



Ames Procedural Requirements

APR 1700.1

Last Revised: 2/6/2009

COMPLIANCE IS MANDATORY

Ames Health and Safety Manual

Chapter 28 - Respiratory Protection

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Chapter 28 - Respiratory Protection

28.1 Overview

This chapter serves as the written respiratory protection program required by OSHA regulations.

NOTE: Engineering and work practice controls are generally regarded as the most effective methods to control exposures to airborne hazardous substances. OSHA considers the use of respirators to be the least

satisfactory approach to exposure control.

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28.2 References

1. 29 CFR 1910.134 (Respirator Regulations) U. S. Dept. of Labor, Occupational Safety and Health
2. 29 CFR 1910.1001 - 1045 (Chemical Specific Regulations)
3. CCR 8, Section 5144
4. American National Standards Institute (ANSI) Standard Z88.2-1992, Practices for Respiratory Protection

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28.3 Responsibilities

28.3.1 Supervisors

1. Each supervisor will be responsible for the administration of the respiratory protection program for his or her personnel.
2. Ensure that required respirator users are trained, fit tested, and have received medical exams annually (ARC 28).
3. If respirator users are not certified to use respirators (not trained, fit tested or medically evaluated within the last year), remove their respirators from service.
4. Ensure all respirator users operate and maintain their respirators as described in this chapter.
5. Do not permit tight-fitting respirators to be worn by employees who have:
 - Any facial hair that comes between the sealing surface of the face-piece and the face, or that interferes with valve function
 - Any other condition that interferes with the face-to-face piece seal or valve function.
6. Maintain compressed breathing-air systems as described in Section 28.10 of this chapter.
7. Provide for proper respirator storage, use, and cleaning.

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28.3.2 Employees

1. Obtain an annual physical exam and fit testing, and attend annual training.
2. Use only those respirators for which the employee has been specifically authorized, trained, and fitted.
3. Clean respirator on a regular basis.
4. Perform positive and negative pressure checks before respirator use.
5. Store respirators as specified in Section 28.9
6. Inform the supervisor of any changes in operation or hazards present.
7. Maintain the respirator and repair it when necessary.
8. Return the respirator upon request.
9. Prior to using a tight-fitting respirator, maintain a clean-shaven face in such a manner that facial hair is not present between the sealing section of the face-piece and the employee's face.

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28.3.3 Safety, Health and Medical Services Division

1. Oversee the NASA ARC Respiratory Protection Program and conduct the annual evaluations of program effectiveness.
2. Appoint NASA ARC Respiratory Protection Administrator to oversee the Respiratory Protection Program.
3. When notified by the supervisor or employee of work operations producing airborne contaminants, select the appropriate respirator for the activity.
4. Provide regularly scheduled respirator fit-testing and training as necessary.
5. Maintain files that document measures taken to assure respiratory protection.
6. The files must include, at a minimum:
 - Current Respiratory Protection Program
 - Records of work conditions evaluated for respirator selection, fit testing, training, medical evaluations, and certificates issued (ARC 28).
 - Copies of medical clearance testing (Health Unit only)

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28.3.4 Ames Health Unit

1. Make medical examinations available for Ames employees who wear respirators as required by the OSHA Respiratory Protection Standard.
2. Provide NASA employees medical examinations as requested by their supervisors.
3. Maintain medical files on individuals who receive respirator medical examinations.
4. Complete ARC Form 28, Request for Respirator Training.
5. Provide a follow-on exam if a person answers "yes" to any of the questions numbered 1 through 8 on the medical questionnaire and shall include medical consultation or diagnostic procedure deemed necessary by the physician or licensed health care professional (PHCP).

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28.3.5 Contractors Officer's Technical Representatives (COTRs)

COTRs shall enforce the requirements for the NASA ARC Respiratory Protection Program as defined in this chapter, for contractors who use respirators.

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28.3.6 Ames Stores Stock

1. Issue respirators to employees who have valid respirator authorization cards only.
2. Issue only the size and type of respirator(s) listed on employees authorization card.
3. Provide at least 2 manufacturers respirators of each size and type.

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28.4 Respirator Selection

28.4.1 Respirator Categories

Respirators are designed to protect only against specific types of substances, in certain concentrations, and must be matched to the user, job, and contaminant. Categories of respirators include:

1. Air-Purifying Respirators - Half mask, full face, PAPR and Hood/Helmet
 - Vapor/Gas removing
 - Particulate removing
 - Combination

2. Atmosphere (Air)-Supplying Respirators
 - Self-Contained Breathing Apparatus (SCBA)
 - Supplied-Air Respirator (Air-line) - pressure demand and continuous flow

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28.4.2 Air-Purifying Respirators

