergency, operate the blower. A blower operator also should be provided. A body harness is required to handle the hose line and the life line, which should be worn in a rescue device (see 7.3.2).	See remarks for Type A at left regarding helper and harness.	Non-inhalable hose should be used if operating pressure is greater than 5 psi (see 3.1.4).	Helmets or hoods are not used with this respirator. See SH on air distribution system.		

† Not approved for use at Company sites

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD FROM PAGE 7)
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 operation	Chemical-Filtr Type			Mechanical-Filtr Type Respirators	Combination Chemical and Mechanical Filter Respirators
	Canister Gas Mask (Full Facepiece Respirator)	Chemical Cartridge Respirator (Small Mask Respirator)	Solid Aerosol 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 exhaust bed of the canister or cartridge. Exhausted breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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 greatest protection consistent with use 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 maximum gas concentration for which the specific canister is recommended (generally 2% maximum or less). Cannot be used in atmospheres irritating to the skin or eyes.			Practical limit of concentration is determined by filter 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. In which conditions the abrasive blasting 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 list. The limitation of dust filters in regard to protection against gases and vapors in mechanical filter type is restricted 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 8.3.3.		See 8.3.7. Presence of the particles to be filtered out of the air controls the thickness of the filtering element, and nature of the facility faced is a governing factor in selection of equipment. * NIOSH approves mechanical filter respirators according to the following specifications: (1) *Pneumocanisters - Producing and blocking - Dual Respirators (2) *Fuels - Dual Respirators (not significantly more toxic than lead) (3) *Dual Respirators (not significantly more toxic than lead) (4) *Fume Respirators (not significantly more toxic than lead)	See 8.3.7. Presence of the particles to be filtered out of the air controls the thickness of the filtering element, and nature of the facility faced is a governing factor in selection of equipment. * NIOSH approves mechanical filter respirators according to the following specifications: (1) *Pneumocanisters - Producing and blocking - Dual Respirators (2) *Fuels - Dual Respirators (not significantly more toxic than lead) (3) *Dual Respirators (not significantly more toxic than lead) (4) *Fume Respirators (not significantly more toxic than lead)

* Dual - Dispersoids or particulate matter, smaller than 100 microns, formed when solid materials are disintegrated by such processes as crushing, grinding, and shredding.
Fume - Solid dispersoids formed when vapors are condensed from heated metals and other substances.
Mists - Liquid dispersoids formed when liquid is disintegrated as in spraying, emulsifying, and dissolving.
- All approved under (2) and some under (4) are approved for protection of dusts that are not significantly more toxic than lead.

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONT'D ON PAGE 8)
Table 1B - Atmosphere Supplying Respirators

	Self-Contained Type		Supplied-Air Respirator			
	Restricting†	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	Air-Line Respirator (Type C Supplied-Air Respirator)	
Method of operation	In Chemical exhaust water vapor reacts with a granular chemical to liberate O ₂ in a container. CO ₂ also is removed. Purified breath is inhaled through breathing bag.	Air from high pressure cylinders normally 2000 psi (2200 psi) supplied to the facemask. Breath exhaled to atmosphere. Available in both normal and pressure demand modes.	Respirable air is forced through a large-diameter seal between a head blower to a full facemask. (U.S. Bureau of Mines has schedule with electric motor on blower.)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.	Continuous Flow Air-Line Respirator	Demand Class Air-Line Respirator
Use	Not approved†	Required under conditions immediately dangerous to life and limb at distances over 300 ft from a source of respirable air-protection for limited periods.	Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Protects air supplied through a small-diameter hose to full-face mask, full facemask, or a loose fitting hood or hood.	Source of air is located by small hose to demand valve actuated by slight negative pressure when wearer inhales.
Limitations		No environmental limitation in regard to toxicity or an 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 an oxygen content. Absorption through the skin or skin irritations are possible limitations. Wearer must return to fresh air by releasing entry route. An uncontaminated supply of fresh air must be secured.	See limitations for Type A and B.	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 atmospheres. Travel is limited by the length of the air-supply hose. Resists must be secured. Absorption through the skin or skin irritations are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an breathable atmosphere. (See 5.1.4)	Desirable to protect head and face from flying particles (dust, dirt, etc.) spraying of mist (dust or rain).
Remarks	Not approved†	Approved for 30 min only. Scott Air Pak is an example.	Blower must permit free entrance of air when it is not operating. Helper should be equipped with no other duties than to observe the man in the hazardous atmosphere, stand by the life line and in emergency, operate the blower. A blower operator also should be provided. A body harness is required to hold the life line and the life line, which always should be worn as a rescue device (see 7.3.3).	See remarks for Type A and B.	Noninhalable hose should be used if operating pressure is greater than 5 psi (see 5.3.4).	Blower in wear.
		* Pressure demand masks maintain the facemask under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmosphere.			Air-supply hose can be attached to the water and detached rapidly in an emergency. See 5.1.4 on air distribution system.	Helmets or hoods are not used with this respirator. See 5.1.4 on air distribution system.

† Not approved for use at Company sites

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

Table 1C - Air Purifying Respirators

(This table is in oxygen-deficient atmosphere or where the concentration of oxygen is less than 19.5% by volume.)

Method of operation	Chemical Filter Type			Mechanical Filter Type Respirators	Combination Chemical and Mechanical Filter Respirators
	Cylinder Gas Mask (Full Facepiece Respirator)	Chemical Cartridge Respirator (Full Mask Respirator)	Self-Contained Breathing Apparatus		
Use	For gases or vapors removed from inspired air by absorption, adsorption, chemical reaction, or catalytic, or a combination of these in a packed or solid bed of the canister or cartridge. Excludes breath gases to atmosphere.	For escape only. Provides greatest protection available with size of device.	For escape only. Provides greatest protection available with size of device.	Respirators remove particulate matter such as dust, fumes, or mist, 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 greatest protection available with size of device.	For escape only. Provides greatest protection available 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 one or more 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 maximum gas concentration for which the specific cartridge is recommended (generally 2% maximum 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 maximum gas concentration for which the specific cartridge is recommended (generally 2% maximum 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 maximum gas concentration for which the specific cartridge is recommended (generally 2% maximum or less). Cannot be used in atmospheres irritating to the skin or eyes.	Practical limit of concentration is determined by filter 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 protective blinding respirator should be used, see Table 1B. Does not protect against cryogenic and toxic vapors or gases.	The limitations of the combination are generally the same as for each type of respirator given on the list. 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 Z89.1.	See 6.3.2.	See 6.3.2.	See 6.3.7. Removal of the particles to be filtered out of the air controls the success 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 Isolating - Dust Respirators (2) "Toxic" - Dust Respirators that significantly more toxic than toxic (3) "Dual Respirators" (not significantly more toxic than toxic) (4) "Toxic Respirators" (not significantly more toxic than toxic)	See 6.3.7. Removal of the particles to be filtered out of the air controls the success 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 Isolating - Dust Respirators (2) "Toxic" - Dust Respirators that significantly more toxic than toxic (3) "Dual Respirators" (not significantly more toxic than toxic) (4) "Toxic Respirators" (not significantly more toxic than toxic)

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

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

Mist - Liquid dispersoids formed when liquid is disintegrated as in spraying, cutting, and abetting.

** All approved under (1) and (2) Some approved under (4) are approved for protection of dusts that are not significantly more toxic than toxic.

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RESPIRATORY PROTECTIVE EQUIPMENT

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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 5.1.4)	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 5.1.4)	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 5.1.4)	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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RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY ENGINEERING STANDARD

ISSUED	JAN 1984
THIS PAGE REVISED	OCT 1980
STANDARD REAPPROVED	DEC 1978

S 2 H

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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 52T. Portable oxygen and toxic-gas detectors are covered in 53T.

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

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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 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 - 5.1.8.1) 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

5.1. 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 LC₅₀ 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	Balance
Odor	Free of pronounced odors

† See 56T 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 maintained. 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 The easily 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
Compressor - supplier, gas in cylinders with any other than air	Check 10 percent of cylinders from each lot for ppm CO and odor.
Compressor - supplier, gas removed with gas meter 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 heading 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 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.

8.2. 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. Maskoff 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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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD 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 S1.4 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 8 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'Aonzo, C. A., and Zapp, 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 9626-TR
Houston, TX 77001

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DUPLICATE

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD ON PAGE 8)
Table 1B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	Supplied-Air Respirator		
	Rebreathing	Demand Type			Continuous Flow Air-Line Resp	Altabine Breathing Resp	Demand Close Air-Line Resp
	Pure oxygen from high pressure cylinder is added in a closed circuit system which recirculates exhaled air. CO ₂ is absorbed.	Air from high pressure cylinder is added to 2200 psi supplied in a closed circuit system which recirculates exhaled air. CO ₂ is absorbed.	Respirable air is forced through a large diameter hose by a hand blower or a bellows (U. S. Bureau of Mines has schedule with electric motor on blower)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.	Pressurized air supplied through a small diameter hose to half-mask, full-facepiece, or a loose fitting hood or hood.	Source of air attached by small hose to demand valve actuated by slight negative pressure when wearer inhales	Source of air attached by small hose to demand valve actuated by slight negative pressure when wearer inhales
Use	Required under conditions immediately dangerous to life and at distances over 300 ft from a source of respirable air protection for limited periods		Up to 300 ft of travel from source of respirable air protection provided for an unlimited period	Nonemergency work, up to 75 ft of travel from source of respirable air protection provided for an unlimited period	Little set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods	Desirable to protect head and face from flying particles (abrasive blasting, spraying of materials or paint)	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 atmospheres. Travel is limited by the length of the air-supply hose. Flexible hose must be retracted through the skin or skin irritation are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an irrespirable atmosphere (See 5.1.4)
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 following due to weight.		Limitation in regard to toxicity or on oxygen content. Absorption through the skin or skin irritation are possible limitations. Worker must return to fresh air by releasing entry valve. An uncontaminated supply of fresh air must be secured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 25 in. H ₂ O or where exhalation resistance exceeds 1 in. H ₂ O. Hose inlet shall be fitted with a fine (200) mesh SST screen, and shall be fastened in a zone of clean air.	Noninhalable dust should be used if operating pressure is greater than 5 psi (see 5.3.4)	Altabine or hood can be attached to the wearer and detached rapidly and sometimes in an emergency. See 5.1H on air distribution system	Altabine or hood can be attached to the wearer and detached rapidly and sometimes in an emergency. See 5.1H on air distribution system
Remarks	Approved for 30 min only. See Air Pak in an example.	Pressure demand masks maintain the full-facepiece under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmospheres.	Blower must permit free entrance of air when it is not operating. Worker should be assigned with no other duties than to observe the man in the hazardous atmosphere, stand by the life line and in emergency, operate the blower. A blower 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.			

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

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REPORT

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD FROM PAGE 7)

(Not for use in oxygen-deficient atmospheres or where the concentration 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 (Half Mask Respirator)	Self-Rescue Breathing Apparatus		
	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. Exhausted breath goes to atmosphere			Respirators remove particulate matter such as dust, fumes, or mist, 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 graded 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 particulates matter, gases and vapors in concentration within capacity of the device.
Limitations	See Section 4. Cannot be used in atmosphere irritating to the skin. Limited to use in atmosphere containing at least 18.5% oxygen and to the maximum gas concentration for which the specific cartridge is recommended (generally 8.1% maximum or less). Cannot be used in atmosphere irritating to the skin or eyes.	See Section 4. Cannot be used in atmosphere containing at least 18.5% oxygen and to the maximum gas concentration for which the specific cartridge is recommended (generally 8.1% maximum or less). Cannot be used in atmosphere irritating to the skin or eyes.	See Section 4. Cannot be used in atmosphere containing at least 18.5% oxygen and to the maximum gas concentration for which the specific cartridge is recommended (generally 8.1% maximum or less). Cannot be used in atmosphere 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 that to be used when flying particles may cause injury to which condition the abrasive blasting 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 list. 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 Z39.1	See 8.3.6		See 8.3.7. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * MDSH approves mechanical filter respirators according to the following classification: (1) *Pneumococcal - Producing and Not-pneumococcal - Dual 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. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * MDSH approves mechanical filter respirators according to the following classification: (1) *Pneumococcal - Producing and Not-pneumococcal - Dual 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)

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

Fume - Solid dispersoids formed when vapors are condensed from heated acids and other substances.

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

** All approved under (1) and (2). Same approved under (4) are approved for protection of dusts that are not significantly more toxic than lead.

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JANUARY 1964

RESPIRATORY PROTECTIVE EQUIPMENT

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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 §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 §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 Alarms-blowing respirator Hose mask without blower
Combination gaseous and particulate contaminant immediately dangerous to life (see §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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RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY ENGINEERING STANDARD

ISSUED	JAN 1984
THIS PAGE REVISED	OCT 1980
STANDARD REAFFIRMED	DEC 1978

S 2 H

Page 1 of 8

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 S2T. Portable oxygen and toxic-gas detectors are covered in S3T.

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 instituting 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 I. 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 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 - 5.1.8.1) 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 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.

8. BREATHING AIR

8.1 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 56T 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 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 heading 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 54H.

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 (54H). 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 facepieces. 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.

8.2 Procedures Applicable to All Respirators

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

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. Maskell 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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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD ON PAGE 7)

Table 1A - Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See SIH 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 5.1.4 and the air-supplied suit should be kept with a slight positive pressure. In any case the air supply should not be less than 15 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'Aonzo, C. A., and Zapp, 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 60 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 9426-TN
Houston, TX 77005

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TABLE 2 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

Hazard	Respirator
Oxygen deficiency	Self-contained breathing apparatus Combination airline respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 3.1.4)	Self-contained breathing apparatus Combination airline 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 airline respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Air-line blower respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 3.1.4)	Self-contained breathing apparatus Combination airline 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 airline 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 should be used in the less hazardous situations.

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD ON PAGE 6)
Table 1B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		Supplied-Air Respirator		
	Rebreathing	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	At-Line Respirator (Type C Supplied-Air Respirator)
					Continuous Flow At-Line Pump Demand Close At-Line Pump
	Pure oxygen from high pressure cylinders is added to a closure circuit system which recirculates exhaled air. CO ₂ is absorbed.	Air from high pressure cylinders (normally 2000 to 2200 psi) supplied to lungs. Breath exhaled to atmosphere. Available in both normal and pressure demand modes.*	Respirable air is forced through a large diameter blower by a hand blower or a full facemask. (U. S. Bureau of Mines has schedule with electric motor on 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 facemask, full facemask, or a loose fitting hood or hood.
Use	Required under conditions immediately dangerous to life and at distances over 300 ft from a source of respirable air protection for limited periods.		Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Limited by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.
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. Wearer must return to fresh air by releasing entry route. An uncontaminated supply of fresh air must be assured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 2.5 in. H ₂ O or where exhalation resistance exceeds 1 in. H ₂ O. Hose trial shall be fitted with a line (2000 mesh 53T screen, and shall be fastened 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. Route must be retraced. Absorption through the skin or skin irritations are possible limitations. Combination of line respirator and self-contained breathing apparatus may be used in an irrespirable atmosphere (See 5.1.4).
Remarks	Approved for 30 min only. Scott Air Pak is an example. * Pressure demand masks maintain the facemask under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmospheres.		Blower must permit free entrance of air when it is not operating. Helper should be assigned with no other duties than to observe the user in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A blower operator also should be provided. A body harness is required to handle the hose line and the life line, which straps should be worn as a rescue device.	See remarks for Type A at left regarding helper and harness.	Workable hose should be used if operating pressure is greater than 5 psi (see 5.3.4). Bulky to wear. Helmets or hoods are not used with this respirator. See 5.1H on air distribution system. Air supply hose can be detached to the wearer and detached rapidly in an emergency. See 5.1H on air distribution system.

