

RESPIRATORY PROTECTION

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1. SCOPE

This standard sets forth accepted practices for respirator users. It provides guidance on the proper selection, use, and care of respirators, and describes the essentials of a respiratory protection program. The standard conforms with regulations promulgated under the Occupational Safety and Health Act (OSHA) CFR 29, Section 1910.134. Specific state and foreign safety and health standards may require special consideration.

2. DEFINITIONS

AIR-PURIFYING RESPIRATOR - A respirator designed to remove contaminants from ambient air prior to its inhalation.

APPROVED RESPIRATOR - A respirator tested and listed as satisfactory in the United States by the Mine Safety and Health Administration, U.S. Department of Labor, and the National Institute for Occupational Safety and Health, or a government agency or nationally recognized scientific body in non-U.S. locations.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH - Any hazardous atmosphere that poses an immediate threat to life or health or that poses an immediate threat of severe exposure to contaminants such as radioactive materials which are likely to have adverse delayed effects on health.

NEGATIVE PRESSURE RESPIRATOR - A respirator in which the air pressure inside the facepiece is positive during exhalation in relation to the air pressure of the outside atmosphere and negative during inhalation in relation to the air pressure of the outside atmosphere.

POSITIVE PRESSURE RESPIRATOR - A respirator in which the air pressure inside the respiratory- inlet covering is positive in relation to the air pressure of the outside atmosphere during exhalation and inhalation.

QUALIFIED PERSONNEL - A qualified person is one who has completed a training course approved by the American Industrial Hygiene Association or NIOSH, or sponsored by an educational institution recognized for its training in the occupational health and safety areas. In lieu of formal training, a qualified person may have worked under the direction of a trained industrial hygienist and demonstrated the knowledge and understanding needed to administer the respiratory protection program.

RESPIRATOR - A device designed to protect the wearer from inhalation of harmful atmospheres.

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SHALL - Denotes a requirement.

SHOULD - Denotes a recommendation.

3. POLICY

3.1 Priorities or Control Methods. Control of potentially harmful occupational exposures shall be accomplished as far as practical or feasible by work practices, or engineering control measures. When these methods of control are not practical or feasible, such as in emergency or demolition activities, or while they are being developed and instituted, employees' health shall be protected by the use of appropriate respirators. Alcoa shall provide respirators as needed for protecting the health of the Alcoa employee.

4. ELEMENTS OF A RESPIRATORY PROTECTION PROGRAM

4. Elements of the program must be documented in a written respiratory protection program.

4.1 Assignment of Responsibility.

4.1.1 Respiratory Protection Administrator. Where the use of respirators is required, a respiratory protection program shall be established which shall comply with the provisions of this standard. A Respiratory Protection Administrator shall be selected from plant safety, industrial hygiene or other qualified personnel to administer and coordinate the overall plant respiratory protection program.

4.1.2 Employee Responsibility. Employees shall use the provided respiratory protection in strict accordance with the training received. They will immediately report any respirator malfunctions to the responsible persons in their departments.

4.1.3 Program Evaluation. An appraisal, including a formal self-evaluation, of the effectiveness of the respirator program shall be carried out at least annually by the Respiratory Protection Administrator. Action shall be taken to correct defects found in the program.

4.2 Respirator Selection.

4.2.1 General. The selection of a proper respirator for any given situation shall require consideration of the following factors:

- (1) The nature of the hazard.
- (2) The location of the hazardous area with respect to a safe area having respirable air.

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- (3) The period of time for which respiratory protection may be provided.
- (4) The physical characteristics, functional capabilities, and limitations of respirators of various types.
- (5) The respirator protection factors and respirator fit.

4.2.2 Nature of Hazard. The following factors concerning the nature of the hazard requiring the use of respirators shall be considered in respirator selection:

- (1) Type of hazard
 - (a) oxygen deficiency
 - (b) contaminant
- (2) Physical properties
- (3) Chemical properties
- (4) Physiological effects on the body.
- (5) Actual or potential concentration of a toxic material
 - (a) Average
 - (b) Peak
- (6) Established permissible exposure limit or peak concentration of a toxic material.
- (7) Whether the hazard is an immediately dangerous to life or health concentration of a toxic material.
- (8) Warning properties.

4.2.3 Location of Hazardous Area. The location of the hazardous area with respect to a safe area having respirable air shall be considered in selecting a respirator, since this will permit planning for the escape of workers if an emergency occurs, for the entry of workers to perform maintenance duties, and for rescue operations.

4.2.4 Duration of Respirator Use. The period of time that a respirator must be worn is an important factor that shall be taken into account in selecting a respirator. Consideration shall be given to the type of respirator application, such as for routine, nonroutine, emergency, or rescue use. It would not be desirable, for example, to select respirators that are heavy or that offer high resistance to breathing for routine wearing for many hours each day.

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4.2.5 Respirator Characteristics. The physical characteristics, the functional capabilities, and the performance limitations of the various types of respirators shall be considered in selecting a respirator.