28.4.2.1 General Limitations

Air-purifying respirators (APRs) only remove specific contaminants from the atmosphere. APRs do not protect against oxygen-deficient atmospheres or against skin irritations, or sorption through the skin of airborne contaminants. Only full-face APRs will provide eye protection from contaminants in addition to respiratory protection. The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the design efficiency and capability of the cartridge, canister, or filter and the facepiece-to-face seal on the user. For gases and vapors, the maximum concentration for which the air-purifying element is designed is specified by the manufacturer or is listed on labels of cartridges and canisters. Nonpowered air-purifying respirators will not provide the maximum design protection specified unless the facepiece or mouthpiece/nose clamp is carefully fitted to the wearer's face to prevent inward leakage. The time period over which protection is provided is dependent on canister, cartridge, or filter type; concentration of contaminant; humidity levels in the ambient atmosphere; and the wearer's respiratory rate. The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. In addition, the time it takes to deplete the cartridge or canister's ability to safely filter the contaminant must be calculated prior to use and a change schedule developed. Nonpowered air-purifying respirators may cause discomfort due to a noticeable resistance to inhalation. This problem is minimized in powered respirators. Respirator facepieces present special problems to individuals required to wear prescription lenses. These devices do have the advantage of being small, light, and simple in operation. Use of air-purifying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specific conditions. Respirator and other personal protective equipment selection should be based on all hazards of the contaminant. An evaluation by a qualified Safety, Health and Medical Services Division (Code QH) industrial hygienist is required prior to assigning respiratory protection to ensure the respiratory protection is appropriate for the hazard.

28.4.2.2 Limitations of Vapor- and Gas-Removing Respirators

1. No protection is provided against particulate contaminants.
2. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air. An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.
3. A change schedule is required for use. A change schedule is the part of the written respirator program which says how often cartridges should be replaced and what information was relied upon to make this judgment. A cartridge's useful service life is how long it provides adequate protection from harmful

chemicals in the air. The service life of a cartridge depends upon many factors, including environmental conditions, breathing rate, cartridge filtering capacity, and the amount of contaminants in the air, therefore a Safety, Health and Medical Services Division (Code QH) qualified industrial hygienist will evaluate each process using vapor or gas removing cartridges and will develop a change schedule using experimental results, the manufacturer's recommendations, or an approved math model.

4. Use should be avoided in atmospheres where the contaminant(s) lack sufficient warning properties such as odor, taste, or irritation at a concentration in air at or above the permissible exposure limit. Vapor- and gas-removing respirators are not approved for contaminants that lack adequate warning properties. However, conservative change schedules will be relied on as the primary basis for determining the service life of gas and vapor cartridges, not odor thresholds and/or other warning properties.
5. Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions.
6. Full Facepiece Respirator: Provides protection against eye irritation in addition to respiratory protection.
7. Quarter-Mask and Half-Mask Facepiece Respirator: A fabric covering (facelet) available from some manufacturers shall not be used. These respirators do not provide eye protection.

28.4.2.3 Limitations for Particulate-Removing Respirators

1. Protection against nonvolatile particles only. No protection against gases and vapors.
2. Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions.
3. Full Facepiece Respirator: Provides protection against eye irritation in addition to respiratory protection.
4. Quarter-Mask and Half-Mask Facepiece Respirator: A fabric covering (facelet) available from some manufacturers shall not be used unless provided for use with respirator. These respirators do not provide eye protection.
5. Combination Particulate- and Vapor- and Gas-Removing Respirators
The advantages and disadvantages of the component sections of the combination respirators as described above apply.

28.4.2.4 Combination Atmosphere-Supplying and Air-Purifying Respirators

The advantages and disadvantages, expressed above, of the mode of operation being used will govern. The mode with the greater limitations (air-purifying mode) will mainly determine the overall capabilities and limitations of the respirator, since the wearer may for some reason fail to change the mode of operation even though conditions would require such a change. Each respirator wearer must complete and submit the ARC 28, Request for Respirator Training, signed by their supervisor. This questionnaire will be used for respirator selection purposes/and medical screening information.

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28.4.3 Atmosphere (Air)-Supplying Respirators

28.4.3.1 General Limitations

1. Atmosphere-supplying or air-supplied respirators delivered breathing-air through a supply hose connected to the wearer's face piece. The breathing-air can be provided from a stationary source, i.e., by a compressed air tank or a breathing air compressor.
2. Atmosphere-supplying respirators are required when there is insufficient oxygen (<19.5 percent), when the concentration of contaminant is too high for an air-purifying cartridge to handle, the toxicity of the material is too hazardous for an air-purifying cartridge, or when required by specific federal occupational safety and health administration (OSHA) regulations.

28.4.3.2 Specific Limitations for Self-Contained Breathing Apparatus (SCBA)

1. The period over which the device will provide protection is limited by the amount of breathing air in the apparatus, the ambient atmospheric pressure (service life of open-circuit devices is cut in half by a doubling of the atmospheric pressure), and the type of work being performed. Some SCBA devices have a short service life (less than 15 minutes) and are suitable only for escape (self-rescue from an irrespirable atmosphere).
2. Other limitations of SCBA devices are their weight or bulk, or both, limited service life, and the training required for their maintenance and safe use.
3. All self-contained breathing apparatus to be used in an IDLH environment must be rated for 30 minutes and must be used in the pressure-demand mode.

28.4.3.3 Specific Limitations for Supplied-Air Respirators (Air-line):

1. Ordinary airline respirators (no emergency escape air bottle) are limited to use in atmospheres from which the wearer can escape unharmed without the aid of the respirator (i.e., non-IDLH and non-oxygen deficient atmospheres).
2. The wearer is restricted in movement by the hose and must return to the respirable atmosphere by retracing his/her route of entry. The hose is subject to being severed or pinched off.