* Coated 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 Facepiece Respirator)	Self-Contained Breathing Apparatus		
	Traps 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. Exhausted breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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 greatest 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 18.5% oxygen and to be minimum gas concentration for which the specific canister is recommended (generally 2% minimum or less).	Limited to use in atmospheres containing at least 18.5% oxygen and to be minimum gas concentration for which the specific canister is recommended (generally 2% minimum or less).		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 breathing 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 limitations 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 Z39.1.	See 6.30		See 3.37. Fitness of the particles to be filtered out of the air controls the fitness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * MICHM approval mechanical filter respirators according to the following classification: (1) *Protonic - Dual Respirators (2) *Tonic - Dual Respirators (not significantly more toxic than toxic) (3) *Dual Respirators (not significantly more toxic than toxic) (4) *Tonic Respirators (not significantly more toxic than toxic)	See 3.37. Fitness of the particles to be filtered out of the air controls the fitness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * MICHM approval mechanical filter respirators according to the following classification: (1) *Protonic - Dual Respirators (2) *Tonic - Dual Respirators (not significantly more toxic than toxic) (3) *Dual Respirators (not significantly more toxic than toxic) (4) *Tonic Respirators (not significantly more toxic than toxic)

* Dust - 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 (2) and same under (4) are approved for protection of dusts that are not significantly more toxic than toxic.

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RESPIRATORY PROTECTIVE EQUIPMENT

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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 5.1.4)	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-cannage respirator
Particulate contaminant immediately dangerous to life (see 5.1.4)	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
Combination gaseous and particulate contaminant immediately dangerous to life (see 5.1.4)	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 case of nitrogenous compounds.

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NOTE

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PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY
ENGINEERING STANDARD

ISSUED	JAN 1984
THIS PAGE REVISED	DEC 1978
STANDARD REAPPROVED	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 approved to meet the requirements of 30 CFR, Part 11 and registered. Refer to manufacturer. Terminal use dates are being recommended 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 Permissibility.

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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Portions printed in red are from OSHA regulations, Section 1910.134.

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.



15ACOMM-77E NO. 28

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

U. S. Bureau of Mines
Health and Safety Research and Testing Center
3800 Forbes Ave
Pittsburgh, PA 15213

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 71-441 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 Brumfield 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

- 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 end 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 SAT 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 Recommendation
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 I 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

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 51H 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. Masek 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 workers 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

ISSUED	JAN 1964
THIS PAGE REVISED	OCT 1980
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 4.6), 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 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 moves 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 instituting the use of this standard.

SUBCOMMITTEE NO. 28



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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 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 - 5.1.8.1) 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 1, 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
Hydrocarbon (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 56T 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 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 I 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 noseclip 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 (-18°C), however, antifog

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

8.9 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.

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

8.11 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).

8.12 Hoses for air supply should be selected to resist the media 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.

8.2 Procedures Applicable to All Respirators

8.2.1 Inspection. All respirators shall be inspected thoroughly 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 repaired 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.

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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.

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 hoses should be checked for wear and tear after each use and be cleaned when necessary. See S111 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. Maskell 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 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 S 1 4 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 Zapp, J. A., "Modern Occupational Medicine," Chapter 7, "Protective Clothing for the Chemical Industry," Lee 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 9823-TX
Houston, TX 77001

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD ON PAGE 8)
Table 1B - Atmosphere Supplying Respirators

Self-Contained Type		Supplied-Air Respirator	
Recticircuiting	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)
Method of operation	At low high pressure cylinders (normally 2000 to 2200 psi) supplied to a closure circuit system which retransmits ambient air. CO ₂ is absorbed.	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facepiece (U. S. Bureau of Mines has suitable with electric motor on blower.)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.
Use	Pure oxygen from high pressure cylinders is added to a closure circuit system which retransmits ambient air. CO ₂ is absorbed.	Up to 300 ft of level from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.
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 retracting only scale. An uncontaminated supply of fresh air must be secured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 2.5 in H ₂ O or where inhalation resistance exceeds 1 in H ₂ O. These must be fitted with a filter (300 mesh SST screen, and shall be fastened in a zone of clean air.
Remarks	Approved for 30 min only. Scott Air Pak is an example. * Pressure demand masks maintain the facepiece under a slight positive pressure during the entire breathing cycle to better protect against leakage of toxic atmospheres.	Blower must permit free entrance of air when it is not operating. Blower should be designed with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A blower operator also should be provided. A body harness is required to handle the hose line and the life line, which always should be worn on a rescue device.	Noninhalable nose should be used if operating pressure is greater than 5 psi (see 6.3.4). Air-supply hose can be attached to the wearer and detached rapidly in an emergency. See 5.11 on air-distribution system. Helmets or hoods are not used with this respirator. See 5.14 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 (CONT'D FROM PAGE 1)
Table 1C - Air Purifying Respirators

(Not for use in oxygen-deficient atmosphere 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		
Method of operation	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 at the canister or cartridge. Exhausted breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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 1 or more gases and vapors.	For escape only. Provides greatest protection available with also 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 2% minimum or less).	Limited to use in atmospheres containing at least 19.5% oxygen and to the maximum gas concentration for which the specific cartridge is recommended (generally 8 1/2% 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 abrasive blasting 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 K12.1.	See 836		See 837. Fineness of the particles to be filtered out of the air controls the fineness 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) *Protonaceous - Protecting and Reliance - Dust Respirators (2) *Toxic - Dust Respirators (not significantly more toxic than lead) (3) *Dual Respirators (not significantly more toxic than lead) (4) *Fume Respirators (not significantly more toxic than lead)	

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

Fume - Solid dispersoids formed when vapors are condensed from heated solids and other substances.

Mist - Liquid dispersoids formed when liquids are disintegrated as in spraying, coating, and atomizing.

** All approved under (1) and (2). Some approved under (4) are approved for protection of dusts that are not significantly more toxic than lead.

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RESPIRATORY PROTECTIVE EQUIPMENT

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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 Aspirate-blowing 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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PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY
ENGINEERING STANDARD

ISSUED	JAN 1964
THIS PAGE REVISED	JUNE 1975
STANDARD REAFFIRMED	JUNE 1975

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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.

* Certain self-contained breathing apparatus may be upgraded to meet the requirements of 30 CFR, Part II and relabeled. Refer to manufacturer.

Portions printed in red are from OSHA regulations, Section 1910.134.

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.

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	March 31, 1977
Supplied air	19B	March 31, 1980
Dust, fume, mist	21B	March 31, 1976
Chemical cartridge	23B	March 31, 1976

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 II 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 II - 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



SUBCOMMITTEE NO. 28

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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
4800 Forbes Ave
Pittsburgh, PA 15213

3.3 A list of respirators for respiratory protection against certain pesticides may be obtained from the U. S. Department of Agriculture, Pesticide Chemicals Research Branch, Beltsville, MD 20705.

3.4 At the present time, there are no approval schedules for the following equipment:

a. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.

b. Air-supplied suits.

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

4. USES AND LIMITATIONS

4.1 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, and

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.

4.2 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.

4.3 Although self-contained breathing apparatus and hose mask with blower 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.

4.4 Respiratory protection is required for human, experimental, or suspected carcinogens under certain conditions. Refer to OSHA regulations for specific requirements, Section 1910.93 and to S2T.

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.

- 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
- g. Expected activity of the wearer
- h. Operating characteristics and limitations of the available respirators
- i. Safety regulations of state or local government

5.1.1 Apparatus rated for at least 30-minute service time should be used for entry into an irrespirable atmosphere.

5.1.2 Fifteen-minute units shall be used only for emergency egress and not for rescue work or re-entry.

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, combination air-line respirator and self-contained

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breathing apparatus, or hose mask with blower shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life. The latter condition is defined as one from which a worker cannot escape uninjured without respiratory protective equipment. 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.

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

5.1.6 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.

5.1.6.1 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. PRECAUTIONS

6.1 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 3.

6.1.1 It shall be determined through tests, vendor certification or other means, that all cylinder breathing air meets specifications for Grade D breathing air as set forth in Table 3.

6.1.2 Purchased cylinders of breathing air should be analyzed before use, by the air, for percent oxygen and carbon monoxide and odor, per Table 3.

6.1.3 In addition a complete analysis should be conducted periodically to assure compliance with Table 3 specifications.

6.2 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.

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

6.4 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. 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.

6.5 A slight negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 2C). 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; some inward leakage of contaminant may be possible.

6.5.1 A pressure-demand type self-contained respirator 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.

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

6.6.1 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.

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6.6.2 As a temporary measure with full-face pieces, glasses with short temple bars or without temple bars may be taped to the wearer's head. Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece.

6.6.3 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.

6.7 A proper seal may not be established if the respirator user has a heavy beard or sideburns. Restrictions on facial hair on employee assignment may be necessary in areas where the use of respirating protection is required.

6.8 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.)

6.9 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 of the eyepiece to prevent its fogging down to about 32 F. Below 0 F, however, antifog compound will not prevent severe fogging.

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

7. CARE

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

7.2 Procedures Applicable to All Respirators

7.2.1 Inspection. All respirators shall be inspected at regular intervals to make sure that they are ready to use.

7.2.1.1 Self-contained breathing apparatus shall be inspected monthly.

7.2.2 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 be replaced as a unit or returned to the manufacturer for repair.

7.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals, when they should be cleaned at least after each day's use.

7.2.4 Storage. All respiratory protective equipment shall be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature.

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

7.3.1 Self-Contained Breathing Apparatus. In demand-type (Table 1B), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. (Minimum pressure is 1600 psi at 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.

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

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

7.3.4 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 steam cleaned when necessary. See SIH on air-supply system.

7.3.5 Self-Rescuers. Frequent 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.

7.3.6 Chemical Cartridge Respirators

7.3.6.1 Chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. Where the expected contaminant has no odor or irritating effect, such as carbon monoxide, a new



cartridge should be installed in the respirator at the start of each day of use. Mouthpiece respirators should not be used for routine protection against gases or vapors, because breathing through the mouth may bypass the odor or irritation warning of an expended cartridge.

7.3.6.2 In plants with centralized maintenance stations, cartridges sometimes are discarded after a given period of use, based upon group experience. In most cases the wearer is responsible for discarding and replacing cartridges in his respirator. Respirators issued to individuals should be marked with the individual's name.

7.3.6.3 Particular care should be exercised in the storage of chemical cartridges because usually they deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where it is necessary for the workmen to use chemical cartridges.

7.3.7 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 reusable filters, in which case the filters are cleaned when the respirator is being serviced.

TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

Table 1A - Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See SIM on air-distribution system.
Use	Operating or repair work where there is exposure to substances that are irritating or corrosive to the skin and mucuous membranes, but where the atmosphere is not immediately dangerous to life.
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.
Remarks	No U. S. Bureau of Mines approval. For additional information, see Fleming, A. J., D'Alonzo, C. A., and Zapp, 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 20-25 cfm of compressed air at 80 - 100 psi and delivers 15-18 cfm of air cooled 50-60 F below the inlet air temperature. The tube can be reversed and used as a heater.

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TABLE 1 - TYPES OF RESPIRATORY EQUIPMENT (CONT'D)
Table 1B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		Supplied-Air Respirator	
	Recirculating	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)
In Chemical exhaust water vapor reacts with a granular chemical to liberate O ₂ in a canister. CO ₂ also is removed. Purified breath is inhaled through breathing bag.		Air from 2000 psi cylinders supplied to facepiece. Breath exhaled to atmosphere.	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facepiece. (U.S. Bureau of Mines has schedule with electric motor on blower.)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.
Not approved	Not approved	Required under conditions immediately dangerous to life and limb at distances over 300 ft from a source of respirable air. Protection for limited periods.	Up to 300 ft at level from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft at level from source of respirable air. Protection provided for an unlimited period.
Limitations	No environmental limitation in regard to toxicity or an 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.	No limitation in regard to toxicity or an oxygen content. Absorption through the skin or skin irritations are possible limitations. Worker must return to fresh air by releasing only a small amount of air to atmosphere. An uncontaminated supply of fresh air must be secured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where radiation resistance exceeds 7.5 in. H ₂ O or where exhalation resistance exceeds 1 in. H ₂ O. Hose inlet (200) mesh SST screen, and shall be fitted with a fine filter to prevent a zone of clean fresh air.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where radiation resistance exceeds 7.5 in. H ₂ O or where exhalation resistance exceeds 1 in. H ₂ O. Hose inlet (200) mesh SST screen, and shall be fitted with a fine filter to prevent a zone of clean fresh air.
Remarks	Not approved	Durham approved for 20 min only. Scott Air Pak is an example.	Blower must permit free movement of air when it is not operating. Worker should be equipped with an oxygen analyzer to observe the amount of oxygen in the atmosphere, attend to the life line and, in case of emergency, the blower. A spare oxygen also should be provided. A back-up line is required to handle the hose line and the life line, which always should be worn as a reserve device (see 7.3.3).	See remarks for Type A at left regarding helper and blower.

Not approved for use at Company sites

Supplied-Air Respirator

Continuous Flow Air-Line Resp	Blowing Resp	Demand Class
Pressurized air supplied through a small-diameter hose to full-mouth facepiece, full facepiece, or a loose fitting helmet or hood.	Source of air is located by small hose in demand where activated by slight negative pressure when wearer inhales.	Source of air is located by small hose in demand where activated by slight negative pressure when wearer inhales.
Limitations set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.	Detachable to protect head and face from flying particles (abrasive blasting, spraying of material, or paint).	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. Rents must be reduced. Absorption through the skin or skin irritations are possible limitations. Combination air-line respirator and self-contained breath-holding apparatus may be used in an irrespirable atmosphere. (See 5.1.6).
	Bully to wear	Noninflatable hose should be used if operating pressure is greater than 5 psi (see 7.3.4).
Air supplied to head covering the whole head and sometimes the torso.	Air supplied to head covering the whole head and sometimes the torso.	Helmets or hoods are not used with this respirator. See 5.1H on air-distribution system.

