

## Chapter 28 – Provisions for Respiratory Protection (REDACTED)

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### 28.1 General Information

#### 28.1.1 Purpose

The purpose of this chapter is to protect employees from airborne chemicals and materials that may be hazardous to one's health.

Provisions for Respiratory Protection

NASA will provide respiratory protection that is applicable and suitable for the purpose intended, when such equipment is necessary or desirable to protect the health or comfort of personnel at Ames. This policy shall apply to all civil servants and contractors and will include all situations where personal protection is required against inhalation of chemicals and hazardous materials. Respiratory Protection shall be used:

- When engineering controls are not feasible,
- During emergencies,
- During certain maintenance operations while controls are being instituted,
- When indicated by the MSDS for certain chemicals or
- If ambient concentrations of toxic or hazardous materials exceed the Permissible Exposure Limit (PEL) or the Threshold Limit Value (TLV's).

#### 28.1.2 Applicability

This manual is applicable to: (1) all Ames Employees; and (2) all persons and entities who agree in writing to comply with this manual.

### 28.2 Responsibilities

#### 28.2.1 Supervisors and Managers

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#### 28.2.2 Employees

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#### 28.2.3 Safety Division

1. Oversee the Respiratory Protection Program at NASA Ames Research Center (ARC) and conduct the required evaluations of program effectiveness.
2. Appoint a Respiratory Protection Program Administrator to oversee the Respiratory Protection Program.
3. Upon request, review respirator use to ensure they are applicable and suitable for the purpose intended.
4. Authorize the use, procurement, and issuance of respirators after review of work conditions.
5. Make available regularly scheduled respirator fit testing and training.

6. Prepare written respirator testing, training, and selection procedures in accordance with applicable standards and the requirements of this issue.
7. Maintain files that document measures taken to assure respiratory protection. The files must include as a minimum:
  - Current Respiratory Protection Program.
  - Records of fit testing, training, and certifications issued.
  - Copies of medical clearance testing (Health Unit only).

#### 28.2.4 Ames Health Unit

1. Make available medical examinations for Ames employees as required by 29 CFR 1910.134 for individuals who wear respirators. At a minimum personnel shall receive a baseline pulmonary function test and an EKG and the OSHA Medical Examination questionnaire 1910.134 Appendix C.
2. Maintain medical files on individuals who receive respirator medical examinations.
3. Schedule individuals for medical examinations.
4. A follow up examination shall be done if a person answers yes to any of the questions numbered 1 through 8 of the medical questionnaire and shall include medical consultation or diagnostic procedure deemed necessary by the physician or licensed health care professional (PHCP).
5. Complete ARC Form 28, Request for Respirator Training.

#### 28.2.5 Contractors

1. Maintain a written respirator program that meets the requirements of 29 CFR 1910.134 or Title 8, CCR Section 5144. Contractors shall be responsible for administering and maintaining their own Respiratory Protection Program in accordance with 29 CFR 1910.134 or Title 8, CCR, 5144. Ensure that each respirator user has current respirator fit-tests.
2. Maintain records to document their program.
3. Identify respirator users under their supervision.
4. Schedule employees for training and medical examination when a respirator is needed.
5. Ensure that users are trained to wear respirators. Contractors are responsible for making arrangements for respirator training. Contractors who use NASA training must first determine that the training provided by NASA will meet their requirements. NASA does not guarantee that their respirator program will meet the requirements of contractors.
6. Ensure respirator users receive the annual training and medical examinations.
7. Ensure respirator users use and operate their respirators under the respiratory protection procedures as described in this chapter.
8. Apply engineering controls when feasible.
9. Ensure that employees utilizing respirators with a tight-fitting face-piece maintain a **clean-shaven** face in such a manner that facial hair growth does not effect the seal between the respirator and the employee's face. Do not permit tight-fitting respirators to be worn by employees who have (1) any facial hair that comes between the sealing surface of the face-piece and the face, or that interferes with valve function; or (2) any other condition that interferes with the face-to-face-piece seal or valve function.
10. Maintain compressed breathing-air systems and ensure that these systems are tested quarterly (see Section 28.8.1).

11. Provide for proper respirator storage, use, and cleaning.
12. Contractors may be issued a respirator through stores stock provided the medical examination, training, and fit testing have been completed. A NASA Respirator Card may then be issued to a contractor in order for their employees to obtain respirators through stores stock. The contractor is responsible for signing NASA Respirator Cards that are use by their employees.
13. Allow employees to leave the respirator-use area for any of the following reasons:
  - To wash their faces and respirator face pieces as necessary to prevent eye or skin irritation associated with respirator use.
  - If they detect vapor or gas breakthrough, changes in breathing resistance, or leakage of the face piece.
  - To replace the respirator or the filter, cartridge, or canister elements.