4.2.6 Assigned Protection Factor. The expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Multiplying the permissible exposure limit or ceiling concentrations, whichever is applicable, by the assigned protection factor gives the maximum concentration of the contaminant for which the respirator should be used.

4.2.6.1 Workplace Protection Factor An experimentally determined measure of protection afforded by a respirator under conditions of use. It is defined as the ratio of the concentration of airborne contaminant outside the respirator to the concentration inside the respirator as measured during actual use situations.

4.2.6.2 Fit Factor The ratio of the concentration of airborne contaminant outside the respirator to the concentration inside the respirator determined under laboratory conditions.

A protection factor is a selection and use guide, and should only be used in conjunction with the selection criteria outlined in this standard and the advice of the Respiratory Protection Administrator. (See Appendix I for list of respirator protection factors.)

4.2.7 Approved Respirators. Approved respirators shall be used when they are available. Any modification that is not authorized by the approval agencies of an approved respirator voids the approval.

4.2.8 Workplace Environmental Measurements. Selection of a proper respirator should be based on the concentration of the respiratory hazard as measured in the work area. Air samples should be collected periodically during respirator use to ensure that continued use of the selected respirator remains appropriate.

4.3 Training. The supervisor, the person issuing respirators, and the respirator wearers shall be given adequate training by a qualified person(s) to ensure the proper use of respirators.

4.3.1 Training Content. To ensure the proper and safe use of a respirator, the minimum training of each respirator wearer shall include the following elements:

- (1) The reasons for the need of respiratory protection.
- (2) The nature, extent, and effects of respiratory hazards to which the person may be exposed.

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- (3) An explanation of why engineering controls are not being applied or are not adequate and of what effort is being made to reduce or eliminate the need for respirators.
- (4) An explanation of why a particular type of respirator has been selected for a specific respiratory hazard.
- (5) An explanation of the operation, and the capabilities and limitations of the respirator selected.
- (6) Instruction in inspecting, donning, checking the fit of, and wearing the respirator.
- (7) An opportunity for each respirator wearer to handle the respirator, learn how to don and wear it properly, check its seals, wear it in a safe atmosphere.
- (8) An explanation of how maintenance and storage of the respirator is carried out.
- (9) Instructions on how to recognize and cope with emergency situations.
- (10) Instructions as needed for special respirator use.
- (11) Regulations concerning respirator use.

4.3.2 Refresher Training. The length of time between training sessions is dependent upon the frequency of use and the complexity of the respiratory protection equipment. Minimum frequency of retraining for infrequent use of nuisance dust respirators should be every year.

4.4 Medical Evaluation. A physician shall determine what physiological conditions are pertinent for the wearing of different types of respirators, and whether or not a person may be assigned to a task requiring the use of a respirator. This determination should be reviewed annually.

4.5 Fit-Testing. Each wearer of a tight-fitting face piece respirator shall pass a qualitative or quantitative fit-test to assure satisfactory fit on an annual basis. Each respirator wearer shall be required to check the seal of the respirator by appropriate means prior to entering a potentially hazardous atmosphere.

4.5.1 Test Method. A qualitative or quantitative respirator fit test shall be used to determine the ability of each individual respirator wearer to obtain a satisfactory fit with all respirators which have tight-fitting face pieces, both positive and negative pressure. The results of qualitative or quantitative fit tests shall be used to select specific types, makes, and models of respirators used by individual respirator wearers.

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Fit Test Protocols. Quantitative fit test protocols used shall insure a fit factor of at least 10 times the assigned protection factor. Qualitative protocols used shall follow validated procedures. The tests shall be designed to assess fit factors 10 times greater than the assigned protection factor. NOTE: Attached are currently acceptable qualitative fit test protocols which can be followed. These protocols are subject to revision.

4.5.2 Facial Hair. A respirator equipped with a facepiece shall not be worn if facial hair comes between the sealing periphery of the facepiece and the face or if facial hair interferes with valve function.

4.6 Respirator Maintenance. Respirator maintenance and inspection shall be performed regularly. Maintenance shall be carried out on a schedule which ensures that each respirator wearer is provided with a respirator that is clean and in good operating condition.

4.6.1 Cleaning and Sanitizing. Each respirator shall be cleaned and sanitized to ensure that the respirator wearer is provided with a clean and sanitized respirator at all times. A respirator issued for other than continuous personal use by a particular worker, such as with routine, non-routine, emergency, or rescue use, shall be cleaned and sanitized after each use.

4.6.2 Inspection. Each respirator shall be inspected routinely before and after use. A respirator shall be inspected by the user immediately prior to each use to ensure that it is in proper working condition. After cleaning and sanitizing, each respirator shall be inspected to determine if it is in proper working condition, if it needs replacement of parts or repairs, or if it should be discarded.

Each respirator stored for emergency or rescue use shall be inspected at least monthly. Respirator inspection shall include a check for tightness of connections; for the condition of the respiratory-inlet covering, head harness, valves, connecting tubes, harness assemblies, filters, cartridges, canisters, end-of-service life indicator, and shelf life date(s); and for the proper function of regulators, alarms, and other warning systems.