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TABLE 1 - TYPES OF RESPIRATORY EQUIPMENT (CONT'D)

(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 (Half Mask Respirator)	Self-Rescue Mouthpiece Respirator		
	Tonic gases or vapors removed from inspired air by absorption, adsorption, chemical reaction, or catalysis, or a combination of these in a packed solvent bed of the canister or cartridge. Exhausted breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, from inspired air by capture on the filter, which is usually a fibrous pad.	Some gas masks 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 greatest 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 18% oxygen and to the maximum gas concentration for which the specific canister is recommended (generally 8 1/2% maximum or less). Cannot be used in atmospheres irritating to the skin or eyes.	See 7.3.6.	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 abrasive blasting 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 7.3.6.	The only Bureau of Mines approved self-rescue type is MSA self-rescue for carbon monoxide. See 7.3.5.	See 7.3.7. U.S. Dept. of Agriculture approves respiratory devices for certain insecticides. See 7.3.3. Efficiency of the filter, fineness of the filter, and nature of the filter material is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) "Pneumocatalytic - Protects against dust and fumes - Dust Respirators" (2) "Fume - Dust Respirators (not significantly more toxic than lead)" (3) "Dust Respirators (not significantly more toxic than lead)" (4) "Fume Respirators (not significantly more toxic than lead)"	

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

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

Mist - Liquid dispersoids formed when liquid is disintegrated as in spray, coating, and atomizing.

** All approved under (3) and some under (4) are approved for (1) and (2). Some approved under (8) 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 Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 5.1.4)	Self-contained breathing apparatus Hose mask with blower 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 5.1.4)	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 5.1.4)	Self-contained breathing apparatus Hose mask with blower 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, and hose mask with blower 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.

TABLE 3 - BREATHING AIR ANALYSIS†

Gas	Content Analysis
O ₂	19 percent min to 23 percent max
CO	20 ppm max
CO ₂	1,000 ppm max
Hydrocarbons	0.020 mg/liter max (as condensables)
H ₂ O	Dew point less than the lowest probable temperature to be encountered ‡
N ₂	Balance
Odor	Free of all objectionable odors

† See S3T for data on direct reading portable detectors for oxygen and other gases and vapors.

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

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NOTE

PROTECTIVE EQUIPMENT		SAFETY ENGINEERING STANDARD																			
RESPIRATORY PROTECTIVE EQUIPMENT		ISSUED	JAN 1984																		
		THIS PAGE REVISED	JUNE 1978																		
		STANDARD REAFFIRMED	JUNE 1978																		
		S 2 H																			
		Page 1 of 8																			
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. * Certain self-contained breathing apparatus may be upgraded to meet the requirements of 30 CFR, Part 11 and relabeled. Refer to manufacturers. Portions printed in red are from OSHA regulations, Section 1910.134. 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.																					
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: <table border="1"> <thead> <tr> <th>Type of Respirator</th> <th>Bureau of Mines Approval Schedule</th> <th>Terminal Use Date</th> </tr> </thead> <tbody> <tr> <td>Self contained</td> <td>13 thru 13E</td> <td>March 31, 1979*</td> </tr> <tr> <td>Gas masks</td> <td>14F</td> <td>March 31, 1977</td> </tr> <tr> <td>Supplied air</td> <td>19B</td> <td>March 31, 1980</td> </tr> <tr> <td>Dust, fume, mist</td> <td>21B</td> <td>March 31, 1976</td> </tr> <tr> <td>Chemical cartridge</td> <td>23B</td> <td>March 31, 1976</td> </tr> </tbody> </table> 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, 1978 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, 1978 shall meet the requirements of Chapter 1, Title 30, Code of Federal Regulations Part 11 - Respiratory Protective Devices; Tests for Permissibility. 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 26503				Type of Respirator	Bureau of Mines Approval Schedule	Terminal Use Date	Self contained	13 thru 13E	March 31, 1979*	Gas masks	14F	March 31, 1977	Supplied air	19B	March 31, 1980	Dust, fume, mist	21B	March 31, 1976	Chemical cartridge	23B	March 31, 1976
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SUBCOMMITTEE NO. 28



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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
3800 Forbes Ave
Pittsburgh, PA 15213

3.3 A list of respirators for respiratory protection against certain pesticides may be obtained from the U. S. Department of Agriculture, Pesticide Chemicals Research Branch, Beltsville, MD 20705.

3.4 At the present time, there are no approval schedules for the following equipment:

a. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.

b. Air-supplied suits.

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

4. USES AND LIMITATIONS

4.1 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, and

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.

4.2 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.

4.3 Although self-contained breathing apparatus and hose mask with blower 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.

4.4 Respiratory protection is required for human, experimental, or suspected carcinogens under certain conditions. Refer to OSHA regulations for specific requirements, Section 1910.93 and to S2T.

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.

- 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
- 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 Apparatus rated for at least 30-minute service time should be used for entry into an irrespirable atmosphere.

5.1.2 Fifteen-minute units shall be used only for emergency egress and not for rescue work or re-entry.

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, combination air-line respirator and self-contained

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breathing apparatus, or hose mask with blower shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life. The latter condition is defined as one from which a worker cannot escape uninjured without respiratory protective equipment. 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.

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

5.1.6 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.

5.1.6.1 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. PRECAUTIONS

6.1 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 3.

6.1.1 It shall be determined through tests, vendor certification or other means, that all cylinder breathing air meets specifications for Grade D breathing air as set forth in Table 3.

6.1.2 Purchased cylinders of breathing air should be analyzed before use, by the site, for percent oxygen and carbon monoxide and odor, per Table 3.

6.1.3 In addition a complete analysis should be conducted periodically to assure compliance with Table 3 specifications.

6.2 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.

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

6.4 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. 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.

6.5 A slight negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 2C). 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; some inward leakage of contaminant may be possible.

6.5.1 A pressure-demand type self-contained respirator 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.

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

6.6.1 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.

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6.6.2 As a temporary measure with full-face pieces, cup-type side shield safety glasses, with temples removed, held in place with an elastic band, may be worn under gas masks without loss of mask to face seal. Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece.

6.6.3 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.

6.7 Persons required to wear respirators for protection against other than nuisance atmospheric contamination must be clean shaven in the area of the respirator seal unless a positive pressure respirator is used.

6.8 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.)

6.9 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 of the eyepiece to prevent its fogging down to about 32 F. Below 0 F, however, antifog compound will not prevent severe fogging.

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

7. CARE

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

7.2 Procedures Applicable to All Respirators

7.2.1 Inspection. All respirators shall be inspected at regular intervals to make sure that they are ready to use.

7.2.1.1 Self-contained breathing apparatus shall be inspected monthly.

7.2.2 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 be replaced as a unit or returned to the manufacturer for repair.

7.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals, when they should be cleaned at least after each day's use.

7.2.4 Storage. All respiratory protective equipment shall be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature.

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

7.3.1 Self-Contained Breathing Apparatus. In demand-type (Table 1B), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. (Minimum pressure is 1600 psi at 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.

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

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

7.3.4 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 steam cleaned when necessary. See SIH on air-supply system.

7.3.5 Self-Rescuers. Frequent 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.

7.3.6 Chemical Cartridge Respirators

7.3.6.1 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

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specific toxic atmospheres on request to assist plants in establishing use period criteria.

7.3.6.2 In most cases, the wearer is responsible for discarding and replacing cartridges in his respirator.

7.3.6.3 In any event, chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. Where the expected contaminant has no odor or irritating effect, such as carbon monoxide, a new cartridge should be installed before cumulative hours of use reaches established breakthrough time, or weekly, whichever comes first.

7.3.6.4 Mouthpiece respirators should not be used for routine protection against gases or vapors.

because breathing through the mouth may bypass the odor or irritation warning of an expended cartridge.

7.3.6.5 Particular care should be exercised in the storage of chemical cartridges because usually 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.

7.3.7 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.

TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

Table 1A - Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See SH 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.
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.
Remarks	No U. S. Bureau of Mines approval. For additional information, see Fleming, A. J., D'Alonzo, C. A., and Zapp, 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 20-25 cfm of compressed air at 80 - 100 psi and delivers 15-18 cfm of air cooled 50-60 F below the inlet air temperature. The tube can be reversed and used as a heater.

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TABLE 1 - TYPES OF RESPIRATORY EQUIPMENT (CONT'D)
Table 1B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		Supplied-Air Respirator		Air-Line Respirators (Type C Supplied-Air Respirators)		
	Rebreathing	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	Continuous Flow Air-Line Respir	Blowing Respir	Demand Class Air-Line Respir
	In Chemical supplied water vapor reacts with a granular chemical to liberate O ₂ in a canister. CO ₂ also is removed. Purified breath is inhaled through breathing bag.	Air from 2000 psi cylinders supplied to facepiece. Breath exhaled to atmosphere.	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facepiece. (U.S. Bureau of Mines has schedule 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-facepiece, full facepiece, or a loose fitting helmet or hood.
Use	Not approved	Required under conditions immediately dangerous to life and limb or at distance of respirable air from a source of respirable air. Protection for limited periods.	Up to 300 ft at level from source of respirable air. Protection provided for an unlimited period.	Emergency work, up to 75 ft at level from source of respirable air. Protection provided for an unlimited period.			Source of air not located by small hose in demand valve actuated by slight negative pressure when wearer inhales.
Limitations		No environmental limitation in regard to toxicity or an O ₂ content. Absorption through the skin or the skin or thin irritations are possible limitations. Extensive training in use and care is required. Fatiguing due to weight.	No limitation in regard to toxicity or an oxygen content. Absorption through the skin or the skin or thin irritations are possible limitations. Worker must return to fresh air by removing only once. An uncontaminated supply of fresh air must be assured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 2.5 in. H ₂ O or where exhalation resistance exceeds 1 in. H ₂ O. Hose inlet shall be fitted with a fine (200) mesh SST screen, and shall be fastened in a same of clean fresh air.	Desirable to protect head and face from flying particles (abrasive blasting, sweeping of materials or paint).		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. Route must be retraced. Absorption through the skin or thin irritations are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an inescapable atmosphere. (See 5.1.4).
Remarks	Not approved	Bureau approved for 30 min only. Scott Air Pak is an example.	Blower must permit free entrance of air when it is not operating. Helper should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A helper 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 7.3.3).	See remarks for Type A at left regarding helper and blower.		Bully to wear	Noninhalable base should be used if operating pressure is greater than 5 psi (see 7.3.4).
					Air-supply hose can be attached to the wearer and detached rapidly in an emergency. See SHN air distribution system.	Air supplied to head covering this whole head and sometimes the torso.	Helmet or hood are not used with this respirator. See SHN air distribution system.

Not approved for use at Company sites

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RESPIRATORY PROTECTIVE EQUIPMENT

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TABLE 1 - TYPES OF RESPIRATORY EQUIPMENT (CONTD)

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 Canister Respirator (Half Mask Respirator)		
	Toxic gases or vapors removed from inspired air by absorption, adsorption, chemical reaction, or catalysis, or a combination of these in a packed solvent bed of the canister or cartridge. Exhausts breathe gas to atmosphere.		Respirators remove particulate matter such as dust, fumes, or mist, 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 canister 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 greatest 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 affords 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 18% oxygen and to the minimum gas concentration for which the specific canister is recommended (generally 2% 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 obstructive blurring 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 7.3.6.	The only Bureau of Mines approved self-rescue type is MSA self-rescue for carbon monoxide. See 7.3.5.	See 7.3.7. U.S. Dept. of Agriculture approves respiratory devices for certain insecticides. See 7.3.3. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and fineness of the tightly heated is a governing factor in selection of equipment. U.S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) **Pharmaceuticals - Protecting and Regulating - Dust Respirators (2) **Toxic - Dust Respirators (not significantly more toxic than lead) (3) **Dust Respirators (not significantly more toxic than lead) (4) **Fume Respirators (not significantly more toxic than lead)

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

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

Mists - Liquid dispersoids formed when liquid is disintegrated as in spray, coating, and atomizing.

** All approved under (3) and some under (4) are approved for (1) and (2). Some approved under (4) 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 Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 5.1.4)	Self-contained breathing apparatus Hose mask with blower 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 5.1.4)	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
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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, and hose mask with blower 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.

TABLE 3 - BREATHING AIR ANALYSIS†

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O ₂	19 percent min to 23 percent max
CO	20 ppm max
CO ₂	1,000 ppm max
Hydrocarbons	0.020 mg/liter max (as condensables)
H ₂ O	Dew point less than the lowest probable temperature to be encountered
N ₂	Balance
Odor	Free of all objectionable odors

† See S3T for data on direct reading portable detectors for oxygen and other gases and vapors.

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

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PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY ENGINEERING STANDARD

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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 Respiratory protective equipment should not be used as a substitute for adequate exhaust ventilation or other engineering control methods.

2.2 Respiratory protective equipment 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 in addition to inert gas: eg, flammability (see 4.4), skin toxicity, or absorption through the skin, particularly hydrogen cyanide. Maximum acceptable concentrations (MAC's) of air contaminants are given in Standard S2T. Portable oxygen and toxic-gas detectors are covered in Standard S3T.

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

2.4 Only equipment listed and approved by the U. S. Bureau of Mines shall be used, if schedules for a particular type of equipment have been established.

2.4.1 Information Circular 8281, "Respiratory Protective Devices Approved by the Bureau of Mines as of October 1, 1965," can be obtained for 25 cents from the Superintendent of Documents, U. S. Government

Printing Office, Washington, DC 20402. Copies of a supplemental list containing approvals since 1965 may be obtained from the Bureau of Mines, Health and Safety Research and Testing Center, 4800 Forbes Ave., Pittsburgh, Pennsylvania 15213. At the present time, the Bureau does not have approval schedules for the following equipment:

a. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.

b. Air-supplied suits.

c. Chemical cartridge respirators for respiratory protection against gases and vapors other than organic vapors.

2.4.2 A list of respirators for respiratory protection against certain pesticides may be obtained from the U. S. Department of Agriculture, Pesticide Chemicals Research Branch, Beltsville, Maryland 20705.

3. MANUFACTURERS

Names and addresses of companies to which approvals on currently available respiratory protective devices have been granted by the U. S. Bureau of Mines are given in Table 1. Companies to which approvals have been given by the U. S. Department of Agriculture for insecticide respiratory protective devices also are indicated in Table 1. The listing of a manufacturer in this standard does not mean necessarily that all of his products are approved.

4. TYPES, USE, AND LIMITATIONS

4.1 A list of the several types of respiratory protective equipment, method of operation, use, limitations, and remarks is given in Table 2. For additional information in this regard, reference should be made to:

USA Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1, United States of America Standards Institute, 10 East 40th Street, New York, New York 10016

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

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.

SUBCOMMITTEE NO. 28



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

4.2 The air-purifying respirators, i.e. canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 2C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators require at least 16 percent oxygen in the air. Other reasons for this requirement are that (a) gas masks are intended for use with no more than 2 percent of most toxic gases, and (b) chemical cartridge respirators are approved for no more than 1000 ppm by volume of organic vapor in air.

4.3 Use of canister masks that bear the label "All-Service," "All-Purpose," or "Universal" is prohibited.

4.4 Although self-contained breathing apparatus and hose mask with blower 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 may be within the flammable range for some gases. Standard F61 provides information and instructions for use of portable flammable vapor and gas detectors.

5. SELECTION

5.1 In general, in choosing a respirator, the following factors should be considered: (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, (g) expected activity of the wearer, (h) operating characteristics and limitations of the available respirators, (i) safety regulations of state or local governments (see Table 2).

5.1.1 Apparatus classified for 30-minute service time, or longer, should be used for entry into an irrespirable atmosphere. In certain cases, 15-minute units may be permitted, depending upon local conditions.

5.1.2 Duration ratings for self-contained apparatus are based upon moderate work rate. Service life of an air cylinder will be less for greater work rate.