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28.4.4 Selection and Use

1. The supervisor is responsible for determining potential respirator users based on their work activities involving airborne contaminants. Supervisors shall either contact the respirator program administrator or Health, Safety and Medical Services Division industrial hygiene representative or have the employee do so to determine if a respirator is required for their work activity. The respiratory protection program administrator or safety division industrial hygienist will select respirators to be used. This selection shall be based on the hazards to which the worker is exposed, the work environment, and the characteristics and limitations of the respirator. Respiratory protective equipment shall be used only for the purpose intended, and no modifications of the equipment shall be made.
2. Each supervisor shall document conditions for respiratory protection use by listing the following information on the ARC 28 form:
 - The toxic substance(s) or hazard(s) present in the work environment
 - The period of time for which the respiratory protection will be required.
 - Expected work place concentrations.
 - For each process the initial determination of work place concentrations and specific toxic substances will be determined with the assistance of a qualified Safety, Health and Medical Services Division (Code QH) industrial hygienist either through calculation or sampling. Subsequent evaluations will also need to be conducted any time process changes occur that would significantly change the concentration, substance, or environment the respirator will be worn in.
3. Once the type of hazard and its concentration are identified, the supervisor shall work with the Safety, Health and Medical Services Division (Code QH) to determine the required type of respirator based on OSHA's Assigned Protection Factors. An Assigned Protection Factor is the level of protection that a particular type of respirator can be expected to provide 95% of the time. An APF of 10 means that type of respirator (if used properly) can be safely used in an atmosphere that has a hazardous concentration of up to 10 times the Permissible Exposure Limit (PEL) for that hazard. Appendix D provides OSHA's Table of Assigned Protection Factors.
 - In addition, OSHA defines the "Maximum Use Concentration (MUC)" as the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the assigned protection factor of the respirator or

class of respirators and the exposure limit of the hazardous substance. Employees may not use a respirator if the MUC has been exceeded. An explanation of MUCs and an example calculation are provided in Appendix E of this document.

4. For protection against gases and vapors, the following forms of protection may be used:
 - An atmosphere-supplying respirator with an appropriate Protection Factor (PF) to reduce exposure below the Permissible Exposure Limit (PEL).
 - An air-purifying respirator, provided that:
 1. The cartridges are replaced as specified in the change out schedule calculated by the Safety, Health and Medical Services Division (Code QH) qualified industrial hygienist.
 2. If the respirator is equipped with an end-of-service-life indicator (ESL) certified by the National Institute for Occupational Safety and Health (NIOSH) for the contaminant, this should be used as well to indicate if the cartridge is depleted sooner than the change schedule predicts.

5. For protection against particulates, any of the following forms of protection may be used:
 - An atmosphere-supplying respirator
 - An air-purifying respirator equipped with a filter certified by NIOSH under 30 CFR part 11 as a high-efficiency particulate air (HEPA) filter, or an air-purifying respirator equipped with a filter certified for particulates by NIOSH under 42 CFR part 84.

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28.4.5 Voluntary Use of Respiratory Protection in Non-Hazardous Atmospheres

1. Supervisors may provide respirators at the request of employees or permit employees to use their own respirators in non-hazardous areas. The supervisor shall provide voluntary respirator users with the following information:

INFORMATION FOR EMPLOYEES USING RESPIRATORS WHEN NOT REQUIRED UNDER THE STANDARD.

- Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employee provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.
 1. Read and need all instructions provided by the manufacturer on use, maintenance, cleaning, and care, and warnings regarding the respirator's limitations.
 2. Choose respirators certified by NIOSH for use to protect against the contaminant of concern. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
 3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
 4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

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28.5 Use of Respirators

28.5.1 Normal Operations

1. Only respiratory protective equipment that has current approval from NIOSH shall be used.
2. Respirators shall be used as issued. No modifications or substitutions to issued equipment shall be permitted. Any modification, no matter how slight, will result in voiding of respirator approval.
3. A respirator shall be used only by the person to whom it was issued.
4. Personnel who use respiratory protection shall leave the space if they detect the odor of a contaminant or experience difficulty in breathing. Re-entry shall not be undertaken until respirator integrity and fit, adequate airflow, or filter cartridge replacement, as appropriate, have been accomplished. If employees experience physical symptoms, they shall immediately leave the area of the hazardous atmosphere and notify their supervisor.
5. Vapor and gas filtering respirator cartridges will be changed out as specified in Section 28.5.10 in this document.
6. Proper use, inspection, fitting, and maintenance of the respirator is the responsibility of the individual to whom the respirator was issued.

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28.5.2 Work in a Confined Space

Chapter 26 of this manual discusses work in confined spaces.

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28.5.3 Procedures for IDLH Atmospheres

For all IDLH atmospheres, the supervisor shall ensure that:

1. One employee or, when needed, more than one employee is located outside the IDLH atmosphere.
2. Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere.
3. The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue.
4. Employee(s) located outside the IDLH atmospheres are equipped with:
 - Pressure-demand or other positive pressure SCBAs, or a pressure-demand or other positive-pressure supplied-air respirator with auxiliary SCBA; and either
 - Appropriate retrieval equipment for removing the employee(s) who enter(s) these hazardous atmospheres where retrieval equipment would contribute to the rescue of the employee(s) and would not increase the overall risk resulting from entry, or
 - Equivalent means for rescue where retrieval equipment is not required.

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28.5.4 Work in Proximity to Unprotected Personnel

Whenever work operations result in the establishment of a respirator-required area that is near an area occupied by unprotected personnel, employees whose tasks do not require them to wear respirators

normally shall not be required to wear them unless their exposures may exceed the Permissible Exposure Limits (PEL) and adequate ventilation cannot be provided. In such instances, work that requires respirators must be performed at a time when a minimum number of other employees are affected.