### **28.2.6 Contracting Officer's Technical Representatives (COTRs)**

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## **28.3 Respirator Selection**

### **28.3.1 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
  - Particulate removing
  - Vapor/Gas removing
  - Combination
2. Atmosphere (Air)-Supplying Respirators
  - Self-Contained Breathing Apparatus (SCBA)
  - Supplied-Air Respirator (Air-line)

### **28.3.2 Air-Purifying Respirators**

#### **28.3.2.1 General Limitations**

Air-purifying respirators remove contaminants from the atmosphere; they must be used only in atmospheres with sufficient oxygen and within specified hazard concentration limitations of the specific device. They do not protect against skin or eye irritation by airborne contaminants. They also do not protect against absorption through the skin by airborne contaminants. Air-purifying respirators may not be used for protection in the following circumstances:

- Air-purifying respirators are not effective protection against certain gaseous materials. Section 28.13.7 gives a partial list of these substances.
- The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the design efficiency and capacity of the cartridge, canister, or filter and the face-piece-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.
- Air-purifying respirators will not provide the maximum design protection specified unless the face piece 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 respiration rate.

- The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. Air-purifying respirators may cause discomfort due to the noticeable resistance in inhalation.
- Respirators with full face pieces present special problems to individuals who are required to wear prescription eyewear; such problems should be directed to the Respiratory Protection Program Administrator.
- It is recommended that contact lenses not be worn with respirators.

#### **28.3.2.2 Specific limitations for air-purifying particulate-removing respirators.**

1. Use for protection against nonvolatile particles only. These respirators offer no protection against gases or vapors.
2. These respirators are not for use in an atmosphere immediately dangerous to life or health (IDLH).
3. Do not use air-purifying particulate-removing respirators in oxygen-deficient atmospheres.

#### **28.3.2.3 Specific limitation for air-purifying vapor/gas-removing respirators:**

1. Do not use air-purifying vapor/gas removing respirators with airborne chemicals that have "poor warning properties."
  - Section 28.13.7 gaseous materials for which air-purifying cartridges should NOT be used.
  - Do not use air-purifying vapor/gas-removing respirators in atmospheres with unknown chemicals. Do not use in atmospheres with unusually high concentrations of a known chemical.
  - Do not use air-purifying vapor/gas-removing respirators in oxygen-deficient atmospheres.

#### **28.3.2.4 Full Face-Piece Respirators**

Full face-piece respirators provide protection against eye irritation in addition to respiratory protection. However, the same limitations given in sections 28.3.2.2 and 28.3.2.3 also apply with full face-piece respirators.

### **28.3.3 Atmosphere (Air)-Supplying Respirators**

#### **28.3.3.1 General**

1. Atmosphere-supplying or air-supplied respirators deliver 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.

#### **28.3.3.2 General Limitations**

Except for some air-line suits, no protection is provided against skin irritation by materials such as ammonia and hydrogen chloride, or against absorption through the skin of materials such as hydrogen cyanide and organic phosphate pesticides. Full-face pieces present special problems to individuals who are required to wear prescription eyewear. Use of atmosphere-supplying respirators in an atmosphere immediately dangerous to life or health is limited to self-contained breathing apparatus or to those air-line respirators equipped with an "escape" bottle of air.

**28.3.3.3 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.

**28.3.3.4 Specific Limitations for Supplied-Air Respirators (Air-line):**

1. Ordinary air-line 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.

**28.3.4 Selection and Use**

1. Selection and use of respirators 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. For protection against gases and vapors, the following forms of protection may be used:
  - An atmosphere-supplying respirator.
  - An air-purifying respirator, provided that:
    - The respirator is equipped with an end-of-service-life indicator (ESLI) certified by the National Institute for Occupational Safety and Health (NIOSH) for the contaminant.
    - If there is no ESLI appropriate for conditions in the employer's workplace, the respirator filters and cartridges are replaced after every eight hours of cumulative use.
3. 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.
  - For contaminants that consist primarily of particles with mass median aerodynamic diameters (MMAD) of at least two micrometers, an air-purifying respirator equipped with any filter certified for particulates by NIOSH.
4. When selecting the appropriate respirator for a worker, the following methodical approach shall be instituted. Each supervisor shall document requirements for respiratory protection by listing the following information on an ARC 27 form by:
  - Identify 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.

5. The Safety Division is available to provide consultation on proper respirator selection. To determine proper selection of the respirator, a Safety Division industrial hygienist may request additional information from the supervisor, such as:
  - Significant factors associated with the job and the nature of the operation or process that may effect the respirator's performance.
  - The location of the hazardous area with respect to a source of uncontaminated respirable air.
  - Physical characteristics of the respirator as well as the respirator's limitations.
  - Facilities and personnel responsible for proper cleaning, storage and maintenance of the respirator.