Each rubber or other elastomeric part shall be inspected for pliability and signs of deterioration. Each air and oxygen cylinder shall be inspected to ensure that it is fully charged according to the manufacturer's instructions.

A record of inspection dates, findings, and remedial actions shall be kept for each respirator maintained for emergency or rescue use.

4.6.3 Repair. Replacement of parts or repairs shall be done only by persons trained in proper respirator assembly and correction of possible respirator malfunctions. Replacement parts shall be only those designed for the specific respirator being repaired. Reducing or admission valves, regulators, and alarms shall be returned to the manufacturer or to a trained technician for repair or adjustment. Instrumentation for valve, regulator, and alarm adjustments and tests must be approved by the valve, regulator, or alarm manufacturer.

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4.6.4 Storage. Respirators shall be stored in a manner that will protect them from dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators shall be stored to prevent distortion of rubber or other elastomeric parts. Respirators shall not be stored in such places as lockers and tool boxes unless protected from contamination, distortion, and damage. Emergency and rescue-use respirators that are placed in work areas shall be quickly accessible at all times. The storage cabinet or container in which they are stored shall be clearly marked.

4.7 Recordkeeping. Records shall be maintained by the Respiratory Protection Administrator or their designee as part of the overall respiratory protection program.

4.7.1 Types of Records. Recordkeeping requirements will vary greatly with the complexity of a location's use of respirators. The following represents a minimum requirement:

- (1) Employee training session outlines and attendance records.
- (2) Results of fit-test.
- (3) Medical acceptance or rejection of an employee's use of respirators on his/her job.
- (4) Reports of monthly inspections of emergency use respirators.

4.7.2 Record Retention. Records required under this section shall be maintained for at least 40 years, or for the duration of employment plus 20 years.

4.8 Written Respiratory Protection Program. The Respiratory Protection Administrator shall prepare a written respiratory protection program which shall include, at the least, all of the provisions described in section 4 of this standard.

5. QUALITY OF RESPIRABLE AIR

5.1 Specifications for Respirable Air. Compressed air and liquid air, used for respiration shall be of high purity. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1973. This currently requires that the carbon monoxide level not exceed 20 ppm, the carbon dioxide content not exceed 1000 ppm, the condensed hydrocarbons (oil mist) not exceed 5 mg/m³, and there be no pronounced odor.

5.2 Compressed Air. Breathing air may be supplied to respirators from cylinders or air compressors.

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A breathing-air type compressor shall be used. A compressor shutoff alarm and suitable in-line air purifying sorbent bed and filters to assure breathing air quality shall also be incorporated into the system. An air-storage receiver shall also be provided to furnish the wearer with an adequate supply of escape air if the compressor fails to operate. In addition, compressor air intakes shall be situated so as to avoid the entry of contaminated air into the system.

If an oil-lubricated compressor is used, it shall have a high temperature or carbon monoxide alarm, or both. If only a high temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to ensure that it meets the specifications for respirable air.

The contents of compressed air cylinders used to provide the air supply for an airline respirator shall be tested for oxygen concentration and carbon monoxide content. The air supply in the cylinder shall be sufficient to permit completion of the work and escape.

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TABLE I - ASSIGNED PROTECTION FACTORS (a)

NEGATIVE PRESSURE RESPIRATORS

Type of Respirator	Respiratory Inlet Covering		
	1/4 Mask	Half Mask (b)	Full Facepiece
Air Purifying	5	10	50
Atmosphere Supplying			
SCBA (demand) (c)	-	10	50
Air Line (demand)	-	10	50

POSITIVE PRESSURE RESPIRATORS

Type of Respirator	Respirator Inlet Covering			
	Half Mask	Full Face	Helmet/Hood	Loose Fitting Facepiece
Powered Air Purifying	50	250	25	25
Atmosphere Supplying				
Air Line	50	1000	-	-
• Pressure Demand				
Air Line	50	1000	25	25
Continuous Flow				
Self Contained Breathing Apparatus (d)				
Pressure Demand	-	>1000	-	-
Open/Closed Circuit				

- (a) These assigned protection factors are intended to be maximum values used by Alcoa facilities. Whenever local regulations require more stringent APF, lower numbers should be used.
- (b) Includes disposable half masks and half masks with elastomeric facepieces.
- (c) Demand SCBA shall not be used for emergency situations such as fire fighting.

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- (d) Although positive pressure respirators are currently regarded as providing the highest level of respiratory protection, a limited number of recent simulated workplace studies concluded that all users may not achieve protection factors of 10,000. Based on this limited data, a definitive assigned protection factor could not be listed for positive pressure SCBA's. For emergency planning purposes where concentrations can be estimated, an assigned protection factor of no higher than 10,000 should be used.

Note: Assigned protection factors are not applicable for escape respirators. For combination respirators e.g. air line respirators equipped with an air purifying filter, the mode of operation in use will dictate the assigned protection factor to be named.

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1. SCOPE

This standard sets forth accepted practices for respirator users. It provides information and guidance on the proper selection, use, and care of respirators. The standard conforms with regulations promulgated under the Occupational Safety and Health Act (OSHA) CFR 29, Section 1910.134, as published in the Federal Register of October 18, 1972.