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28.5.5 Concurrent Work Requiring Respiratory Protection

Two or more different jobs that both require respiratory protection may be worked simultaneously, provided that the level and type of respiratory protection worn is adequate for all the airborne contaminants and the concurrent work does not create additional hazards.

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28.5.6 Assist Trades and Supervisors

Employees required to support, assist, or supervise a respirator-requiring job shall wear the proper respiratory protection. Trades that support or assist respirator-requiring work shall have personnel qualified for respirator use for those individuals who need to access locations where respirators are required.

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28.5.7 Posting/Guarding Access to Controlled Areas

Unless the area in which respiratory protection is required is limited to the space occupied by the employee who is performing the work, posting or guarding access shall be established and controlled.

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28.5.8 Prohibited Uses

1. Air-purifying respirators shall not be used for the accomplishment of work in the following environments:
 - Untested tanks or voids.
 - Oxygen-deficient atmospheres.
 - Atmosphere immediately dangerous to life or health (IDLH).
2. Access to life-threatening areas is limited to emergency situations. Such areas must be tested and ventilated to safe conditions prior to accomplishment of routine work.

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28.5.9 Surveillance of Work Area

Supervisors who assign personnel to operations that require the use of respiratory protection shall, when possible, observe the operation to ensure that conditions have not changed. They should also assure compliance with this or other applicable instructions.

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28.5.10 Changing Cartridges

1. Particulate-Filter Elements

- Particulate filters, including paint-mist prefilters, should be changed if breathing becomes more difficult.
- Type R filters (rated under 42 CFR 84) must be changed at the end of each shift where exposure includes airborne oil mists.

2. Vapor and gas-removing cartridges and canisters

- Cartridges or canisters should be replaced as specified in the change schedule, after eight hours of continuous use, or more often if necessary, i.e. if the wearer can smell or taste the airborne contaminant.
- If the wearer detects an odor or taste of gas in the inspired air, or feels eye or throat irritation, he/he should leave the hazardous area immediately and go to a clean area to change out the cartridges.

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28.5.11 Personal Protective Equipment

Many operations that require respirators also require other personal protective clothing and gear. These requirements are delineated in Chapter 33 of this manual and shall be complied with in all instances.

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28.5.12 Powered Air-Purifying Respirator (PAPR)

1. The use of powered air-purifying respirators (PAPRs) in lieu of supplied air respirators or respirators with a lower Protection Factor (PF) may be allowed and/or required under special circumstances as determined by the Ames Safety division.
2. Powered air-purifying respirators may be a half-mask, full-face, or hood type, depending on the type of hazard and working conditions.

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28.6 Respirator User's Inspection Guide

28.6.1 General

1. All respirators shall be inspected for obvious defects by the user prior to use.
2. Emergency respirators (e.g., SCBA) shall be inspected monthly and after each use. A log shall be maintained by the cognizant organization to document these inspections.

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28.6.2 Air-Purifying (Half-Mask or Full-Face) Respirators

1. Respirators shall be free of the following defects, as applicable:
 - Excessive dirt
 - Cracks, tears, or deterioration
 - Distortion
 - Inflexibility

- Cracked or badly scratched lenses
 - Incorrectly mounted lenses
 - Poorly seated or torn inhalation and/or exhalation check valves or diaphragms
 - * Deterioration; if the device has a corrugated breathing tube, examine it for deterioration by stretching the tube and looking for cracks
2. Straps shall be free of the following defects, as applicable:
- Breaks, tears, or cuts
 - Loss of elasticity
 - Broken buckles
 - Worn serration or missing tabs or a head harness that may permit slippage.

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28.6.3 Air-Supplied (Half-Mask or Full-Face) Respirators

1. Inspect face piece and straps as outlined in section 28.6.2.
2. If the device has a corrugated breathing tube, examine it for deterioration by stretching the tube and looking for cracks.
3. Also examine the respirator system components for accumulation of dirt, grit, oil, tears, breaks, etc.

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28.6.4 Air-Supplied Hoods

Air-supplied hoods shall be inspected for holes and tears prior to use. Air-supplied hoods may be used in lieu of air-supplied respirators, provided the hood has NIOSH approval for the work being performed.

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28.7 Respirator Fitting/Testing Procedures

28.7.1 General

A respirator cannot provide optimum levels of protection unless an air-tight seal is obtained between the respirator and the user's face. Accordingly:

1. A respirator shall not be worn if facial hair comes between the sealing periphery of the face piece and the face, or if facial hair interferes with valve functions.
2. Because half-mask respirators are manufactured in small, medium, and large sizes to fit various sized and shaped faces, and since the wearer is required to have a properly fitting respirator, it is imperative that supervisors make arrangements to obtain the specific model and size respirator certified for each employee who must use one.
3. If spectacles, goggles, face shield, or welding helmet must be worn with a face piece, it shall be worn so as not to interfere with the seal of the face piece to the face.
4. Pressure Test: The face-piece seal of any respirator shall be checked by the wearer each time the respirator is donned. To check the seal, complete the following negative- and positive-pressure tests.
 - Negative-pressure test:

1. Close off the air inlet for the canister, cartridge(s), filter(s), or hose(s) by covering with the palms, being careful not to dislodge the face piece.
 2. Inhale gently so that the face piece collapses slightly, and
 3. Hold breath for ten seconds.
 4. If the face piece remains slightly collapsed and no inward leakage is detected, the respirator fit is adequate.
- Positive-pressure test:
 1. Close off the opening of the exhalation valve by covering with the palm, being careful not to dislodge the face piece.
 2. Exhale gently into the face piece.
 3. If slight positive pressure can be built up inside the face piece without leaking, the respirator fit is considered satisfactory.