5.1.3 Only self-contained breathing apparatus, combination air-line respirator and self-contained breathing apparatus, or hose mask with blower shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life. The latter condition is defined as one from which a

worker cannot escape uninjured without respiratory protective equipment. 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.

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

5.1.5 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, which has a maximum rated service time of 30 minutes). Some equipment now on plants may not have these alarms. These can and should be obtained from equipment suppliers for apparatus not so equipped.

5.1.5.1 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.

5.2 Table 3 lists the hazards and the respirators that are recommended to afford respiratory protection against them. By reference to this table, and by considering the foregoing factors, the user can determine the type of respirator that should be used.

6. PRECAUTIONS

6.1 Purchased cylinders of breathing air should be analyzed for oxygen and carbon monoxide content before use. This analysis normally should be done by the plant (see S3T).

6.2 An extensive list of instructions in use and precautions for each type of respirator is given in the previously



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referenced USAS Z2.1. Some precautions are given in Table 2 under headings of Limitations and Remarks.

6.3 The manufacturer's instructions or precautions of the USA Standard should be posted with the respiratory device.

6.4 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. 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.

6.5 A negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 2C). 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; some inward leakage of contaminant may be possible. A pressure-demand type self-contained respirator may be used where special precautions must be taken to prevent the wearer from inhaling any trace of contaminant. (A small positive pressure is maintained at all times and, even if a leak should develop, there would be no leakage of contaminant into the facepiece.)

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

6.6.1 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 USA Standard Safety Code for Eye Protection.

6.6.2 As a temporary measure with full-face pieces, glasses with short temple bars or without temple bars may be taped to the wearer's head. Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece.

6.6.3 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.

6.7 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.)

6.8 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 of the eyepiece to prevent its fogging down to about 32 F. Below 0 F, however, antifog compound will not prevent severe fogging.

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

7. CARE

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

7.2 Procedures Applicable to All Respirators

7.2.1 Inspection. All respirators shall be inspected at regular intervals to make sure that they are ready to use. It is good practice to integrate the respiratory and fire-extinguisher inspection and maintenance program.

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

7.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals. Respiratory equipment can be cleaned with detergent and lukewarm water (less than 125 F) by hand brushing or agitation in a washing machine, rinsed, and dried. The quaternary ammonium salt disinfectants* are recommended for sterilizing respiratory devices. Rinse completely in clean, warm water. Assure thorough drying of mask and demand apparatus after cleaning to prevent freezing if used in cold weather.

7.2.4 Storage. All respiratory protective equipment should be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature (see Chemox mask in Table 2B).

* Willson Germi-Cloth; American Optical Co, No. 101 and 102 Germicidal Detergent; Pulmosan Sanitizer; MSA Cleaner Sanitizer



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

7.3.1 **Self-Contained Breathing Apparatus.** In demand-type (Table 218), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. (Minimum pressure is 1600 psi at 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.

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

7.3.3 **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 steam cleaned when necessary. See Standard S111 on air-supply system.

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

7.3.5 **Chemical Cartridge Respirators.** Chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. In plants with centralized maintenance stations, cartridges sometimes are discarded after a given period of use (based upon group experience); but, in most cases, the wearer is responsible for discarding and replacing cartridges in his respirator. Particular care should be exercised in the storage of chemical cartridges because usually they deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where it is necessary for the workmen to use chemical cartridge respirators.

7.3.6 **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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TABLE 1 — MANUFACTURERS OF APPROVED RESPIRATORY DEVICES*

- ** Acme Protection Equipment Co, 1201 Kalamazoo Street, South Haven, Michigan 49090
- ** American Optical Co, Southbridge, Massachusetts 01551
- Bausch & Lomb, Inc, P. O. Box 478, Rochester, New York 14602
- Binas Manufacturing Co, 3114 Corroll Avenue, Chicago, Illinois 60612
- E. D. Bullard Co, 2680 Bridgeway, Sausalito, California 94965
- Cesco Safety Products, Inc (formerly Chicago Eye Shield Co), 2727 West Roscoe Street, Chicago, Illinois 60618
- H. S. Cover, Station A, South Bend, Indiana 46614
- Davis Emergency Equipment Co, Inc, 45 Hallick St, Newark, New Jersey 07104
- The DeVilbiss Co, Toledo, Ohio 43601
- The Fireweel Co, Inc, Subsidiary of The Aero Corporation, 3695 Broadway, Buffalo, New York 14225
- The Fyr-Fyter Co, 221 Crane Street, Dayton, Ohio 45401
- Glendale Optical Co, Inc, 130 Crossways Park Drive, Woodbury, New York 11797
- Globe Safety Products, Inc (formerly Globe Industries, Inc), 125 Sunrise Place, Dayton, Ohio 45407
- Metallizing Engineering Co, Inc, 1101 Prospect Avenue, Westbury, New York 11590
- ** Mine Safety Appliances Co, 201 North Braddock Avenue, Pittsburgh, Pennsylvania 15208
- Mine Safety Appliances Co, Ltd, Queenslie Industrial Estate, Glasgow E. 3, Scotland
- Minnesota Mining and Manufacturing Co, 2501 Hudson Road, St Paul, Minnesota 55101
- Pangaorn Corporation, Hagerstown, Maryland 21740
- ** Puimasan Safety Equipment Corp, 30-48 Linden Place, Flushing, New York 11354
- Rite Hardware Manufacturing Co, 540 West Chevy Chase Drive, Glendale, California 91209
- Safeline Products, Post Office Box 550, Putnam, Connecticut 06260
- Scott Air-Pak, Ltd, 2254 South Sheridan Way, Clarkson, Ontario, Canada
- Scott Aviation Corporation, Lancaster, New York 14086
- U. S. Divers Co, 3323 West Warner Avenue, Santa Ana, California 92700
- W. W. Sly Manufacturing Co, 4735 Train Avenue, Cleveland, Ohio 44102
- Welsh Manufacturing Co, 9 Magnolia Street, Providence, Rhode Island 02909
- ** Willson Products Division, The Electric Storage Battery Co (formerly Willson Products Division, Ray-O-Vac Co, and Willson Products, Inc), P. O. Box 622, Reading, Pennsylvania 19603

TABLE 2 — TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

Table 2A — Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See Standard SH on air-distribution system.
Use	Operating or repair work where there is exposure to substances that are irritating or corrosive to the skin and mucuous membranes, but where the atmosphere is not immediately dangerous to life.
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.
Remarks	No U. S. Bureau of Mines approval. For additional information, see Fleming, A. J., D'Alonzo, C. A., and Zapp, 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 20-25 cfm of compressed air at 80 - 100 psi and delivers 15-18 cfm of air cooled 50-60 F below the inlet air temperature. The tube can be reversed and used as a heater.

- * Approvals on currently available respiratory protective devices which have been granted by U. S. Bureau of Mines
- ** Approval given by U. S. Department of Agriculture for certain pesticides
- † Supply alarms described in 5.1.5



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Table 18 - Atmosphere Supplying Respirators

	Self-Contained Type		Supplied-Air Respirator			
	Recirculating	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	Air-Line Respirator (Type C Supplied-Air Respirator)	
Method of operation	In Chamber selected water vapor reacts with a granular chemical to liberate O_2 in a container. CO_2 also is removed. Purified breath is inhaled through breathing bag.	Air from 2000 psi cylinders supplied to facepiece. Breath exhaled to atmosphere.	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facepiece. (U.S. Bureau of Mines has schedule with electric motor on blower.)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.	Continuous Flow Air-Line Resp	Demanded Class Air-Line Resp
Use	Required under conditions immediately dangerous to life and distances over 300 ft from a source of respirable air. Protection for limited periods.		Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Pressurized air supplied through a small-diameter hose to half-mask facepiece, full facepiece, or a loose fitting hood or head.	Source of air is locked by small hose to demand valve actuated by slight negative pressure when wearer inhales.
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.		No 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 removing entry route. An unannounced supply of fresh air must be assured.	See limitations for Type A at left regarding helper and harness.	When used alone, this device is limited to concentrations of gases or vapors that are not immediately dangerous to life, or from which the worker 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. Route must be retraced. Absorption through the skin or skin irritations are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an irrespirable atmosphere. (See 5.1.3)	Desirable to protect head and face from flying particles (obstructive blocking, spraying of materials or paint).
Remarks	Chamber approved for either 30 min or 1 hr. Must be started in fresh air. Store at temperatures above freezing. Caution: Chamber container is not for other use. For safe disposal of used canister, punch a 1/2 in. diameter hole on each of 2 opposite sides and place in bucket of water until gas (O_2) evolution stops. The resulting solution is KOH. Do not get liquid on skin or clothing. Notes: Other recirculating types approved up to 2 hr.	Breath approved for 30 min only. Scott Air Pak is an example.	Blower must point face away from air when it is not operating. Helper should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A blower 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 7.3.2).	Bully in wear	Mask/inkable hose should be used if operating pressure is greater than 5 psi (see 7.3.3).	1. Air-supply hose can be attached to head covering the whole head and sometimes the torso. Air supplied to head covering the whole head and sometimes the torso. Helmets or hoods are not used with this respirator. See Standard S111 on air-distribution system.

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Method of operation	Chemical Filter Type			Mechanical Filter Type Respirators	Combination Chemical and Mechanical Filter Respirators	
	Canister Gas Mask	Chemical Cartridge Respirators	Self-Rescue (Manholes)			
	Toxic gases or vapors removed from inspired air by absorption, chemical reaction, or cartridge by the granular fill of the canister or cartridge. Exhaled breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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.			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 4.2 to 4.4. Cannot be used in atmospheres irritating to the skin.			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 abrasive blasting respirator should be used. See Table 2B. 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 4.2 to 4.4.	
Remarks	See 4.2 to 4.4. Limited to use in atmospheres containing at least 16% oxygen and not more than 2% of most toxic gases (2% of ammonia).			See 7.3.6. U. S. Dept of Agriculture approves respiratory devices for certain insecticides. See 2.4.2. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) ***Pneumocystis - Producing and Nuisance - Dust Respirators (2) ***Toxic - Dust Respirators (not significantly more toxic than lead) (3) ***Dust Respirators (not significantly more toxic than lead) (4) Fume Respirators (not significantly more toxic than lead)	See 7.3.6. U. S. Dept of Agriculture approves respiratory devices for certain insecticides. See 2.4.2. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) ***Pneumocystis - Producing and Nuisance - Dust Respirators (2) ***Toxic - Dust Respirators (not significantly more toxic than lead) (3) ***Dust Respirators (not significantly more toxic than lead) (4) Fume Respirators (not significantly more toxic than lead)	

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

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

Mists - Liquid dispersoids formed when liquid is disintegrated as in spraying, cutting, and atomizing.

** All approved under 3 and some under 4 are approved for 1 and 2.

*** Same approved under 4 are approved for protection of dusts that are not significantly more toxic than lead.



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TABLE 3 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

Hazard	Respirator
Oxygen deficiency	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 5.1.3)	Self-contained breathing apparatus Hose mask with blower 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 5.1.3)	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
Combination gaseous and particulated contaminant Immediately dangerous to life (see 5.1.3)	Self-contained breathing apparatus Hose mask with blower 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, and hose mask with blower 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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1. SCOPE

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2. GENERAL

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

2.2 Respiratory protective equipment 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.

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2.2.2 An oxygen deficiency may indicate a hazard in addition to inert gas; eg. 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 Standard S2T. Portable oxygen and toxic-gas detectors are covered in Standard S3T.

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

2.4 Only equipment listed and approved by the U. S. Bureau of Mines shall be used, if schedules for a particular type of equipment have been established.

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the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. Copies of a supplemental list containing approvals since 1965 may be obtained from the Bureau of Mines, Health and Safety Research and Testing Center, 4800 Forbes Ave., Pittsburgh, Pennsylvania 15213. At the present time, the Bureau does not have approval schedules for the following equipment:

a. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.

b. Air-supplied suits.

c. Chemical cartridge respirators for respiratory protection against gases and vapors other than organic vapors.

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USA Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1, United States of America Standards Institute, 10 East 10th Street, New York, New York 10016

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

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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Respiratory Protective Devices Manual published American Industrial Hygiene Association and American Conference of Governmental Industrial Hygienists. Copies are available from Braun and Company, Inc. Box 1203, Ann Arbor, Michigan.)

4.2 The air purifying respirators, ie, canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 2C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators require at least 16 percent oxygen in the air. Other reasons for this requirement are that (a) gas masks are intended for use with no more than 2 percent of most toxic gases, and (b) chemical cartridge respirators are approved for no more than 1000 ppm by volume of organic vapor in air.

4.3 Use of canister masks that bear the label "All-Service," "All-Purpose," or "Universal" is prohibited.

4.4 Although self-contained breathing apparatus and hose mask with blower 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 may be within the flammable range for some gases. Standard E-1 provides information and instructions for use of portable flammable vapor and gas detectors.

5. SELECTION

5.1 In general, in choosing a respirator, the following factors should be considered: (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, (g) expected activity of the wearer, (h) operating characteristics and limitations of the available respirators, (i) safety regulations of state or local governments (see Table 2).

5.1.1 Apparatus classified for 30-minute service time, or longer, should be used for entry into an irrespirable atmosphere. In certain cases, 15-minute units may be permitted, depending upon local conditions.

5.1.2 Duration ratings for self-contained apparatus are based upon moderate work rate. Service life of an air cylinder will be less for greater work rate.

5.1.3 Only self-contained breathing apparatus, combination air-line respirator and self-contained breathing apparatus, or hose mask with blower shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life. The latter condition is defined as one from which a worker cannot escape uninjured without respiratory protective equipment. 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.

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

5.1.5 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, which has a maximum rated service time of 30 minutes). Some equipment now on plants may not have these alarms. These can and should be obtained from equipment suppliers for apparatus not so equipped.

5.1.5.1 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.

5.2 Table 3 lists the hazards and the respirators that are recommended to afford respiratory protection against them. By reference to this table, and by considering the foregoing factors, the user can determine the type of respirator that should be used.

6. PRECAUTIONS

6.1 Purchased cylinders of breathing air should be analyzed for oxygen and carbon monoxide content before use. This analysis normally should be done by the plant (see S3T). Also, the water content of cylinder air used for air masks should be below the dew point for the lowest probable temperature to be encountered. This is necessary to prevent freezeup and stoppage of air flow to the mask. Dew points at various temperatures can be obtained from the "Handbook of Compressed Gases."

6.2 An extensive list of instructions in use and precautions for each type of respirator is given in the previously

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referenced USAS Z2.1. Some precautions are given in Table 2 under headings of Limitations and Remarks.

6.3 The manufacturer's instructions or precautions of the USA Standard should be posted with the respiratory device.

6.4 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. 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.

6.5 A negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 2C). 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; some inward leakage of contaminant may be possible. A pressure-demand type self-contained respirator may be used where special precautions must be taken to prevent the wearer from inhaling any trace of contaminant. (A small positive pressure is maintained at all times and, even if a leak should develop, there would be no leakage of contaminant into the facepiece.)

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

6.6.1 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 USA Standard Safety Code for Eye Protection.