2. GLOSSARY OF TERMS

AIR CONTAMINATION LEVEL -- The standards of contaminant levels prescribed by the Secretary of Labor in accordance with the provisions of Section 1910.93 of the Occupational Safety and Health Act of 1970.

AIR-LINE RESPIRATOR - An air-supplied respirator wherein respirable air is supplied to a respiratory-inlet covering by means of a small diameter hose connected to a positive pressure supply of respirable air.

AIR-PURIFYING RESPIRATOR - A respirator designed to remove contaminants from ambient air prior to its inhalation.

APPROVED RESPIRATOR - A respirator tested and listed as satisfactory by the Bureau of Mines, U. S. Department of the Interior, and the National Institute of Occupational Safety and Health, U. S. Department of Health, Education and Welfare.

ATMOSPHERE-SUPPLYING RESPIRATOR - A respirator wherein the respirable atmosphere is supplied to the wearer from a source independent of the ambient air.

EXHALATION VALVE - A device that allows exhaled air to be expelled from a respirator while preventing outside air from entering the respirator through it.

FACEPIECE - A tight-fitting device that covers the wearer's nose and mouth making an airtight fit with his face and which may also cover his eyes. A head harness usually is included in the assembly of the facepiece.

FILTER - A medium that removes particles from air passing through it.

FULL FACEPIECE - A tight-fitting device that covers the wearer's nose, mouth, eyes and face and which makes an airtight fit with his face. A head harness usually is included in the assembly of the facepiece.

FUME - Solids produced from physiochemical reactions such as combustion, sublimation,

generally of metallic origin, and having individual sizes well below one micrometer in diameter.

HALF-MASK FACEPIECE - A tight-fitting device that covers the wearer's nose and mouth and which makes an airtight fit with his face. A head harness usually is included in the assembly of the facepiece.

HEAD HARNESS - A device that holds a facepiece securely in place on the wearer's face.

HELMET - A loose-fitting rigid device that covers the face or which may completely cover the head and neck and sometimes a portion of the shoulders.

HOOD - A loose-fitting device of nonrigid construction that completely covers the head, neck, and portion of the shoulders.

INHALATION VALVE - A device that allows respirable air to enter the respiratory-inlet covering of a respirator and which prevents air from leaving the covering through the intake part.

MIST - A liquid condensation particle with sizes ranging from submicroscopic to visible or macroscopic.

OXYGEN-DEFICIENT ATMOSPHERE - Ambient air having less than 19.5% by volume of oxygen.

PARTICULATE MATTER - Finely divided solid or liquid particles. A suspension of particulate matter in air is commonly known as an aerosol.

POWERED PARTICULATE-FILTER RESPIRATOR - An air-purifying respirator that employs a blower to pass ambient air through a filter that removes particles and supplies respirable air to a respiratory-inlet covering.

RESISTANCE - Opposition to the flow of air.

RESPIRABLE DUST - A dust particle aerodynamically capable of reaching the terminal airways of the lung.

RESPIRATOR - A device designed to protect the wearer from inhalation of harmful atmospheres.

REUSABLE PARTICLE-FILTER RESPIRATOR - An air-purifying respirator which removes particles from ambient air prior to its inhalation and which is designed so that the filter may be replaced or cleaned and the respirator reused.

SELF-CONTAINED BREATHING APPARATUS - An atmosphere-supplying respirator wherein a

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supply of air, oxygen or oxygen-generating material is carried by the wearer. The respirator provides respiratory protection in atmospheres immediately hazardous to life or health including atmospheres deficient in oxygen.

SELF-RESCUE MOUTHPIECE RESPIRATOR - An air-purifying respirator designed for self-rescue from immediately dangerous atmospheres of gases and vapors. A nose clip is used to prevent nasal breathing.

SHALL - Denotes a requirement.

SHOULD - Denotes a recommendation.

SINGLE-USE PARTICULATE-FILTER RESPIRATOR - An air-purifying respirator which removes particles from ambient air prior to inhalation and which is designed to be discarded after a single use or after one day's use.

VAPOR - The gaseous state of a substance that is solid or liquid at ordinary temperatures and pressures.

3. PROGRAM ADMINISTRATION

3.1 Objective. In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used.

3.2 Alcoa Responsibility. Respirators shall be provided by Alcoa when such equipment is necessary to protect the health of the employee. Respirators shall be applicable and suitable for the purpose intended. Where the use of respirators is required, a respiratory protective program shall be established which shall comply with the provisions of this standard.

3.3 Plant Administration. The plant safety and industrial hygiene personnel, in cooperation with the Medical Department, shall oversee the plant respiratory protection program. Specific responsibility for the program within a department shall be vested in one individual, the Departmental Coordinator, who will coordinate his efforts with similar appointees of other departments to meet the requirements of the overall plant respiratory protection program.

3.4 Employee Responsibility. The employee shall use the provided respiratory protection in strict accordance with instructions and training received. Also he will immediately report any malfunction of the respirator to the responsible person of his department.