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28.7.2 Respirator Face Piece Fit-Test Requirements

The respirator cannot provide proper respiratory protection unless it seals air-tight with the face of the wearer and thereby excludes all the contaminated atmosphere. To do this, the respirator must be properly fitted to the individual.

Fit testing is required for employees required to wear respirators and may also be performed on employees voluntarily wearing respirators upon request. Employees who are required to wear half-facepiece APRs will be fit tested:

- Prior to being allowed to wear any respirator with a tight fitting facepiece
- Annually
- When there are changes in the employee's physical condition that could affect respiratory fit (e.g., obvious change in body weight, facial scarring, etc.)

Quantitative fit testing is the preferred method of testing a proper face piece fit, and is required for the use of SCBA respirators. However, qualitative tests using irritant smoke or other agent approved by the Ames Safety division may also be conducted. All fit testing performed must be conducted annually and documented on all persons who will wear a tight fitting respirator. The procedure contained in the OSHA approved Irritant Smoke (Stannic Chloride) Qualitative Fit Testing Protocol in Appendix A of the Respiratory Protection Standard, shall be used to fit-test respirators with irritant smoke. The results of the qualitative fit test shall be used to select specific types, makes, and models of negative-pressure respirators for use by the individual.

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28.8 Respirator Inspection, Cleaning, Maintenance, and Storage

28.8.1 General

Reusable rubber face piece respirators shall be inspected and cleaned after each use to prevent spread of contamination and to maintain rubber parts in good repair. Spare parts for reusable respirators must be procured from the respirator supplier.

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28.8.2 Cleaning Procedures

Respirators shall be cleaned by the employees in designated respirator cleaning area, as determined by their supervisor. Respirators issued for the exclusive use of an employee shall be cleaned as often as necessary, but at least after each use. Respirators may not be cleaned with solvents or paint removers, because damage to rubber or plastic pieces may result. Respirators shall be cleaned in accordance with the respirator manufacturer's instructions or by the following method:

1. Removed filters by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.
2. Wash components in warm (430 C [1100 F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.
3. Rinse components thoroughly in clean, warm (430 C [1100 F] maximum), preferably running water. Drain.
4. When the cleaner used does not contain a disinfecting agent, respirator components should be disinfected with commercially available cleansers or wipes of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.
5. Rinse components thoroughly in clean, warm (430 C [1100 F] maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on face pieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.
6. Components should be hand-dried with a clean, lint-free cloth or air-dried in a clean area.
7. Test the respirator to ensure that all components work properly.
8. For self-contained breathing apparatus (SCBA), disassemble and hand-clean the pressure-demand and exhalation valve as appropriate, exercising care to avoid damaging the rubber diaphragm.
9. Visually inspect face pieces and all parts for deterioration, distortion, or other faults that might affect the performance of the respirator. Discard faulty items, replacing only with parts specifically designed for the particular respirator.
10. Place respirator in a clean container for storage after it has completely dried.

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28.8.3 Pesticide Contamination

For decontamination against pesticide residues, wash with alkaline soap and rinse with 50-percent ethyl or isopropyl alcohol.

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28.8.4 Respirator Storage

1. Cleaned respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. The storage area shall be clean and sanitary.
2. Respirators shall be packed or stored so that the face piece and exhalation valve will rest in a normal position and function will not be impaired because the face piece sat in an abnormal position.
3. Storage of issued respirators - Respirators issued to individuals shall be stored in a clean plastic bag, carton, or carrying case, as appropriate.

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28.8.5 Emergency-Use Respirators

1. Emergency escape-only respirators shall be inspected before being carried into the workplace for use.
2. Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be maintained in a fully charged state and shall be recharged when the pressure falls to 90 percent of the manufacturer's recommended pressure level. The inspection must:
 - Establish that the regulator and warning devices function properly.
 - Check the respirator function, tightness of connections, and the condition of the various parts including, but not limited to, face piece, head straps, valves, and connecting tube; and
 - Check the elastomeric parts for pliability and signs of deterioration.
3. For respirators maintained for emergency use, the maintaining organization shall:
 - Certify the respirator by documenting the date the inspection was performed, the name (or signature) of the person who made the inspection, the findings, required remedial action, and a serial number or other means of identifying the inspected respirator.
 - Provide this information on a tag or label that is attached to the storage compartment for the respirator, is kept with the respirator, or is included in inspection reports stored as paper or electronic files. This information shall be maintained until replaced following a subsequent certification.

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28.9 Breathing-Air Quality and Supplied Air Systems

28.9.1 Air Quality for Supplied Air Systems

Compressed air for breathing purposes shall be of at least Grade D quality. Grade D air contains

1. Oxygen content: 19.5-23.5 percent.
2. Less than 10 ppm carbon monoxide.
3. Less than 1000 ppm carbon dioxide.
4. Less than 5 mg/m³ total hydrocarbons.
5. No objectionable odors.

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28.9.2 Temperature Considerations

Compressed air that is to be used at temperatures below freezing should have excess water vapor removed so as to attain a dew point below the minimum temperature anticipated. Compressed air, as it passes through regulators and valves from a high pressure to a low pressure, expands and cools down, resulting in a temperature lower than the surrounding temperature.