6.6.2 As a temporary measure with full-face pieces, glasses with short temple bars or without temple bars may be taped to the wearer's head. Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece.

6.6.3 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.

6.7 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.)

6.8 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 of the eyepiece to prevent its fogging down to about 32 F. Below 0 F, however, antifog compound will not prevent severe fogging.

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

7. CARE

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

7.2 Procedures Applicable to All Respirators

7.2.1 Inspection. All respirators shall be inspected at regular intervals to make sure that they are ready to use. It is good practice to integrate the respiratory and fire-extinguisher inspection and maintenance program.

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

7.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals. Respiratory equipment can be cleaned with detergent and lukewarm water (less than 125 F) by hand brushing or agitation in a washing machine, rinsed, and dried. The quaternary ammonium salt disinfectants* are recommended for sterilizing respiratory devices. Rinse completely in clean, warm water. Assure thorough drying of mask and demand apparatus after cleaning to prevent freezing if used in cold weather.

7.2.4 Storage. All respiratory protective equipment should be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature (see Chemox mask in Table 2B).

* Willson Germi-Cloth; American Optical Co., No. 101 and 102 Germicidal Detergent; Pulmeson Sanitizer; MSA Cleaner Sanitizer



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

7.3.1 Self-Contained Breathing Apparatus. In demand-type (Table 2B), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. (Minimum pressure is 1600 psi at 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.

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

7.3.3 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 steam cleaned when necessary. See Standard S111 on air-supply system.

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

7.3.5 Chemical Cartridge Respirators. Chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. In plants with centralized maintenance stations, cartridges sometimes are discarded after a given period of use (based upon group experience); but, in most cases, the wearer is responsible for discarding and replacing cartridges in his respirator. Particular care should be exercised in the storage of chemical cartridges because usually they deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where it is necessary for the workmen to use chemical cartridge respirators.

7.3.6 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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TABLE 1 - MANUFACTURERS OF APPROVED RESPIRATORY DEVICES*

- ** Acme Protection Equipment Co, 1201 Kalamazoo Street, South Haven, Michigan 49090
- ** American Optical Co, Southbridge, Massachusetts 01551
- Bausch & Lomb, Inc, P. O. Box 478, Rochester, New York 14602
- Binks Manufacturing Co, 3114 Carroll Avenue, Chicago, Illinois 60612
- E. D. Bullard Co, 2680 Bridgeway, Sausalito, California 94965
- Cesco Safety Products, Inc (formerly Chicago Eye Shield Co), 2727 West Roscoe Street, Chicago, Illinois 60618
- H. S. Cover, Station A, South Bend, Indiana 46614
- Davis Emergency Equipment Co, Inc, 45 Halleck St, Newark, New Jersey 07104
- The DeWitt Co, Toledo, Ohio 43601
- The Firewel Co, Inc, Subsidiary of The Aero Corporation, 3695 Broadway, Buffalo, New York 14225
- The Fyr-Fyter Co, 221 Crane Street, Dayton, Ohio 45401
- Glendale Optical Co, Inc, 130 Crossways Park Drive, Woodbury, New York 11797
- Globe Safety Products, Inc (formerly Globe Industries, Inc), 125 Sunrise Place, Dayton, Ohio 45407
- Metallizing Engineering Co, Inc, 1101 Prospect Avenue, Westbury, New York 11590
- ** Mine Safety Appliances Co, 201 North Braddock Avenue, Pittsburgh, Pennsylvania 15208
- * Mine Safety Appliances Co, Ltd, Queenslie Industrial Estate, Glasgow E. 3, Scotland
- Minnesota Mining and Manufacturing Co, 2501 Hudson Road, St Paul, Minnesota 55101
- Pangborn Corporation, Hagerstown, Maryland 21740
- ** Putman Safety Equipment Corp, 30-48 Linden Place, Flushing, New York 11354
- Pile Hardware Manufacturing Co, 540 West Chevy Chase Drive, Glendale, California 91209
- Safeline Products, Post Office Box 550, Putnam, Connecticut 06260
- * Scott Air-Pak, Ltd, 2254 South Sheridan Way, Clarkson, Ontario, Canada
- * Scott Aviation Corporation, Lancaster, New York 14086
- U. S. Divers Co, 3323 West Warner Avenue, Santa Ana, California 92700
- W. W. Sly Manufacturing Co, 4735 Train Avenue, Cleveland, Ohio 44102
- Welsh Manufacturing Co, 9 Magnolia Street, Providence, Rhode Island 02909
- ** Willson Products Division, The Electric Storage Battery Co (formerly Willson Products Division, Ray-O-Vac Co, and Willson Products, Inc), P. O. Box 622, Reading, Pennsylvania 19603

TABLE 2 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

Table 2A - Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See Standard SIM 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.
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.
Remarks	No U. S. Bureau of Mines approval. For additional information, see Fleming, A. J., D'Alonzo, C. A., and Zapp, 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 20-25 cfm of compressed air at 80 - 100 psi and delivers 15-18 cfm of air cooled 50-60 F below the inlet air temperature. The tube can be reversed and used as a heater.

* Approvals on currently available respiratory protective devices which have been granted by U. S. Bureau of Mines

** Approval given by U. S. Department of Agriculture for certain pesticides

1 Supply alarms described in 5.1.5

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Table 2B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		Supplied-Air Respirator			
	Recirculating	Demand Type	With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	Air-Line Respirator (Type C Supplied-Air Respirator)	
	In Chemicals released water vapor reacts with a granular chemical to liberate O_2 in a canister. CO_2 also is removed. Purified breath is inhaled through breathing bag.	Air from 2000 psi cylinders supplied to facepiece. Breath inhaled to atmosphere.	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facepiece. U.S. Bureau of Mines has developed a self-actuating blower.	Respirable air is drawn through a large flexible hose by worker's breathing effort.	Continuous Flow Air-Line Respirator	Demanded-Flow Air-Line Respirator
Use	Required under conditions immediately dangerous to life and distances over 300 ft from a source of respirable air. Protection for limited periods.		Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Emergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Pressurized air supplied through a small diameter hose to full-face mask, full facepiece, full facepiece, or a loose fitting hood or head.	Source of air at- tached by small hose to demand valve ac- tuated by slight nega- tive pressure when worker inhales.
Li- mitations	No environmental limitations 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.		No limitations in regard to toxicity or on O_2 content. Absorption through the skin or skin irritations are possible limitations. Under most circumstances, water must remain to keep air by attaching entry to face. An unobstructed supply of fresh air must be assured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 2.5 in. H_2O or where conduction resistance ex- ceeds 1 in. H_2O . Hose inlet shall be fitted with a line (200) each 55 ft section, and shall be fastened in a case of clean leak out.	When used alone, this device is limited to concentrations of gases or vapors that are not immediately dangerous to life, or from which the worker can escape unharmed with- out the aid of the respirator. Not to be worn in oxygen- deficient atmosphere. Travel is limited by the length of the air supply hose. Route must be selected. Absorption through the skin or skin irritation are possible limitations. Combination air-line respirator and self-contained breath- ing apparatus may be used in an irrespirable atmosphere. (See 5.1.3)	Desirable to protect head and face from flying particles (ob- servative blasting, spraying of mat- erials or paint).
Remarks	Chemicals approved for either 30 min or 1 hr. Must be stored in fresh air. Store at temperatures above freezing. Caution: Chemical canister is for after use. For safe dis- posal of used canister, punch a 1/2 in. dia hole on each of 2 opposite sides and place in bucket of water until gas (O_2) evolution stops. The resulting solution is COH . Do not get liquid on skin or clothing.	Bureau approved for 30 min only. Scott Air Pak is an example.	Blower must permit free en- trance of air when it is not operating. Filter should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emer- gency, operate the blower. A blower operator also should be provided. A body harness is required to hold the hose line and the life line, which always should be worn on a rescue device (see 7.3.2).	See remarks for Type A or left regarding harness and harness.	Nonadjustable hose should be used if operating pressure is greater than 5 psi (see 7.3.3).	Belly to wear
	Other recirculating types approved up to 2 hr.				Air supplied to head covering the whole head and sometimes the torso.	Headsets or hoods are not used with this respirator. See Standard S1H on air- line distribution system.

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RESPIRATORY PROTECTIVE EQUIPMENT

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Table 2C - 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	Chemical Cartridge Respirators	Self-Rescue (Bump-off) Respirators	
	Toxic gases or vapors removed from inspired air by absorption, chemical reaction, or adsorption by the granular fill of the canister or cartridge. Exhaled breath goes to atmosphere.			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 greatest protection consistent with size of device.	For particulate matter, gases and vapors in concentration within capacity of the device.
Limitations	See 4.2 to 4.4. Cannot be used in atmospheres irritating to the skin. See 4.2 to 4.4. Limited to use in atmospheres containing at least 16% oxygen and not more than 7% of most toxic gases (7% of known).			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 the mechanical filter type is modified by the protection afforded by the chemical filter respirator against gases and vapors. See 4.2 to 4.4.
Remarks	Canisters are color coded for identification.	See 7.3.5.	The only Bureau of Mines approved self-rescue type is MSA self-rescue for carbon monoxide.	See 7.3.6. U. S. Dept of Agriculture approves respiratory devices for certain insecticides. See 7.4.2. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) ...Pneumococcus - Producing and Mortality - Dust Respirators (2) ...Tonic - Dust Respirators (not significantly more toxic than lead) (3) ...Dust Respirators (not significantly more toxic than lead) (4) Fume Respirators (not significantly more toxic than lead)

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

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

Mist - Liquid dispersoids formed when liquid is disintegrated as in spray, coating, and atomizing.

** All approved under 3 and some under 4 are approved for 1 and 2.

*** Some approved under 4 are approved for protection of dusts that are not significantly more toxic than lead.



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TABLE 3 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

Hazard	Respirator
Oxygen deficiency	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 5.1.3)	Self-contained breathing apparatus Hose mask with blower 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 5.1.3)	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
Combination gaseous and particulated contaminant Immediately dangerous to life (see 5.1.3)	Self-contained breathing apparatus Hose mask with blower 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, and hose mask with blower 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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PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY
ENGINEERING STANDARD

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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 Respiratory protective equipment should not be used as a substitute for adequate exhaust ventilation or other engineering control methods.

2.2 Respiratory protective equipment 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 in addition to inert gas; eg. flammability (see 1.1), skin toxicity, or absorption through the skin, particularly hydrogen cyanide. Threshold limit values (TLV's) of air contaminants are given in Standard S2T. Portable oxygen and toxic-gas detectors are covered in Standard S3T.

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

2.4 Only equipment listed and approved by the U. S. Bureau of Mines shall be used, if schedules for a particular type of equipment have been established.

2.4.1 Information Circular 8281, "Respiratory Protective Devices Approved by the Bureau of Mines as of October 1, 1965," can be obtained for 25 cents from

the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. Copies of a supplemental list containing approvals since 1963 may be obtained from the Bureau of Mines, Health and Safety Research and Testing Center, 1800 Forbes Ave., Pittsburgh, Pennsylvania 15213. At the present time, the Bureau does not have approval schedules for the following equipment:

a. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.

b. Air-supplied suits.

c. Chemical cartridge respirators for respiratory protection against gases and vapors other than organic vapors.

2.4.2 A list of respirators for respiratory protection against certain pesticides may be obtained from the U. S. Department of Agriculture, Pesticide Chemicals Research Branch, Beltsville, Maryland 20705.

3. MANUFACTURERS

Names and addresses of companies to which approvals on currently available respiratory protective devices have been granted by the U. S. Bureau of Mines are given in Table 1. Companies to which approvals have been given by the U. S. Department of Agriculture for insecticide respiratory protective devices also are indicated in Table 1. The listing of a manufacturer in this standard does not mean necessarily that all of his products are approved.

4. TYPES, USE, AND LIMITATIONS

4.1 A list of the several types of respiratory protective equipment, method of operation, use, limitations, and remarks is given in Table 2. For additional information in this regard, reference should be made to:

USA Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1, United States of America Standards Institute, 10 East 40th Street, New York, New York 10016

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

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4.2 The air-purifying respirators, ie, canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 2C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators require at least 16 percent oxygen in the air. Other reasons for this requirement are that (a) gas masks are intended for use with no more than 2 percent of most toxic gases, and (b) chemical cartridge respirators are approved for no more than 1000 ppm by volume of organic vapor in air.

4.3 Use of canister masks that bear the label "All-Service," "All-Purpose," or "Universal" is prohibited.

4.4 Although self-contained breathing apparatus and hose mask with blower 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 may be within the flammable range for some gases. Standard F61 provides information and instructions for use of portable flammable vapor and gas detectors.

5. SELECTION

5.1 In general, in choosing a respirator, the following factors should be considered: (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, (g) expected activity of the wearer, (h) operating characteristics and limitations of the available respirators, (i) safety regulations of state or local governments (see Table 2).

5.1.1 Apparatus classified for 30-minute service time, or longer, should be used for entry into an irrespirable atmosphere. In certain cases, 15-minute units may be permitted, depending upon local conditions.

5.1.2 Duration ratings for self-contained apparatus are based upon moderate work rate. Service life of an air cylinder will be less for greater work rate.

5.1.3 Only self-contained breathing apparatus, combination air-line respirator or self-contained breathing apparatus, or hose mask with blower shall be used in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life.

The latter condition is defined as one from which a worker cannot escape uninjured without respiratory protective equipment. 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.

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

5.1.5 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, which has a minimum rated service time of 30 minutes). Some equipment now on plants may not have these alarms. These can and should be obtained from equipment suppliers for apparatus not so equipped.

5.1.5.1 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.

5.2 Table 3 lists the hazards and the respirators that are recommended to afford respiratory protection against them. By reference to this table, and by considering the foregoing factors, the user can determine the type of respirator that should be used.

6. PRECAUTIONS

6.1 Purchased cylinders of breathing air should be analyzed before use, preferably by the plant. The analysis should be within the range listed in Table 4.

6.2 An extensive list of instructions in use and precautions for each type of respirator is given in the previously

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referenced USAS Z2.1. Some precautions are given in Table 2 under headings of Limitations and Remarks.

6.3 The manufacturer's instructions or precautions of the USA Standard should be posted with the respiratory device.

6.4 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. 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.

6.5 A negative pressure occurs inside the facepiece of face-fitting air-purifying respirators (Table 2C). 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; some inward leakage of contaminant may be possible. A pressure-demand type self-contained respirator may be used where special precautions must be taken to prevent the wearer from inhaling any trace of contaminant. (A small positive pressure is maintained at all times and, even if a leak should develop, there would be no leakage of contaminant into the facepiece.)

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

6.6.1 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 USA Standard Safety Code for Eye Protection.

6.6.2 As a temporary measure with full-face pieces, glasses with short temple bars or without temple bars may be taped to the wearer's head. Full-face masks have been developed with systems for mounting corrective lenses inside the facepiece.

6.6.3 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.

6.7 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.)

6.8 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 of the eyepiece to prevent its fogging down to about 32 F. Below 0 F, however, antifog compound will not prevent severe fogging.

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

7. CARE

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

7.2 Procedures Applicable to All Respirators.

7.2.1 Inspection. All respirators shall be inspected at regular intervals to make sure that they are ready to use. It is good practice to integrate the respiratory and fire-extinguisher inspection and maintenance program.