4. REQUIREMENTS OF A RESPIRATORY PROTECTION PROGRAM

4.1 Procedures. Written standard operating procedures governing the selection and use of respirators shall be established.

4.2 Assessment of Work Atmosphere. Appropriate surveillance of work area conditions and degree of employee exposure shall be maintained.

4.3 Selection. Respirators shall be selected on the basis of hazards to which the employee is exposed.

4.4 Approved Respirators. Approved respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by competent authorities.

4.4.1. Under OSHA regulations all respirators will eventually carry the approval of both the U. S. Bureau of Mines and the National Institute of Safety and Health (NIOSH). It will be some time before manufacturers will obtain approvals under the current schedules. Until such times, the Bureau of Mines approvals under the older schedules shall be used.

4.5 Personal Use. Where a respirator is required to be used on a regular basis it shall be assigned to the employee for his exclusive use.

4.6 Instruction and Training. Employees shall be instructed and trained in the proper use and limitations of respirators.

4.7 Maintenance and Inspection. Respirators shall be regularly maintained in proper condition, cleaned and sanitized. Those issued to the employee for his exclusive use should be cleaned by him after each day's use, or more often if necessary. Those used on a one-time basis shall be returned to the cleaning station where they will be sanitized prior to reissue.

Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

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4.8 Storage. Respirators shall be stored in a convenient and clean location.

4.9 Program Evaluation. There shall be regular evaluation by the Departmental Coordinator to determine the continued effectiveness of the program.

5. CLASSIFICATION OF RESPIRATORY HAZARDS

5.1 Hazards. Respiratory hazards for the purpose of this standard are classified as follows:

1. Oxygen deficiency
2. Gas and vapor contaminants
 - a. Immediately dangerous to life or health
 - b. Not immediately dangerous to life or health
3. Particulate contaminants
 - a. Immediately dangerous to life or health
 - b. Not immediately dangerous to life or health

6. SELECTION OF RESPIRATORS

6.1 Requirements. When there is doubt about the concentration of oxygen or hazardous material present in the atmosphere, only those respirators listed as suitable in oxygen deficient environments shall be used. Any erring in the selection of respirators shall be on the safe side.

The selection of a proper respirator for any given situation requires consideration of the following factors:

1. Nature of the hazard (Section 6.2)
2. Extent of the hazard (Section 6.3)
3. Work requirements and conditions (Section 6.4)
4. Characteristics and limitation of available respirators (Section 7)

6.2 Nature of the Hazard. The chemical and physical properties, toxicity and concentration of the hazardous material shall be considered in respirator selection.

Evaluation of the atmospheric contaminant concentration to which a person wearing a respirator may be exposed is an integral part of an effective respirator program. Air sampling data are important in the selection of the proper respirator and should include the identification, toxicity and concentration of the contaminant in the breathing zone.

In an air monitoring program, sampling should be carried out over at least one cycle of operation and, preferably, over several cycles when production activity varies. Normally, samples are collected at the worker's breathing zone.

6.3 Extent of Hazard. The extent of the hazard in space and time and its physical location shall be considered in respirator selection. This includes the length of time protection will be needed, entry and exit times, accessibility of a fresh air supply, and the ability to use air lines or move about freely while wearing the respirator. The location of the contaminated area in respect to a possible source of respirable air requires consideration.

6.4 Work Requirements. Work time usually determines the length of time for which respiratory protection is needed, including the time necessary to enter and leave a contaminated area. A self-contained breathing apparatus or chemical-cartridge respirator provides respiratory protection for relatively short periods, whereas the hose mask with blower, air-line respirator, and abrasive-blasting respirator provide protection for as long as the facepiece is supplied with adequate respirable air.

Particulate-filter respirators can provide protection for long periods, without need for filter replacement, only if atmospheric particulate loading is low. Where particulate concentrations are high, the filter will quickly load up, resulting in an intolerably high pressure drop. Therefore, for extended periods of use, the hose mask with blower and air-line respirators offer definite advantages.

Experience has demonstrated that not all persons can obtain a satisfactory facepiece-to-face seal with air-purifying respirators. Therefore, to provide an adequate facepiece-to-face seal on a variety of facial features, it may be necessary that two or more models of respirators be available. When an individual can be fitted with two or more respirators, he should be permitted to select the most comfortable one.

6.5 Guide for Selection of Respirators. Table 1 is a quick reference for the selection of respiratory protection appropriate to the type and degree of hazard. The Table provides minimal guidance, however, and shall be used along with other information from this standard and from the respirator manufacturers.