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28.9.3 Breathing-Air Compressors

Breathing-air compressors must be located where contaminated air cannot enter the system. If the compressor is oil-lubricated, it shall be equipped with both a high-temperature and carbon monoxide alarm. The high-temperature alarm will be set at the temperature specified in the manufacturer's literature. The carbon monoxide alarm will be set at 10 ppm. Compressors used for breathing air must be specifically designed and certified for the purpose.

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28.9.4 Breathing-Air Testing

Breathing-air quality shall be laboratory tested and certified at least quarterly. Supervisors of those activities capable of producing their own breathing air are responsible for such testing and record keeping (see item 9 in section 28.2.1). The air from non-oil-lubricated, low-pressure air pumps designed specifically to provide respirator breathing-air does not need to be tested.

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28.9.5 Breathing-Air Hoses

1. Only hoses designed for breathing-air shall be used and they shall have NIOSH approval and be compatible with the respirator being used.
2. Air-line hoses shall be protected from damage. Hoses shall be arranged to prevent tripping and allow ready access/exit.
3. Air-lines used for supplying breathing air shall be tagged or labeled as "Breathing-Air Supply Line." Breathing-air-lines shall be labeled by the owning organization.
4. All breathing-air-line couplings shall be incompatible with outlets for other gas systems.
5. When not in use, ends of breathing-air system shall be capped or sealed.
6. The total hose length shall be limited to a maximum of 300 feet.
7. All equipment used from the respirator face piece to the breathing-air pump must be from the same manufacturer.

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28.10 Respirator Training

28.10.1 Trainer Qualifications

Training shall be conducted by an instructor who is qualified as determined by the NASA safety division or who is an industrial hygienist by profession.

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28.10.2 Who Requires Training

All personnel who will use or issue respirators and their supervisors shall receive appropriate respirator training annually.

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28.10.3 Respirator Training Topics

1. Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator.
2. The limitations and capabilities of the respirator.
3. How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions.
4. How to inspect, put on and remove, use, and check the seals of the respirator.
5. The procedures for maintenance and storage of the respirator.

6. How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators.
7. The general requirements of the OSHA respiratory standard (29 CFR 1910.134).

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28.10.4 Request for Respirator Training

To schedule respirator training, ARC Form 28, Request for Respirator Training (see section 28.13.2, Respirator Authorization) must be properly prepared.

Section I: To be filled out by the employee and the employee's supervisor. The supervisor may need to consult with a Safety, Health and Medical Services Division (Code QH) qualified industrial hygienist for assistance with concentration and toxicity information.

Section II: After completion of Section I, the ARC Form 28 is forwarded to the Ames Safety, Office where the form is reviewed by an industrial hygienist.

Section III: After completion of Section II, the form is forwarded to the Ames Health Unit or medical professional. The Ames Health Unit or other licensed health care professional performs the respiratory protection medical clearance, which has been scheduled by the employee or supervisor named in Section I. This section is then completed by the physician or licensed health care professional.

Section IV: This section is completed by the trainer and fit tester after successful completion of training and fit-testing.

Following completion of Sections I-IV, schedule training and fit testing by following the links on the Code Q Occupational Safety Health and Medical Service Website for training.

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28.10.5 Respirator Authorization Card

1. Each person who satisfactorily completes the respirator physical examination, training, and fit-testing shall be issued a Respirator Authorization Card (see section 28.13.3).
2. The expiration date on the card shall be one year from the earliest date of:
 - Respirator physical examination,
 - Respirator training; or
 - Respirator fit-testing.
3. The Respirator Authorization Card shall show the respirators for which the person was satisfactorily fit-tested.
4. The Respirator Authorization Card shall be carried on the individual's person when the individual is using a respirator.

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28.10.6 Respirator Issue

Respirators and filter cartridges are issued through shop stores only upon the presentation of a completed and signed Respirator Authorization Card.

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28.11 Loss of Qualification

Employees may lose their respirator use qualification and/or respirator at any time for any of the following reasons:

1. Expiration of qualification (health certificate or training).
2. Determination by a medical officer that the employee is not physically qualified for respirator use.
3. Lack of knowledge or willful neglect of requirements, as demonstrated by failing the qualification exam or by serious violations of this instruction, such as:
 - Use of the wrong type of respirator.
 - Failure to wear a respirator where required.
 - Removal of a respirator in a respirator area.
 - Tampering with a respirator.
 - Entry into an untested, oxygen-deficient, or life-hazardous space unprotected.
 - Wearing the respirator with facial hair that prohibits proper sealing or interferes with proper internal valve operation.

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28.12 Definitions

Air-Purifying Respirator: A respirator that purifies the air by drawing contaminated air through a filter or sorbent media. This type of respirator is distinguished from a supplied-air respirator, which supplies breathing-air from an outside source versus the ambient atmosphere to the respirator wearer.

Protection Factor (PF): An Assigned Protection Factor is the level of protection that a particular type of respirator can be expected to provide 95% of the time. An APF of 10 means that type of respirator (if used properly) can be safely used in an atmosphere that has a hazardous concentration of up to 10 times the Permissible Exposure Limit (PEL) for that hazard. APF's are determined by the Occupational Safety and Health Administration (OSHA). For example, a half face negative pressure air purifying respirator has an APF of 10. Full-face negative pressure air purifying respirators have an APF of 50.