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

7.2.3 Cleaning and Disinfecting. Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after each use, unless assigned to individuals. Respiratory equipment can be cleaned with detergent and lukewarm water (less than 125 F) by hand brushing or agitation in a washing machine, rinsed, and dried. The quaternary ammonium salt disinfectants* are recommended for sterilizing respiratory devices. Rinse completely in clean, warm water. Assure thorough drying of mask and demand apparatus after cleaning to prevent freezing if used in cold weather.

7.2.4 Storage. All respiratory protective equipment should be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature (see Chemox mask in Table 2B).

* Willman Germi-Cloth; American Optical Co, No. 101 and 102 Germicidal Detergent; Pulmoxen Sanitizer; MSA Cleaner Sanitizer



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

7.3.1 Self-Contained Breathing Apparatus. In demand type (Table 2B), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. (Maximum pressure is 1600 psi at 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.

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

7.3.3 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 steam cleaned when necessary. See Standard S111 on air-supply system.

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

7.3.5 Chemical Cartridge Respirators. Chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. In plants with centralized maintenance stations, cartridges sometimes are discarded after a given period of use (based upon group experience); but, in most cases, the wearer is responsible for discarding and replacing cartridges in his respirator. Particular care should be exercised in the storage of chemical cartridges because usually they deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where it is necessary for the workmen to use chemical cartridge respirators.

7.3.6 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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TABLE 1 — MANUFACTURERS OF APPROVED RESPIRATORY DEVICES*

- ** Acme Protection Equipment Co, 1201 Kalamazoo Street, South Haven, Michigan 49090
- ** American Optical Co, Southbridge, Massachusetts 01551
- Bausch & Lomb, Inc, P. O. Box 478, Rochester, New York 14602
- Binks Manufacturing Co, 3114 Carroll Avenue, Chicago, Illinois 60612
- E. D. Bullard Co, 2680 Bridgeway, Sausalito, California 94965
- Casco Safety Products, Inc (formerly Chicago Eye Shield Co), 2727 West Roscoe Street, Chicago, Illinois 60618
- H. S. Cover, Station A, South Bend, Indiana 46614
- Davis Emergency Equipment Co, Inc, 45 Halleck St, Newark, New Jersey 07104
- The DeVilbiss Co, Toledo, Ohio 43601
- The Firewel Co, Inc, Subsidiary of The Ara Corporation, 3695 Broadway, Buffalo, New York 14225
- The Fyr-Flyer Co, 221 Crane Street, Dayton, Ohio 45401
- Glendale Optical Co, Inc, 130 Crossways Park Drive, Woodbury, New York 11797
- Globe Safety Products, Inc (formerly Globe Industries, Inc), 125 Sunrise Place, Dayton, Ohio 45407
- Metallizing Engineering Co, Inc, 1101 Prospect Avenue, Westbury, New York 11590
- ** Mine Safety Appliances Co, 201 North Braddock Avenue, Pittsburgh, Pennsylvania 15208
- * Mine Safety Appliances Co, Ltd, Queenslie Industrial Estate, Glasgow E. 3, Scotland
- Minnesota Mining and Manufacturing Co, 2501 Hudson Road, St Paul, Minnesota 55101
- Pangaorn Corporation, Hagerstown, Maryland 21740
- ** Pulmosan Safety Equipment Corp, 30-48 Linden Place, Flushing, New York 11354
- Pine Hardware Manufacturing Co, 540 West Chevy Chase Drive, Glendale, California 91209
- Safeline Products, Post Office Box 550, Putnam, Connecticut 06260
- * Scott Air-Pak, Ltd, 2254 South Sheridan Way, Clarkson, Ontario, Canada
- * Scott Aviation Corporation, Lancaster, New York 14086
- U. S. Divers Co, 3323 West Warner Avenue, Santa Ana, California 92700
- W. W. Sly Manufacturing Co, 4735 Train Avenue, Cleveland, Ohio 44102
- Welsh Manufacturing Co, 9 Magnolia Street, Providence, Rhode Island 02909
- ** Willson Products Division, The Electric Storage Battery Co (formerly Willson Products Division, Ray-O-Vac Co, and Willson Products, Inc), P. O. Box 622, Reading, Pennsylvania 19603

TABLE 2 — TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

Table 2A — Air-Supplied Suit

Method of Operation	Air supply from supplied-air breathing apparatus. See Standard SHM 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.
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.
Remarks	No U. S. Bureau of Mines approval. For additional information, see Fleming, A. J., D'Alonzo, C. A., and Zapp, 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 20-25 cfm of compressed air at 80 - 100 psi and delivers 15-18 cfm of air cooled 50-60 F below the inlet air temperature. The tube can be reversed and used as a heater.

* Approvals on currently available respiratory protective devices which have been granted by U. S. Bureau of Mines

** Approval given by U. S. Department of Agriculture for certain pesticides

1 Supply alarms described in 5.1.5



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Table 2B - Atmosphere Supplying Respirators

Method of operation	Self-Contained Type		Supplied Air Respirator		Air-Line Respirator (Type C) Supplied Air Respirator	
	Recirculating	Dropped Type	With Blower (Type A) Supplied Air Respirator	Without Blower (Type B) Supplied Air Respirator	Continuous Flow Air-Line Resp	Demand Class Air-Line Resp
	In Chemox exhaled water vapor reacts with a granular chemical to liberate O ₂ in a canister. CO ₂ often is removed. Purified breath is inhaled through breathing bag.	Air from 2000 psi cylinders supplied to facepiece. Breath exhaled to atmosphere.	Respirable air is forced through a large flexible hose by use of a blower to a full facepiece. (U.S. Bureau of Mines has schedule with electric motor on blower.)	Respirable air is drawn through a large flexible hose by use of a breathing effort.	Pressurized air supplied through a small-diameter hose to half-mask facepiece, full facepiece, or a loose fitting helmet or hood.	Source of air attached by small hose to demand valve actuated by slight negative pressure when wearer inhales.
Use	Required under conditions immediately dangerous to life and distances over 200 ft from a source of respirable air. Protection for limited periods.		Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited limited period.	Emergency work, up to 95 ft of travel from source of respirable air. Protection provided for an unlimited period.	Limits set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.	
Limitations	No environmental limitation in regard to toxicity or an 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.		No limitation in regard to toxicity or an oxygen content. Absorption through the skin or skin irritations are possible limitations. Worker must return to fresh air by releasing entry route. An uncommunicated supply of fresh air must be assured.	See limitations for Type A at left. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 2.5 in. H ₂ O or where inhalation resistance exceeds 1 in. H ₂ O. Hose inlet shall be fitted with a fine (200) mesh SST screen, and shall be fastened in a case of clean fresh 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 uninjured without the aid of the respirator. Not to be worn in oxygen-depleted atmosphere. Travel is limited by the length of the air supply hose. Route must be retraced. Absorption through the skin or skin irritation are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an irrespirable atmosphere. (See 5.1.3)	Desirable to protect head and face from flying particles (abrasive blasting, spraying of materials or paint).
Remarks	Chemox approved for either 30 min or 1 hr. Must be stored in fresh air. Store at temperatures above freezing. Caution: Chemox canister is for other use. For safe disposal of used canisters, puncture 1/2 in. diameter hole in each of 2 opposite sides and place in bucket of water until fumes (O ₂) evolution stops. The resulting solution is KOH. Do not get liquid on skin or clothing. Note: Other recirculating types approved up to 2 hr.	Chemox approved for 30 min only. Scott Air Pak is an example.	Blower must permit free entrance of air when it is not operating. Helper should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A helper, 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 7.3.2).	See remarks for Type A at left regarding helper and harness.	Unsuitable hose should be used if operating pressure is greater than 5 psi (see 7.3.3).	Bully to wear
					Air supply hose can be attached to the back of the helmet or hood and connected to the whole head and shoulders distribution system. See the notes.	Helmet or hood are not used with this respirator. See Standard SHH on air distribution system.

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Table 2C - Air Purifying Respirators
(Not for use in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life)

	Chemical-Filter Type			Mechanical-Filter Type Respirators	Combination Chemical and Mechanical Filter Respirators
	Canister Gas Mask	Chemical Cartridge Respirators	Salt Reseal (Nonrebreather) Respirators		
Method of operation	Toxic gases or vapors removed from inspired air by absorption, chemical reaction, or cartridge by the granular fill of the canister or cartridge. Exhaled breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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.			Designed to provide respiratory protection against a single specific dust, fume, or mist, or a single class such as toxic dusts or a combination of several classes of particulate matter such as dusts, fumes, and mists. It affords no protection against gases or vapors.	For particulate matter, gases and vapors in concentration within capacity of the device.
Limitations	See 4.2 to 4.4. Cannot be used in atmospheres irritating to the skin. See 4.2 to 4.4. Limited to use in atmospheres containing at least 16% oxygen and not more than 2% of most toxic gases (3% of unreacted).			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 where flying particles may cause injury, for which condition the above limiting system should be used. See Table 2B. 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 limitations 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 respirators against gases and vapors. See 4.2 to 4.4.
Remarks	Canisters are color coded for identification. See 7.3.5.			The only Bureau of Mines approved self-rescue type is MSA self-rescue for carbon monoxide.	See 7.3.6. U. S. Dept. of Agriculture approves respiratory devices for certain insecticides. See 7.3.2.2. Fineness of the particles to be filtered out of the air is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) ... Pneumonometers - Producing and Measuring - Dust Respirators (2) ... Toxic - Dust Respirators (not significantly more toxic than lead) (3) ... Dust Respirators (not significantly more toxic than lead) (4) Fume Respirators (not significantly more toxic than lead)

** Dust - Dispersoids or particulate matter, smaller than 100 microns, formed when solid materials are disintegrated by such processes as crushing, grinding, and abrad- ing.

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

Mist - Liquid dispersoids formed when liquid is disintegrated as in spray, coating, and atomizing.

** All approved under 3 and some under 4 are approved for 1 and 2.

*** Some approved under 4 are approved for protection of dusts that are not significantly more toxic than lead.



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TABLE 3 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

Hazard	Respirator
Oxygen deficiency	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Gaseous contaminant Immediately dangerous to life (see 5.1.3)	Self-contained breathing apparatus Hose mask with blower 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 5.1.3)	Self-contained breathing apparatus Hose mask with blower Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 5.1.3)	Self-contained breathing apparatus Hose mask with blower 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, and hose mask with blower 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.

TABLE 4 - BREATHING AIR ANALYSIS:

Gas	Content Analysis
O ₂	20 percent min to 25 percent max
CO	10 ppm max
CO ₂	1,000 ppm max
Rare gases	1 percent max
Hydrocarbons	0.020 mg/liter max
H ₂ O	Dew point less than the lowest probable temperature to be encountered †
N ₂	Balance
Odor	Free of all objectionable odors

† See S3T for data on direct reading portable detectors for oxygen and other gases and vapors

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

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NOTE

PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY AND WELFARE ENGINEERING STANDARD

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1. SCOPE

1.1 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 Respiratory protective equipment should not be used as a substitute for adequate exhaust ventilation or other engineering control methods.

2.2 Respiratory protective equipment 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 oxygen content of the air is less than 16 percent by volume, 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. *Self-contained breathing apparatus or a hose mask with blower shall be worn in oxygen-deficient atmospheres.*

2.2.2 An oxygen deficiency may indicate a hazard in addition to inert gas: eg, flammability (see paragraph 4.4), skin toxicity, or absorption through the skin, particularly HCN. Maximum acceptable concentrations (MAC's) of air contaminants are given in Standard S2T. Portable oxygen and toxic-gas detectors are covered in Standard S3T.

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

2.4 Only equipment listed and approved by the U. S. Bureau of Mines shall be used, if schedules for a particular type of equipment have been established. (U. S. Department of Agriculture has approved respiratory devices which may be used for protection against certain pesticides.)

2.4.1 Information Circular 7885, "Respiratory Protective Devices Approved by the Bureau of Mines

as of October 16, 1958" together with a list of supplemental approvals since 1958 can be obtained from the Publications Distribution Section, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pennsylvania. At the present time, the Bureau does not have approval schedules for the following equipment (d and e are Du Pont approved):

e. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.

b. Air-supplied suits.

c. Chemical cartridge respirators for respiratory protection against gases and vapors other than organic vapors.

d. Escape-type self-contained breathing apparatus.

e. Combination airline and self-contained breathing apparatus.

2.4.2 A list of "Respiratory Devices for Protection Against Inhalation Hazards of Dusts, Mists, and Low Vapor Concentrations of Certain Pesticides," can be obtained from the U. S. Department of Agriculture, Agricultural Research Service, Washington 25, DC.

3. MANUFACTURERS

3.1 Names and addresses of companies to which approvals on currently available respiratory protective devices have been granted by the U. S. Bureau of Mines are given in Table 1. Companies to which approvals have been given by the U. S. Department of Agriculture for insecticide respiratory protective devices also are indicated in Table 1. The listing of a manufacturer in this standard does not mean necessarily that all of his products are approved.

4. TYPES, USE, AND LIMITATIONS

4.1 A list of the several types of respiratory protective equipment, method of operation, use,

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



limitations, and remarks is given in Table 2. For additional information in this regard, reference should be made to:

American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1, American Standards Association, 70 East Forty-fifth Street, New York 17, NY

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

Respiratory Protective Devices Manual published by American Industrial Hygiene Association and American Conference of Governmental Industrial Hygienists (copies are available from Braun and Brumfield Inc, Box 1203, Ann Arbor, Mich.

4.2 The air-purifying respirators, ie, canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 2C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators require at least 16 percent oxygen in the air. Other reasons for this requirement are that (a) gas masks are intended for use with no more than 2 percent of most toxic gases, and (b) chemical cartridge respirators are approved for no more than 1000 ppm by volume of organic vapor in air.

4.3 Use of canister masks that bear the label "All-Service," "All-Purpose," or "Universal" has been prohibited by the Safety and Fire Protection Division.

4.4 Although self-contained breathing apparatus and hose mask with blower 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 may be within the flammable range for some gases. Standard F6J provides information and instructions for use of portable flammable vapor and gas detectors.

5. SELECTION

5.1 In general, in choosing a respirator, the following factors should be considered: (a) nature of the hazard; (b) severity of the hazard. (Only self-contained breathing apparatus or hose mask with blower, shall be used in oxygen-deficient atmospheres or where the contaminant is, or may be, immediately dangerous to life.); (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; (g) expected activity of the wearer; (h) operating characteristics and limitations of the available respirators (see Table 2).

5.2 Table 3 lists the hazards and the respirators that are recommended to afford respiratory protection against them. By reference to this table, and by considering the foregoing factors, the user can determine the type of respirator that should be used.

6. PRECAUTIONS

6.1 An extensive list of instruction in use and precautions for each type of respirator is given in the previously referenced ASA Z2.1. Some precautions are given in Table 2 under headings of Limitations and Remarks.

6.2 The manufacturer's instructions should be posted with the respiratory device. Where these are not available, precautions of ASA should be posted at the respiratory storage locations.