TABLE 1

GUIDE FOR SELECTION OF RESPIRATORS

Hazard	Respirator
<u>Oxygen Deficiency</u>	Self-contained breathing apparatus. Hose mask with blower. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
<u>Gas and Vapor Contaminants</u> Immediately dangerous to life or health	Self-contained breathing apparatus. Hose mask with blower. Self-rescue mouthpiece respirator (for escape only) Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Not immediately dangerous to life or health	Air-line respirator. Hose mask without blower. Air-purifying half-mask respirator with chemical cartridge.
<u>Particulate Contaminants</u> Immediately dangerous to life or health	Self-contained breathing apparatus. Hose mask with blower Air-purifying full facepiece respirator with appropriate filter. Self-rescue mouthpiece respirator (for escape only) Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Not immediately dangerous to life or health	Air-purifying half-mask respirator with filter pad or cartridge. Air-line respirator. Air-line abrasive-blasting respirator. Hose mask without blower.
<u>Combination Gas, Vapor, and Particulate Contaminants</u> Immediately dangerous to life or health	Self-contained breathing apparatus. Hose mask with blower. Self-rescue mouthpiece respirator (for escape only) Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Not immediately dangerous to life or health	Air-line respirator. Hose mask without blower. Air-purifying half-mask respirator with chemical cartridge and appropriate filter.

Note 1: For details on use of respirators in hazardous atmospheres and for descriptions, capabilities and limitations of respirators, refer to Section 7.

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**7. DESCRIPTION, CAPACITIES AND
LIMITATIONS OF RESPIRATORS**

7.1 Types of Respirators. The purpose of this section is to provide a description of the various types of respirators, their limitations and capacities for subsequent selection of suitable respiratory protection. Respirators fall into the following classification according to mode of operation:

1. Atmosphere-supplying respirators
 - a. Self-contained
 - b. Hose-mask
 - c. Air-line
 - d. Combination self-contained and hose-mask or air-line
2. Air-purifying respirators
 - a. Chemical cartridge - for gas and vapor contaminants
 - b. Filter - for particulate contaminants
 - c. Combination filter and chemical cartridge - for combination gas, vapor and particulate contaminants
3. Gas masks

7.2 Atmosphere-Supplying Respirators. Atmosphere-supplying respirators provide protection against oxygen deficiency and most toxic atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions. Section 8 details the specifications on respirable atmospheres of air and oxygen.

Except for the supplied-air suit, no protection is provided against skin irritation or against sorption of materials through the skin.

7.2.1 Self-Contained Breathing Apparatus. The self-contained breathing apparatus has no limitation as to the concentration of gaseous or particulate contaminants in which it may be worn and use is permissible in atmospheres immediately dangerous to life. Since the wearer carries his own supply of respirable atmosphere with him, he may leave the work area through any available exit. The period over which the device will provide protection is limited by the amount of air in the apparatus, the ambient atmospheric pressure (service life is cut in half by a doubling of the atmospheric pressure), and work load. A warning device shall be provided to indicate to the wearer when the service life has been reduced to a low level. Some of these devices have a short service life (few minutes) and are suitable only for escape (self-rescue) from an irrespirable atmosphere.

The chief limitations of this type of apparatus are weight and bulkiness, limited service life, and the training required for

its maintenance and safe use. The weight of these units vary from 13-40 pounds. In choosing apparatus for a particular job, consideration should be given to the effect of the location of the bulky parts and the size and weight of the device on the wearer's ability to perform the job efficiently and safely.

7.2.2 Hose Masks. The hose mask with blower is approved for respiratory protection in any atmosphere regardless of the type or consideration of contaminant, provided that enough respirable air is supplied to the wearer. The respirable air supply is not limited to the quantity the individual can carry, and the devices are light weight and simple. The wearer is restricted in movement by the hose or air-line and must return to a respirable atmosphere by retracing his route of entry. The hose or air-line is subject to being severed or pinched off.

Hose masks are furnished in two types - one with a blower, the other without. If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation. Use is permissible in atmospheres immediately dangerous to life or health. The hose mask without blower is limited to use in atmospheres from which the wearer can escape unharmed without aid of the respirator.

Both types have limitations as to the length and type of hose; the manufacturer's literature should be consulted.

7.2.3 Air-Line Respirators (Continuous Flow, Demand and Pressure-Demand Types) The demand type produces a negative pressure in the facepiece on inhalation whereas continuous flow and pressure-demand types maintain a positive pressure in the facepiece at all times and are less apt to permit inward leakage of contaminants. Air-line respirators are not approved for use in immediately dangerous atmospheres because no protection is provided if the air supply fails. However, pressure-demand or continuous-flow airline respirators with full facepiece provide the wearer with a degree of respiratory protection equal to that afforded by a positive pressure self-contained breathing apparatus as long as an adequate flow of respirable air is maintained.

The airline hose shall be protected from damage, including cutting, kinking, crushing or burning. Hose couplings shall be protected against disconnection. Trailing airline hoses shall be arranged to minimize tripping and to permit ready escape. Airline couplings shall be

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incompatible with outlets for other gas systems to prevent inadvertent servicing of airline respirators with nonrespirable gases or oxygen.

Continuous-flow airline respirators are designed for maximum comfort with a minimum airflow that will adequately protect the wearer in a non-hazardous atmosphere. However, they are capable of providing adequate airflow to protect the wearer in a hazardous atmosphere. This adequate airflow is obtained when the airflow control valve is fully open.

The recommended minimum airflows for use of airline respirators in hazardous atmospheres are five cubic feet per minute to tight-fitting facepieces and seven cubic feet per minute to loose-fitting hoods or helmets.