Belt-Mounted Respirator: A respirator in which the cartridges are worn at belt level so that end-of-cartridge-life indicators may be easily viewed by the wearer or so that the cartridges will not interfere with protective facial equipment.

Canister or cartridge: A container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.

Dust: A solid, mechanically produced particle that is generally greater than one micron in size. Examples of dusts include sawdust, cement, and metal grindings.

Employee exposure: Exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

End-of-service-life indicator (ESLI): A system that warns the respirator user of the approach of the end of adequate respiratory protection, for example, that the sorbent is approaching saturation or is no longer effective.

Escape-only respirator: A respirator intended to be used only for emergency exit.

Filter or air-purifying element: A component used in respirators to remove solid or liquid aerosols from the

inspired air.

Filtering face piece (dust mask): A negative-pressure particulate respirator with a filter as an integral part of the face piece or with the entire face piece composed of the filtering medium.

Fit factor: A quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit-Test: The use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

Fume: A solid condensation particle generally less than one micron in size. An example of a fume is the particles generated by welding operations.

Gas: A material that has no liquid phase at standard temperature and pressure. Examples of gases include oxygen, nitrogen, and hydrogen.

High Efficiency Particulate Air (HEPA): A filter that is at least 99.97 percent efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Immediately Dangerous to Life and Health (IDLH): An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

Loose-fitting face piece: A respiratory inlet covering that is designed to form a partial seal with the face.

Maximum Use Concentration (MUC): The maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator. The MUC is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance (See Appendix E).

Mist: A liquid condensation particle that is generally greater than one micron in size. An example of a mist is paint overspray.

National Institute of Occupational Safety and Health (NIOSH): The governmental agency that assigns approval numbers to respirators.

Negative pressure respirator (tight fitting): A respirator in which the air pressure inside the face piece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Organic Vapor: The gaseous phase of a liquid at room temperature that is carbon based. Examples of materials that create organic vapors include xylene, toluene, and 1,1,1-trichloroethane.

Oxygen-Deficient Atmosphere: An atmosphere with an oxygen content below 19.5 percent by volume.

Permissible Exposure Limits (PEL): Chemical airborne concentrations that are promulgated by either Federal or California OSHA. These are the concentrations of chemicals that a healthy individual may be exposed to for up to eight hours in a normal working day, every workday of the year, without suffering adverse health effects.

Physician or other licensed health care professional (PLHCP): An individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all the health care services required by the OSHA respiratory protection standard.

Powered Air-Purifying Respirator: An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Program Manager: The single point of contact within NASA ARC or within a contractor with responsibility for overseeing the respiratory protection program.

Self-contained breathing apparatus (SCBA): An atmosphere-supplying respirator for which the breathing-air source is designed to be carried by the user.

Service life: The period of time that a respirator, filter, sorbent, or other respiratory equipment provides adequate protection to the wearer.

Supplied-air respirator (SAR) or air-line respirator: An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Vapor: The gaseous phase of a liquid at room temperature. Examples of materials that create vapors include xylene, toluene, and 1,1,1-trichloroethane.

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28.13.1 Appendix A: The NIOSH Designations for Filters (42 CFR 84)

Code Letters N - Not for oil mists R - Resistant to Oil (good for a single shift) P- Oil-Proof (good for use with oily mists, and over several shifts)

Filter Designations

	N	R	P
95%	N95	R95	P95
99%	N99	R99	P99
99.97%	N100	R100	P100

1. Filter or prefilter labeled N95 may be used for:

- Non oily dusts, fumes, mists
- Most metal welding fumes
- Airborne dusts (non oily)
- Sawdust
- Nuisance dusts
- Water-based pesticide mists *
- Paint Spray Mists (Enamel and waterbase paints) *

2. Filter or prefilter labeled R95 or P95 may be used for oily mists to include:

- Lubricant oil mists
- Cutting oil mists
- Glycerine mists
- PCBs *
- Triphenyl phosphate

- Asphalt fumes
- Oil/solvent-based pesticides *
- Coal-tar pitch volatiles *
- Coke oven emissions
- Paint spray mists (oil-based paints) *

3. Filter or prefilter labeled N99 may be used for:

- Tuberculosis germ exposures

4. Filter or prefilter labeled N100 may be used for:

- Asbestos dusts
- Lead dusts and fumes
- Cadmium dusts and fumes

5. Filter or prefilter labeled P100 may be used for:

- Radionuclides and radioactive dusts
- When used in conjunction with an appropriate chemical cartridge.

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28.13.2 Appendix B: Respirator Authorization