6.3 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. 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. CARE

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

7.2 Procedures Applicable to All Respirators

7.2.1 *Inspection.* All respirators shall be inspected at regular intervals to make sure that they are ready to use. It is good practice to integrate the respiratory and fire-extinguisher inspection and maintenance program.

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

7.2.3 *Cleaning and Disinfecting.* Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after

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each use, unless assigned to individuals. Respiratory equipment can be cleaned with detergent and lukewarm water by hand brushing or agitation in a washing machine, rinsed, and dried. The quaternary ammonium salt disinfectants* are recommended for sterilizing respiratory devices, since they are not particularly irritating to the skin if they are not completely rinsed from the device after sterilization.

7.2.4 Storage. All respiratory protective equipment should be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature (see Chemox mask in Table 2B).

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

7.3.1 Self-Contained Breathing Apparatus. In demand-type (Table 2B), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. Recharge after each use, following manufacturer's instructions. Follow manufacturer's instructions on tightness tests for self-contained respirators.

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

7.3.3 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 steam cleaned when necessary. See Standard S111 on air-supply system.

7.3.4 Gas Masks. The canister should be replaced at least annually whether or not it has been used. At the time of replacement of canister, the face-piece, harness, hose, and headband should be examined carefully for any signs of leak or deterioration, and should be replaced if any are found.

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

7.3.6 Chemical Cartridge Respirators. Chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. In plants with centralized maintenance stations, cartridges sometimes are discarded after a given period of use (based on group experience); but, in most cases, the wearer is responsible for discarding and replacing cartridges in his respirator. Particular care should be exercised in the storage of chemical cartridges because they usually deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where it is necessary for the workmen to use chemical cartridge respirators.

7.3.7 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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* Willson Germi-Cloth; American Optical Co, No. 101 and 102 Germicidal Detergent; Pulmox Sanitizer; MSA Cleaner Sanitizer



TABLE 1 - APPROVED RESPIRATORY PROTECTIVE DEVICES*

- ** Acme Protection Equipment Co, 1201 Kalamazoo St, South Haven, Michigan
- American-LaFrance Corp, Elmira, NY
- ** American Optical Co, Southbridge, Mass.
- Binks Manufacturing Co, 3114 Carroll Ave, Chicago 12, Ill.
- E. D. Bullard Co, 2680 Bridgeway, Sausalito, Calif
- ** Chicago Eye Shield Co, 2727 West Roscoe St, Chicago 18, Ill.
- H. S. Cover, Station A, South Bend, Ind
- Davis Emergency Equipment Co, Inc, 45 Halleck St, Newark 4, NJ
- The DeVilbiss Co, Toledo 1, Ohio
- Globe Industries, Inc, 125 Sunrise Place, Dayton 7, Ohio
- B. F. McDonald Co, 5721 West 96th St, Los Angeles 45, Calif
- Metallizing Engineering Co, Inc, 1101 Prospect Ave, Westbury, NY
- ** Mine Safety Appliances Co, 201 N Braddock Ave, Pittsburgh 8, Pa.
- Mine Safety Appliances Co, Ltd, Queenslie Industrial Estate, Glasgow E 3, Scotland
- Pangborn Corp, Hagerstown, Md
- ** Pulman Safety Equip Corp, 644 Pacific St, Brooklyn 17, NY
- Scott Aviation Corp, Lancaster, NY
- U. S. Divers Co, 3323 West Warner Ave, Santa Ana, Calif
- W. W. Sly Manufacturing Co, 4735 Train Ave, Cleveland 2, Ohio
- Welsh Manufacturing Co, 9 Magnolia St, Providence, RI
- ** Willson Prod Div, Ray-O-Vac Co, Reading, Pa. (formerly Willson Prod, Inc)

TABLE 2 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

TABLE 2A - AIR-SUPPLIED SUIT

Method of Operation	Air supply from supplied air or self-contained breathing apparatus.
Use	Rescue work or repair work where there is exposure to substances that are irritating or corrosive to the skin and mucuous membranes and are also acutely toxic.
Limitations	Air must be supplied to the suit as well as to the mask. 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.
Remarks	No generally accepted specifications. For additional information, see Fleming, A. J., D'Alanzo, C. A., and Zapp, J. A., "Modern Occupational Medicine," Chapter 7, "Protective Clothing for the Chemical Industry," Lea and Febiger, Philadelphia, 1960. See Standard S1H on air distribution system.

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- * Approvals on currently available respiratory protective devices which have been granted by U. S. Bureau of Mines
- ** Approval given by U. S. Department of Agriculture for certain pesticides



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TABLE 28 - ATMOSPHERE SUPPLYING RESPIRATORS

Method of Operation	Self-Contained Type		Supplied Air Respirator			
	Recirculating Self-Contained Type (Closed)	Open Type	With Blower (Type A Supplied Air Respirator)	Without Blower (Type B Supplied Air Respirator)	Continuous Flow Air-Line Respirator	Demand Class Air-Line Respirator (Type C Supplied Air Respirator)
	Exhaled water vapor reacts with a granular chemical to liberate O_2 in a canister. CO_2 is also removed. Purified breath is inhaled through breathing bag.	Air from 2000 psi cylinders supplied to facepiece. Breath exhaled to atmosphere.	Respirable air is forced through a large diameter flexible hose by a hand blower to a full facepiece.	Respirable air is drawn through a large flexible hose by wearer's breathing effort.	Pressurized air supplied through a small diameter hose to full-face or hood.	Pressurized air supplied through a small diameter hose to full-face or hood.
Use	Required under conditions immediately hazardous to life and distances over 150 ft from a source of respirable air. Protection for limited periods.		Up to 150 ft travel from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Limits set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.	Limits set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.
Limitations	No environmental limitations in regard to toxicity or an oxygen content. Absorption through the skin or skin irritations are possible limitations. Extensive training in use and care is required. Fatiguing due to weight.		No limitation in regard to toxicity or an oxygen content. Absorption through the skin or skin irritations are possible limitations. Further must refer to fresh air by reducing entry route.	See limitations for Type A at 150 ft. Not for emergency work. Not approved in any situation where inhalation resistance exceeds 2.5 in. H_2O or where exhalation resistance exceeds 1 in. H_2O . Hose inlet shall be fitted with a flame (2000) mesh SST screen, and shall be functioned in a zone of clean fresh air.	Desirable to protect head and face from flying particles (abrasive blasting, spraying of molten salt, or paint).	Desirable to protect head and face from flying particles (abrasive blasting, spraying of molten salt, or paint).
Remarks	Approved for 45 min. Must be stored in fresh air. Store at temperatures above freezing. Canister: consider in hot after use. For safe disposal of used canisters, punch a 1/2 in. hole on each of 2 opposite sides and place in bucket of water until gas (O_2) evolution stops. The resulting solution is KOH. Canister: do not get liquid on skin or clothing.	Burns approved for 30 min only. Scott Air Pak is an example. Nonapproved 15-min Scott Air Pak may be used for self-rescue (1800 psi for 15 min Air Pak) (see per. 7.3.1).	Blower must permit free entrance of air when it is not operating. Helms should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line, and in emergency, operate the blower. A spare operator also should be provided. A body harness is required to handle the hose line and the life line, which always should be worn, or rescue device (see per. 7.3.2).	See remarks for Type A at 150 ft regarding helmet and harness.	Nonadjustable hose; could be used if operating pressure is greater than 5 psi (see per. 7.3.3). Air-supply hoses can be attached to the hand covering the whole head and neck rapidly in an emergency. See Standard S1H on air-distribution system.	Nonadjustable hose; could be used if operating pressure is greater than 5 psi (see per. 7.3.3). Helms or heads are not used with this respirator. See Standard S1H on air-distribution system.

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TABLE 2C - AIR P1 INC RESPIRATORS

Method of Operation	Chemical Filter Type			Mechanical Filter Type Respirators	Combination Chemical and Mechanical Filter Respirators
	Canister Gas Mask	Chemical Cartridge Respirators	Self-Rescue Respirators		
	Toxic gases or vapors removed from inspired air by absorption, chemical reaction, or cartridge by the granular fill of the canister or cartridge. Enabled breath gas to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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 consistent with use of device. The degree of protection usually falls between that provided by gas masks and by chemical cartridge respirators.			Designed to provide respiratory protection against a single specific dust, fume, or mist, or a single class such as toxic dusts or a combination of several classes of particulate matter such as dusts, fumes, and mists.	For particulate matter, gases and vapors in concentration within capacity of the device.
Limitations	See per. 4.2 to 4.4. Cannot be used in atmospheres irritating to the skin. See per. 4.2 to 4.4. Limited to use in atmospheres containing at least 16% oxygen and not more than 2% of most toxic gases (2% of ammonia).	See per. 4.2 to 4.4. Limited to concentrations not in excess of 1000 ppm by vol (60.7%) organic vapor in air and to atmospheres containing at least 16% by vol oxygen. Cannot be used in atmospheres irritating to the skin or eyes.	The only Bureau of Mines approved self-rescue type is MSA Table 2B on use of room-proved 15 min. Scott Air Pak for self-rescue work.	Practical limit of concentration is determined by time required to plug filter. Not to be used when flying particles may cause injury, for which condition the obsolete blaring respirator should be used. See Table 2B. Does not protect against oxygen deficiency and toxic vapors or gases. The use of dust on some respirators in high concentrations of these contaminants requires frequent replacement of disposable filters, or frequent cleaning of reusable filters.	The limitations of the combination are generally the same as for each type of respirator given on the left. The limitations 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 per. 4.2 to 4.4.
Remarks	Canisters are color coded for identification. See per. 7.3.4 on replacement of canisters.	See per. 7.3.6.		See per. 2.3.7, U. S. Dept. of Agriculture approves respiratory devices for certain pesticides. See per. 2.4.3. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity based is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classification: (1) "P" - Pneumonia - Producing and Narcosis - Dust Respirators, (2) "T" - Toxic - Dust Respirators (not significantly more toxic than lead), and (3) "D" - Dust Respirators (not significantly more toxic than lead).	

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

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

Mist - Liquid dispersoids formed when liquid is disintegrated as in spray, coating, and abrading.

** All approved under 3 and some under 4 are approved for 3 and 2.

*** Some approved under 4 are approved for protection of dusts that are not significantly more toxic than lead.

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TABLE 3 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

Hazard	Respirator
Oxygen deficiency	Self-contained breathing apparatus Hose mask with blower
Gaseous contaminant Immediately dangerous to life Not immediately dangerous to life	Self-contained breathing apparatus Hose mask with blower Air-line respirator Hose mask without blower Chemical-cartridge respirator
Particulate contaminant	Mechanical filter respirator Air-line respirator Abrasive-blasting respirator
Combination gaseous and particulated contaminant Immediately dangerous to life Not immediately dangerous to life	Self-contained breathing apparatus Hose mask with blower Air-line respirator Hose mask without blower Combination chemical and mechanical filter respirators

NOTE: The self-contained breathing apparatus and the hose mask with blower 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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RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY ENGINEERING STANDARD

ISSUED JAN 1964

THIS PAGE
REVISED JUNE 1984STANDARD
REAFFIRMED JUNE 1984

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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

1.1 This standard does not apply for exposure to airborne radioactive contamination for which special consideration may be necessary.

1.2 Du Pont policy and stated public position on engineering controls and respirators is that "each employee's personal work environment should be maintained at a safe exposure level through implementation of cost effective engineering controls augmented as necessary by personal protective equipment and/or work practice controls."

1.3 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.

2. GENERAL

2.1 Each site should have a properly-trained individual responsible for the respirator program.

2.2 Respirator training is available through ESD sponsored courses. Ref (1) through (5) outline requirements for a proper respirator program. The individual responsible for the site program should be familiar with Ref (1) through (6).

2.3 Engineering Standard 99H outlines requirements for canister/cartridge use for air-purifying respirators. S8H for fit testing, and S1H for air distribution.

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

2.5 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 areas where workers may be exposed above safe limits. See S2T for information on exposure limits.

2.6 Each location shall develop written procedures describing the selection, use, and care 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 when available.

3.1.1 Respirators purchased after Sept 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 is 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, 1973, 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. 80-144 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

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

4. USES AND LIMITATIONS

4.1 Users of respiratory protective equipment shall have medical approval. This should be documented in each person's medical record.

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. These respirators do not supply oxygen and therefore do not protect against possible oxygen deficiencies. Another reason for this requirement is that these masks are not intended for use against unlimited or unknown concentrations of contaminants.

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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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4.2.1 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.

4.2.2 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. Portable oxygen and toxic-gas detectors are described in S3T.

4.3 Air-purifying respirators should not be used in atmospheres immediately dangerous to life and health or when the contaminant has poor warning properties, except as noted in S9H.

4.4 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.

4.5 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 Many toxic gases and vapors are flammable and the user could be exposed to a potential fire or explosion. 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 may be 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 - 5.1.8.1) and Tables 1 and 2 should be considered. Engineering Dept Report, Accession No. 15167 "Respirator Selection," 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
- 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 potentially 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 upon moderate work rates. Operating time is reduced by increased respiration required by heavy exertion.

5.1.4 Only positive pressure 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 and health (Table 1A). 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.

5.1.5 Escape masks are used only for exit from or through contaminated area. These masks are air supplied or in certain cases a cartridge respirator may be used. For detailed information on selection and limitations, consult Haskell Laboratory reports listed as Ref (7), (8), and (9). These reports should be available from the Departmental OSH Coordinators.

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). 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 the following tabulation 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)	5mg/m
H ₂ O††	Dew point less than the lowest probable temperature to be encountered††
N ₂	Balance
Odor	Free of pronounced odors

* See S6T for data on direct reading portable oxygen analyzers.

†† This is necessary to prevent freeze-up and stoppage of airflow to the mask. For tables, refer to "Handbook of Compressed Gases."

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 tabulation in 6.1.

* Available from Compressed Gas Association Inc, 1236 Jefferson Davis Highway, Arlington, VA 22202
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6.6 Pure oxygen shall not be used in open circuit, self-contained, atmosphere-supplying respirators, or in air-line type respirators.

6.7 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.

7. PRECAUTIONS

7.1 An extensive list of instructions in use and precautions for each type of respirator is given in ANSI Z88.1. 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.

7.3.1 Training in the use and fit testing of respirators is an essential part of a respiratory protection program and is specified in OSHA regulations. Training shall be completed prior to fit testing. See S8H for fit testing protocols. Additional references are listed in section 9.

7.3.2 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 less protection. When purchasing new air-supplied, self-contained or combination type, pressure demand should be specified.

7.4 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, irritation, or taste, 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. (See also section 5 of S9H.)

7.5 A proper seal cannot be established if the temple bars of eyeglasses 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:

- a. Using only air with low moisture content
- b. Installing a nosecup in the mask
- c. Thoroughly drying masks after cleaning
- d. Keeping SCBAs in a warm location between uses (if practical)
- e. Visually checking pressure gages for low air supply
- f. 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 (-18°C), however, antifog compounds 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.

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7.10 Persons required to wear respirators must be clean shaven in the area of the respirator seal, except as noted in Safety and Fire Protection Guidelines, Section 9.13.

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 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. Also, only hose approved for that respirator may be used.

8. CARE

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

8.2 Procedure 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 air-supplied units at most plants, it is preferable that parts of 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 daily.