Supplied-air suits protect against atmospheres that affect the skin or mucous membranes or that may be absorbed through the unbroken skin. These suits are limited in use to atmospheres not immediately dangerous to life or health except under the conditions specified in Table 1. Persons wearing supplied-air suits shall follow the manufacturer's instructions concerning minimum airflow.

The wearer shall be properly trained in the use of the airline respirator and shall be well-informed of the hazard. A standard operating procedure shall be prepared for each situation for which airline respirators are employed in atmospheres immediately hazardous to life or health, and airline respirator users shall be thoroughly familiar with this procedure.

7.2.4 Combination Self-Contained and Air-Line Respirators. The equipping of an airline respirator with a small cylinder of compressed air to provide an emergency air supply qualifies the respirator for use in immediately dangerous atmospheres. See Table 1.

7.3 Air-Purifying Respirators. Air purifying respirators are designed for use in atmospheres that are not immediately hazardous to life or health, but where long term exposure to low and moderate concentrations of air contaminants may cause bodily harm. These respirators should never be used in atmospheres deficient in oxygen (less than 19.5%).

The maximum contaminant concentration against which an air purifying respirator will protect is determined by the designed efficiency and capacity of the cartridge or filter. For gases and vapors and for particles, the maximum concentration for

which the air purifying unit is designed is specified on the label. Respirators will not provide the maximum design protection specified unless the facepiece is carefully fitted to the wearer's face to prevent inward leakage. The time period over which protection is provided is dependent on cartridge or filter type, concentration of contaminant, and the wearer's respiratory rate.

The proper type of cartridge or filter shall be selected for the particular atmosphere and conditions and shall have Bureau of Mines approval.

Cartridge respirators present minimal interference with the wearer's movements. The wearer is not confined to a specific area determined by the length of hose supplying respirable air, and there are no hoses to drag or trip over.

Cartridges are easy to change, primarily screw-in type on most models or easily replaced filter pads on others. The same facepiece can be used with different cartridges for protection against a number of contaminants, both gaseous and particulate (including both), simply by using the correct cartridge(s).

7.3.1 Gas and Vapor Respirators.

Chemical cartridge respirators provide respiratory protection against certain gases and vapors in concentrations not in excess of 0.1% (1000 ppm) by volume. No protection is provided against particulate contaminants, unless specified on the cartridge label. With chemical cartridge respirators the amount of absorbent or fill is relatively small and has no warning device when exhausted. The wearer must recognize the odor of the contaminant and replace the cartridge.

7.3.1.1. The following general rules apply to the use of chemical cartridge respirators:

1. They should not be used for exposure to harmful gaseous contaminants which cannot clearly be detected by odor.
2. They should not be used against gases or vapors in concentrations which are highly irritating to the eyes.
3. They should not be used against gases and vapors which are extremely toxic in very low concentrations.
4. They cannot be used for protection against gases that are not effectively removed by the absorbant in the cartridge.

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5. Cotton facelets should not be used with this type respirator because of leaks of the gaseous contaminant around the facepiece.

7.3.2 Particulate Respirators. Mechanical filter respirators provide respiratory protection against particulate matter such as non-volatile dusts, mists and metal fumes, but offer no protection against gases and vapors. Selection of the appropriate respirator is based on the type, toxicity and particle size of the particulates. These respirators shall not be used for shot and sand blasting operations. For these operations abrasive-blasting respirators shall be used.

With these filters, increased resistance to breathing indicates a plugging of the filter and the time to replace the filtering unit.

Note: A single use filter respirator has been given both U. S. Bureau of Mines and NIOSH approval under the new schedule for respiratory protection against pneumoconiosis and fibrosis producing dusts including but not limited to aluminum, asbestos, coal, flour, iron ore or free silica.

7.4 Combinations of Gas and Vapor and Particulate Respirators. Combinations of chemical cartridge and mechanical filter respirators provide protection where exposure is both gaseous and particulate. Respirators with independently replaceable mechanical filters are preferred for this type because the particulate filter normally plugs before the chemical cartridge is exhausted. One combination mechanical-chemical filter respirator employs a back mounted filter element and is especially suited for spray painting and welding operations where the air contaminant is concentrated in front of the worker.

7.5 Gas Masks. The use of gas masks with air purifying canisters as respiratory protective devices should be discontinued as soon as the current supply of canisters is exhausted.

When gas masks are used in an emergency, the atmosphere in which they are used may unknowingly be deficient in oxygen or contain higher concentrations of the contaminant than specified for the air-purifying canister (nominally a maximum of 2% by volume). Also the service life of a canister depends upon a number of factors, not only the duration of usage and the concentration of the contaminant, but also the breathing rate of the wearer and the temperature and humidity of the atmosphere.

Since these exposure conditions are subject to wide variations, it is most difficult to estimate the safe service life of a gas mask canister. Furthermore, there are a number of types of canisters available, and each is intended to be used for protection against specific contaminants. In emergency situations it is too easy to choose a mask with an improper canister.

An atmosphere-supplying respirator is the recommended replacement for a gas mask.