		REQUEST FOR RESPIRATOR TRAINING		
SECTION I: Employee Work Information				
NAME (Last, First, Middle Initial)			SOCIAL SECURITY NO.	
ORG CODE	CONTRACTOR	MARL STOP	ROOM	EXT
POSITION/TITLE		SUPERVISOR		
What type of work will the employee be performing?				
To what contaminants will the employee be exposed?				
CONTAMINANT		CONCENTRATION	EXPOSURE (Hours/Week)	
SUPERVISOR NAME (Print and Sign)		DATE		
SECTION II: (To be completed by Industrial Hygienist)				
I certify that I have reviewed the above described work operations.				
INDUSTRIAL HYGIENIST NAME (Print and Sign)			DATE	
SECTION III: (To be completed by the approving physician)				
I certify that I have examined as necessary, (minimum: history, FEV ₁ , and FVC) the individual described in Section I. This individual is physically fit to use respirators as protection against the contaminants itemized in Section I, subject to the following restrictions:				
			EMPLOYEE EXAM DATE	
PHYSICIAN NAME (Print and Sign)			DATE	
SECTION IV: TRAINING AND FIT TESTING				
Employee attended respiratory training class on: _____ Test Score _____				
Employee was qualitatively fit tested on _____ using irritant smoke with the following equipment donned:				
<input type="checkbox"/> Half-face Respirator	<input type="checkbox"/> MSA	<input type="checkbox"/> X-Small		
<input type="checkbox"/> Full-face Respirator	<input type="checkbox"/> North	<input type="checkbox"/> Small		
<input type="checkbox"/> Other _____	<input type="checkbox"/> 3M	<input type="checkbox"/> Medium		
	<input type="checkbox"/> Other _____	<input type="checkbox"/> Large		
TRAINER NAME (Print and Sign)			DATE	
EMPLOYEE STATEMENT: I have been trained in the following areas: the limitations and proper use of a respirator, APF cartridge selection, pre-use inspection, positive and negative pressure fit testing, the use, cleaning, and maintenance of APF. I understand that I am responsible for using the respirator in areas or conditions required, pre-use inspection, positive and negative pressure fit test, proper cleaning, maintenance, and storage, reporting respirator malfunctions or damage to the supervisor, leaving the contaminated area immediately if respirator malfunctions, breathing becomes difficult, or if I am small or toxic chemicals.				
EMPLOYEE SIGNATURE			DATE	

ARC 28 (July 95)E Previous editions are obsolete

Part 1 and 2: Safety Office
Part 3: Certifying Physician Part 4: Supervisor

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28.13.3 Appendix C: Respirator Authorization Card

NASA AMES RESEARCH CENTER
RESPIRATOR AUTHORIZATION

Name: _____ ORG: _____

Employee Number or Contractor: _____

The above named person has been trained, fitted, and medically approved to use the respirator(s) listed on the back of this card. Authorization to use these respirators is voided if the user has any facial hair that interferes with the seal of the respirator facepieces against the face.

If you no longer require a respirator, contact the Safety, Health, and Environmental Services Office

_____ Date

Health & Safety Signature

Authorized Respirators:	Expires
Half Face Air-Purifying	
<input type="checkbox"/> 3M <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	_____
<input type="checkbox"/> MSA <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	_____
<input type="checkbox"/> North <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	_____
Full Face Air-Purifying	
<input type="checkbox"/> 3M <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	_____
<input type="checkbox"/> MSA <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	_____
Powered Air-Purifying (PAPR)	
Make _____	
Size <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	_____
Filter Type	

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28.13.4 Appendix D: OSHA's List of Assigned Protection Factors

Type of Respirator ^{1,2}	Quarter Mask	Half Mask	Full Facepiece	Helmet/Hood	Loose-Fitting Facepiece
1. Air-Purifying Respirator	5	10 ³	50	—	—
2. Powered Air-Purifying Respirator (PAPR)	—	50	1,000	25/1,000 ⁴	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	—	10	50	—	—
• Continuous flow mode	—	50	1,000	25/1,000 ⁴	25
• Pressure-demand or other positive-pressure mode	—	50	1,000	—	—
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand mode	—	10	50	50	—
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)	—	—	10,000	10,000	—

- Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.
- The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.
- This APF category includes filtering facepieces, and half masks with elastomeric facepieces.
- The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.
- These APFs do not apply to respirators used solely for escape. For escape respirators used in association with specific substances covered by 29 CFR 1910 subpart Z, employers must refer to the appropriate substance-specific standards in that subpart. Escape respirators for other IDLH atmospheres are specified by 29 CFR 1910.134 (d)(2)(ii).

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28.13.5 Appendix E: Maximum Use Concentrations

Maximum Use Concentration

OSHA defines the "Maximum Use Concentration as the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC usually can be determined mathematically by multiplying the assigned protection factor specified for a respirator by the permissible exposure limit, short term exposure limit, ceiling limit, peak limit, or any other exposure limit used for the hazardous substance." The MUC is the highest concentration of contaminant in which a respirator can be used safely. At no time should a respirator be used in an environment that exceeds the MUC. The MUC must be calculated for gases and vapors and is not appropriate for particulates dusts and fumes.

If the contaminant concentration is unknown, a respirator with an "unlimited" maximum use concentration should be selected. These include SCBA, pressure-demand air-line devices with an emergency-escape capability, and other respirators as applicable.

The MUC is calculated by multiplying PF times PEL. Below gives an example of calculating the MUC for nitric acid.

To Calculate the MUC

$$\text{MUC} = \text{PF} \times \text{PEL}$$

For Nitric Acid exposure the Maximum Use Concentration would be calculated as follows:

Half Face Respirator

PEL for nitric acid	= 2 parts per million (ppm)
PF of half-face respirator	= 10
MUC	= 2 PPM x 10 = 20 PPM
A half-face respirator cannot be used in atmospheres with a nitric acid concentration greater than 20 PPM	

Full Face Respirator

PEL for nitric acid	= 2 parts per million (ppm)
PF of Full-face respirator	= 50
MUC	= 2 PPM x 50 = 100 PPM
A half-face respirator cannot be used in atmospheres with a nitric acid concentration greater than 100 PPM	

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END OF DOCUMENT

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