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. The cylinder pressure shall be checked monthly and recharged if below rated pressure [corrected to 70°F (21°C)]. Recharge after each use, following manufacturer's instructions. Follow manufacturer's instructions on functional tests for self-contained respirators

and hydrostatic testing of compressed-air cylinders. Assure that regulator and low-pressure alarms are functioning.

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. Air-line 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, or at the end of the shift, 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 Cartridges should be discarded after a predetermined period of use. See S9H.

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 at the end of the work shift. Some mechanical filter respirators use recleanable filters, in which case the filters are cleaned when the respirator is being serviced.

9. REFERENCES

1. Safety and Fire Protection Guidelines, Section 9.13 Respiratory Protection.
2. OSHA Respiratory Protection Standard CFR 29 1910.134.
3. NIOSH Publication 76-189, "A Guide to Industrial Respiratory Protection."
4. ANSI Standard Z88.2-1980, "Practices for Respiratory Protection."
5. Haskell Lab Monograph, "Respirator Cartridge - Guidelines and Evaluation."
6. Engineering Standards SIH, S8H, S9H, and S2T.
7. Percival, L. F., "Escape Respirators," Haskell Lab Report 327-82; MR-5468-001 (June 1982).
8. Percival, L. F., "Escape Respirators," Part II, Haskell Lab Report 665-8L; MR-5391-001 (October 1982).
9. Kayser, J. M. and Fisher, F.M., "Escape Respirator Study," Haskell Lab Report 573-83; MR-5526 (January 1984).

Portions printed in red are from OSHA regulations, Section 1910.134



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DUP 0960581

TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONTD 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 S.1.4 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'Aonzo, C. A., and Zapp, J. A., "Modern Occupational Medicine," Chapter 7, "Protective Clothing for the Chemical Industry," Lee and Febiger, Philadelphia (1980). 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 9826-TX
Houston, TX 77001

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7-4-66 100 - Attachment Supplying Foundation

Method of operation	Self-Contained Type		Demand Type	Supplied-Air Respirator		Remarks
	Rebreathing†			With Blower (Type A Supplied-Air Respirator)	Without Blower (Type B Supplied-Air Respirator)	
Pure oxygen from high pressure cylinders is added to a closure circuit system which restricts rebreathed air. C_2 is absorbed.		Air from high pressure cylinders (normally 2000 to 2200 psi) supplied to the facepiece through a hose which restricts rebreathed air. C_2 is absorbed.	Respirable air is forced through a large-diameter flexible hose by a hand blower or a bellows (U. S. Bureau of Mines has schedule with electric motor on blower.)	Respirable air is drawn through a large flexible hose by wearer's breathing effort.	Continuous Flow Air-Line Respir Intermittent Flow Air-Line Respir Demand Close Air-Line Respir	Source of air attached by small hose to demand valve actuated by slight negative pressure when wearer inhales Pressurized air supplied through a small-diameter hose to half-mask facepiece, full facepiece, or a loose fitting helmet or hood.
Required under conditions immediately dangerous to life and at distances over 300 ft from a source of respirable air-protection for limited periods			Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.		Limits set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods. Detachable to protect head and face from flying particles (also eye bleeding, spraying of molten air or paint)
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 an oxygen content. Absorption through the skin or skin irritation are possible limitations. Wearer must return to fresh air by retracing route. An uncontaminated supply of fresh air must be secured	See limitations for Type A work. Not for emergency situation where inhalation resistance exceeds 2.5 in. H_2O or where exhalation resistance exceeds 1 in. H_2O . Hose must be fitted with a flow (200) mesh SST screen, and shall be belted 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. Route must be retraced. Absorption through the skin or skin irritation are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an irrespirable atmosphere (See 5.1.4)
		Approved for 30 min only. Scott Air Pak is an example.	Blower must permit free entrance of air when it is not operating. Helper should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A blower 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 belt regarding helper and harness	Bulky to wear Nonleakable hose should be used if operating pressure is greater than 5 psi (see 5.3.4).	Air supplied to hood covering the whole head and sometimes the torso Air supplied to the wearer and detached rapidly in an emergency. See STH on air-distribution system
			* Pressure demand masks maintain the facepiece under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmosphere			Helmets or hoods are not used with this respirator. See STH on air-distribution system

(d) Closed circuit oxygen generating type equipment is not approved for use

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

Table 1C - Air Purifying Respirators

(Noted for use in oxygen-deficient atmospheres or where the contaminant is, or might be, immediately dangerous to life)

Method operation	Chemical-Filter Type		Self-Rescue Mouthpiece Respirator	Mechanical-Filter Type Respirators	Combination Chemical and Mechanical Filter Respirators
	Canister Gas Mask (Full Facepiece Respirator)	Chemical Cartridge Respirator (Half Mask 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. Exhaled breath goes to atmosphere			Respirators remove particulate matter such as dust, fumes, or mist, 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 greatest 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			Practical limit of concentration is determined by time required to plug filter but if use 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 abrasive breathing 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.	Limited to use in atmospheres containing at least 19.5% oxygen and to be minimum gas concentration for which the specific cartridge is recommended (generally 8 1/2% minimum or less). Cannot be used in atmospheres irritating to the skin or eyes.	See 8.3.6.	See 8.3.7. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. * MDSH approves mechanical filter respirators according to the following classification: (1) *Pneumotoxics - Producing and Nuisance - Dust Respirators (2) *Toxic - Dust Respirators (not significantly more toxic than lead) (3) *Dust Respirators (not significantly more toxic than lead) (4) *Toxic Respirators (not significantly more toxic than lead)	

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

Fume - Solid dispersoids formed when vapors are condensed from heated solids and other substances.

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

** As approved under (2) and some under (4) are approved for (1) and (2). Some approved under (4) are approved for protection of dusts that are not significantly more toxic than lead.

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RESPIRATORY PROTECTIVE EQUIPMENT

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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 5.1.4) Not immediately dangerous to life	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus Air-line respirator Hose mask without blower Chemical-cartridge respirator
Particulate contaminant Immediately dangerous to life (see 5.1.4) Not immediately dangerous to life	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus Mechanical filter respirator Air-line respirator Alarm-blowing respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 5.1.4) Not immediately dangerous to life	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus 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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DUP 0960585

RESPIRATORY PROTECTIVE EQUIPMENT

SAFETY ENGINEERING STANDARD

ISSUED	JAN 1984
THIS PAGE REVISED	OCT 1983
STANDARD REAFFIRMED	OCT 1983

S 2 H

Page 1 of 9

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

1.1 This standard does not apply for exposure to airborne radioactive contamination for which special consideration may be necessary.

1.2 Du Pont policy and stated public position on engineering controls and respirators is that "each employer's personal work environment should be maintained at a safe exposure level through implementation of cost effective engineering controls augmented as necessary by personal protective equipment and/or work practice controls."

1.3 This standard provides information for the selection, use, and care of respiratory protective equipment (respirators). The term "respirator" in this standard is defined inclusively and applies to atmosphere-supplying and air-purifying devices that provide breathable air to the worker within the limits of the equipment, whatever the source of air.

2. GENERAL

2.1 Each site should have a properly-trained individual responsible for the respirator program.

2.2 Respirator training is available through ESD sponsored courses. References (1) through (5) outline requirements for a proper respirator program. The individual responsible for the site program should be familiar with Ref (1) through (6).

2.3 Engineering Standard S911 outlines requirements for canister/cartridge use for air-purifying respirators, S811 for fit testing, and S111 for air distribution.

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

2.5 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 areas where workers may be exposed above safe limits. See S2T for information on exposure limits.

2.6 Each location shall develop written procedures describing the selection, use, and maintenance of respirators.

Portions printed in red are from OSHA regulations, Section 1910.134.

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.

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 when available.

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 is 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. 80-144 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

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

4. USES AND LIMITATIONS

4.1 Users of respiratory protective equipment shall have medical approval. This should be documented in each person's medical record.

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. This is because these respirators do not supply oxygen and therefore do not protect against possible oxygen deficiencies. Another reason for this

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NOTE

requirement is that these masks are not intended for use against unlimited or unknown concentrations of contaminants.

4.2.1 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.

4.2.2 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. Portable oxygen and toxic-gas detectors are discussed in S3T.

4.3 Air-purifying respirators should not be used in atmospheres immediately dangerous to life and health or when the contaminant has poor warning properties, except as noted in S9H.

4.4 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.

4.5 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 Many toxic gases and vapors are flammable and the user could be exposed to a potential fire or explosion. 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 may be 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 - 5.1.8.1) and Tables 1 and 2 should be considered. Engineering Dept Report, Accemin No. 15167 "Respirator Selection," 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
- 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 potentially irrespirable atmospheres.

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 upon moderate work rates. Operating time is reduced by increased respiration required by heavy exertion.

5.1.4 Only positive pressure 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 and health (Table 1A). 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.

Portions printed in "red" are from OSHA regulations, Section 1910.1000 series.



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5.1.5 Escape masks are used only while the wearer leaves a contaminated area. For escape or emergency purposes from unknown concentrations of extremely hazardous atmospheres, 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). 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 5.6T for data on direct reading portable oxygen analyzers

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

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 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.

* Available from Compressed Gas Association Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202

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

6.7 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.

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.

7.3.1 Training in the use and fit testing of respirators is an essential part of a respiratory protection program and is specified in OSHA regulations. Training shall be completed prior to fit testing. See SMH for fit testing protocols. Additional references are listed in section 9.

7.3.2 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 less protection. When purchasing new air-supplied, self-contained or combination type, pressure demand should be specified.

7.4 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, irritation, or taste, 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. (See also section 5 of S911.)

7.5 A proper seal cannot be established if the temple bars of eyeglasses 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:

- a. Using only air with low moisture content
- b. Installing a noseclip in the mask
- c. Thoroughly drying masks after cleaning
- d. Keeping SCBAs in a warm location between uses (if practical)
- e. Visually checking pressure gauges for low air supply
- f. 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 (-18°C), however, antifog compounds 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.



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7.10 Persons required to wear respirators must be clean-shaven in the area of the respirator seal, except as noted in Safety and Fire Protection guideline 9.13.

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 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. Also, only hose approved for that respirator may be used.

8. CARE

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

8.2 Procedure 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 air-supplied units at most plants, it is preferable that parts or 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 daily.

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. The cylinder pressure shall be checked monthly and recharged

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

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. Air-line 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 S1H 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-Cantridge Respirators

8.3.6.1 Cartridges should be discarded after a predetermined period of use. See S9H.

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 at the end of the work shift. Some mechanical filter respirators use recleanable filters, in which case the filters are cleaned when the respirator is being serviced.

9. REFERENCES

1. Safety and Fire Protection Guidelines, Section 9.13 Respiratory Protection.
2. OSHA Respiratory Protection Standard CFR 29 1910.134.
3. NIOSH Publication 76-189, "A Guide to Industrial Respiratory Protection."
4. ANSI Standard Z88.2-1980, "Practices for Respiratory Protection."
5. Haskell Lab Monograph, "Respirator Cantridge - Guidelines and Evaluation."
6. Engineering Standards S1H, S8H, S9H, and S2T.

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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 S1.4 and the air-supplied suit should be kept with a slight positive pressure. In any case the air supply should not be less than 15 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 Zapp, J. A., "Modern Occupational Medicine," Chapter 7, "Protective Clothing for the Chemical Industry," Lee 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 9426-714
Houston, TX 77061

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RESPIRATORY PROTECTIVE EQUIPMENT

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TABLE 1 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT (CONT'D ON PAGE 8)
Table 1B - Atmosphere Supplying Respirators

Method of operation	Demand Type	With Blower (Type A Supply-Air Respirator)	Without Blower (Type B Supply-Air Respirator)	Supply-Air Respirator		
				Continuous Flow Air-Line Resp	Alternate Breathing Resp	Demand Chase Air-Line Resp
Pure oxygen from high pressure cylinders is added to a closure circuit system which recirculates exhaled air. CO ₂ is absorbed.	Air from high pressure cylinders (normally 2000 to 2200 psi) supplied to facemask through a hose which recirculates exhaled air. CO ₂ is absorbed.	Respirable air is forced through a large-diameter flexible hose by a hand blower to a full facemask. (U. S. Bureau of Mines has suitable with electric motor on 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 facemask, full facemask, or a loose fitting helmet or hood.	Sound of air inhaled by mask hose to demand valve actuated by slight negative pressure when wearer inhales.	Sound of air inhaled by mask hose to demand valve actuated by slight negative pressure when wearer inhales.
Required under conditions immediately dangerous to life and at distances over 300 ft from a source of respirable air protection for limited periods.	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.	Up to 300 ft of travel from source of respirable air. Protection provided for an unlimited period.	Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.	Limit set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.	Due to the fact that face from typing particles (dust, shrapnel, etc.) spraying of molten air or paint.	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. Rescues must be relayed. Absorption through the skin or skin irritations are possible limitations. Combination air-line respirator and self-contained breathing apparatus may be used in an irrespirable atmosphere. (See 5.1.4.)
Approved for 30 min only. Scott Air Pak is an example.	* Pressure demand masks maintain the facemask under a slight positive pressure during the entire breathing cycle to further protect against leakage of toxic atmospheres.	Blower must permit free entrance of air when it is not operating. Helper should be assigned with no other duties than to observe the man in the hazardous atmosphere, attend to the life line and, in emergency, operate the blower. A blower 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 5.1.4).	Aluminum or hood can be attached to the whole head and sometimes the torso in an emergency. See 5.1.4 on air distribution system.	Aluminum or hood can be attached to the whole head and sometimes the torso in an emergency. See 5.1.4 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 7)
Table 1C - Air Purifying Respirators

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

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Method 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-Rescue 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 in the canister or cartridge. Exhausted breath goes to atmosphere.			Respirators remove particulate matter such as dust, fumes, or mist, 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 greatest 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 10.5% oxygen and to be maximum gas concentration for which the specific cartridge is recommended (generally 2% maximum or less).	Limited to use in atmospheres containing at least 10.5% oxygen and to the maximum gas concentration for which the specific cartridge is recommended (generally 2% maximum 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 breathing 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 Z13.1	See 8.3.6.		See 8.3.7. Fluorescence of the particles to be filtered out of the air controls the fineness 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) "Protonicant" - Producing and Nuisance - Dust Respirators (2) "Toxic" - Dust Respirators that significantly more toxic than lead (3) "Dust" - Dust Respirators that significantly more toxic than lead (4) "Toxic" - Dust Respirators that significantly more toxic than lead	

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

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

Mist - Liquid dispersoids formed when liquid is disintegrated as in spraying, cutting, and atomizing.

** All approved under (2) and some under (4) are approved for (1) and (2). Some approved under (4) are approved for protection of dusts that are not significantly more toxic than lead.

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RESPIRATORY PROTECTIVE EQUIPMENT

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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 5.1.4)	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 5.1.4)	Self-contained breathing apparatus Combination air-line respirator and self-contained breathing apparatus
Not immediately dangerous to life	Mechanical filter respirator Air-line respirator Aerosol-blasting respirator Hose mask without blower
Combination gaseous and particulate contaminant Immediately dangerous to life (see 5.1.4)	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 should be used in the less hazardous situations.

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