8. RESPIRABLE AIR AND OXYGEN

8.1 Specifications for Respirable Air and Oxygen. Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity. Oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. This currently requires that the carbon monoxide level not exceed 20 ppm, the carbon dioxide content not exceed 1000 ppm and condensed hydrocarbons not exceed 5 mg/m³ and there be no pronounced odor.

8.2 Compressed Air. Breathing air may be supplied to respirators from cylinders or air compressors.

The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing-air type compressor shall be used. An air-storage receiver shall also be provided to furnish the wearer with an adequate supply of escape air if the compressor fails to operate. A compressor shutoff alarm and necessary aerosol and vapor and gas filters shall also be incorporated into the system.

If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications for respirable air.

The cylinder containing the air supply for an airline respirator shall be tested for oxygen concentration and carbon monoxide content and shall be respirable. The air supply in the cylinder shall be adequate for completion of the work and escape.

8.3 Compressed Oxygen. Compressed oxygen shall not be used in supplied-air respirators or in open-circuit self-contained breathing apparatus that have previously used



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compressed air. Compressed air might contain low concentrations of oil. When high-pressure oxygen passes through an oil- or grease-coated orifice, an explosion or fire may occur.

9. TRAINING AND EDUCATION IN PROPER USE OF RESPIRATORY PROTECTION DEVICES

9.1 Training and Education. For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Minimum training shall include the following:

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

9.2 Instructions for Use. Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly. It should be noted that an improper fit can be caused by a growth of beard, sideburns, a skull cap, temple pieces on glasses and absence of one or both dentures.

Persons using air-line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres.

A standby man or men with suitable self-contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

9.3 Facepiece Fit Tests. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece-fitting instructions. Two simple field tests are described:

1. Positive Pressure Test

Close the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires that the wearer first remove the exhalation valve cover and then carefully replace it after the test.

2. Negative Pressure Test

Close off the inlet opening of the cartridge(s) by covering with the palm of the hand(s) or by replacing the seal(s), inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is probably satisfactory.

To check the fit of a respirator equipped with a high-efficiency particulate filter, an irritant smoke tube, filled with stannic chloride-impregnated pumice, produces a very irritating smoke when air is blown through it. The smoke is directed at the facepiece seal and leakage is indicated by irritation of the nose and throat.

10. MAINTENANCE AND CARE OF RESPIRATORS

10.1 Program. A program for maintenance and care of respirators shall be adjusted to the type of plant, working conditions and hazards involved. Equipment shall be properly maintained to retain its original effectiveness. The Departmental Coordinator shall have the responsibility for implementing the following basic services:

1. Inspection for defects
2. Cleaning and sanitizing
3. Repair
4. Storage

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10.2 Respirator Inspection. The respirator shall be inspected routinely before and after each use by the employee to whom it has been assigned. A respirator that is not routinely used, but is kept ready for emergency use, shall be inspected after each use and at least monthly to assure that it is in satisfactory working condition.

Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tube and cartridges. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration.

The Departmental Coordinator shall keep a record of inspection dates and findings for respirators maintained for emergency use.

10.3 Cleaning and Sanitizing. Routinely used respirators shall be cleaned and sanitized as frequently as necessary to insure that proper protection is provided for the wearer. Each worker should be briefed on the cleaning procedures. Respirators maintained for emergency use shall be cleaned and sanitized after each use.

10.3.1 Method of Cleaning and Sanitizing. The following description is the recommended method of cleaning and sanitizing respirators:

1. Disassemble respirator.
2. Clean and disinfect facepiece and breathing tube in warm (120 F) cleaner-disinfectant solution. This may be prepared from quaternary-ammonia, detergent and alkaline-salt compounds that are available from respirator manufacturers and other sources. Rinse thoroughly in warm water since wearer may be allergic to quaternary-ammonia compounds.

or

Clean facepiece and breathing tube in a warm (120 F) liquid detergent solution, rinse in warm water, then immerse for 2 minutes in one of the following:

- a. Hypochlorite solution (50 ppm chlorine) prepared by diluting concentrated hypochlorite solution (5 percent chlorine) with water.

- b. Aqueous iodine solution (50 ppm iodine) prepared by dissolving soluble iodine compound in water.
Note: 50 ppm is equivalent to .005 percent. Chlorine and iodine solutions stronger than 50 ppm may damage rubber parts.

3. Air dry in a clean place.

10.3.2 Responsibility. The Departmental Coordinator shall be responsible for assigning the duty of cleaning and sanitizing of respirators.

Routinely used respirators, because of their frequency of use, can be maintained by the employee himself after he has been instructed in the proper method.

Respirators for emergency use shall be cleaned and sanitized after each use. Although this service is normally provided by the Medical Department, it may be assigned elsewhere.

10.4 Repair and Storage. Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or to make adjustments or repairs beyond the manufacturer's recommendations. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

10.4.1. After inspection, cleaning and necessary repairs, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for the purpose. The compartments should be clearly marked. Routinely used respirators, such as dust respirators, may be placed in plastic bags. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

10.4.2. Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position so as to insure the integrity of the valve and prevent impairment of function because of distortion of the elastomer facepiece.



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