**28.3.5 NIOSH Approvals**

**28.3.5.1 Air Purifying Respirator Approval**

All respiratory protective equipment used shall carry the NIOSH approval. The following are the currently approved schedule number and letter designations for the various types of respiratory equipment:

Schedule	Type
23C	Chemical cartridges (organic vapor, acid gas, ammonia, etc.)
21C	Dust, mist, fume, HEPA (until July 1998)
42C	Particulates, HEPA, bio-aerosol
19C	Airline (supplied air)
14F and G	Gas mask
13F	Self-contained breathing apparatus (SCBA)

**28.3.5.2 NIOSH Filter efficiency**

NIOSH certifies three levels of filter efficiency: 95%, 99% and 99.7%. These efficiencies are based on the amount of measurable penetration of particles through a respirator filter.

**28.3.5.3**

NIOSH has developed regulations in 42 CFR\* 84 (also referred to as "Part 84") for testing and certifying nonpowered, air-purifying, particulate-filter respirators.

The Part 84 regulation provides for nine classes of filters (three levels of filter efficiency, each with three categories of resistance to filter efficiency degradation). The three levels of filter efficiency are 95%, 99%, and 99.97%. The three categories of resistance to filter efficiency degradation are labeled N, R, and P. The class of filter will be clearly marked on the filter, filter package, or respirator box. For example, a filter marked N95 would mean an N-series filter is at least 95% efficient. Chemical cartridges that include particulate filter elements will carry a similar marking that pertains only to the particulate filter element.

The new classes of nonpowered particulate respirators require new decision logic for selection of the proper respirator. The selection process for using the new particulate classification is discussed fully in Section II (Detailed Guidelines for Use) and outlined as follows:

The selection of N-, R-, and P- series filters depends on the presence or absence of oil particles, as follows:

- If no oil particles are present in the work environment, use a filter of any series (i.e., N-, R-, or P- series).
- If oil particles (i.e., lubricants, cutting fluids, glycerin, etc.) are present, use an R- or P-series filter. Note: N- series filters cannot be used if oil particles are present.

- If oil particles are present and the filter is to be used for more than one work shift, use only a P- series filter.

In summary, when choosing a filter that is appropriate for a hazard both the type of filter and the filter efficiency must be considered. The type of filter and efficiency are presented in 13.8 Appendix H.

### **28.3.6 Respirator Designation**

The correct respirator shall be specified for each applicable job by the Supervisor with assistance from the Safety Office or by the Contractor's Safety Office/Representative. Respiratory protection requirements for all new or revised processes shall be determined during the technical review of such processes.

### **28.3.7 Factors that Influence Respirator Selection**

1. Nature of the hazard - this factor has several important aspects.
  - The physical state of the air contaminant; i.e., dust, fume, mist, gas, or chemical vapor. The physical state determines some limitations of the respirator.
  - The relative toxicity of the material; e.g., trichloroethylene is more toxic than 1,1,1-trichloroethane; brazing fumes from cadmium alloys are more toxic than fumes from steel alloys; etc.
  - The rate at which the contaminant affects the human body. For example, excessive concentrations of silica dust, although hazardous, will not cause an immediate effect; however, an excessive concentration of chlorine gas can overcome an individual almost instantly, making escape impossible.
  - The possibility exists that more than one air contaminant in different physical states may be involved.
2. Extent of the hazard - this factor includes the anticipated airborne concentrations and physical area in which the hazard exists.
3. Work requirements and conditions - this factor includes proximity to the source of the airborne contamination and physical restriction of the working area.

### **28.3.8 Procedure for Respirator Selection**

1. Determine hazard classification, i.e., oxygen deficiency or toxic contaminant (gases, particulate, or combination) and type of respiratory protection recommended.
2. Sections 28.13.1 through 28.13.5 identify specific airborne hazards and note respirator use codes.
3. Using the table in section 28.13.6 and the respirator use code determined from step 2, select the corresponding respirator type.
4. Section 28.13.7 lists gaseous materials for which air-purifying cartridges should NOT be used, although not a complete list. (This list was compiled from NIOSH and other sources.)
5. Section 28.13.8 provides a description of respirator filter classifications established by 42 CFR 84.
6. Questions concerning respirator use and selection shall be directed to the Ames Safety Office Respiratory Protection Program Administrator or to the Contractor's Safety Office for contract employees.

### **28.3.9 Voluntary Use of Respiratory Protection in Nonhazardous Atmospheres**

1. Supervisors may provide respirators at the request of employees or permit employees to use their own respirators in nonhazardous areas if the employer determines that such respirator use will not in itself create a hazard. If the supervisor determines that any

voluntary respirator use is permissible, the employer shall provide the respirator users with the following information:

**INFORMATION FOR EMPLOYEES USING RESPIRATORS WHEN NOT REQUIRED UNDER THE STANDARD (29 CFR 1910.134, Appendix D)**

- 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 employer 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.
- You should do the following:
  1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning, and care, and warnings regarding the respirator's limitations.
  2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. 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.
- 2. The supervisor must establish and implement those elements of the respiratory protection program necessary to ensure that any employee who voluntarily uses a respirator is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user.
- 3. Exception: Supervisors are not required to include in a written respiratory protection program those employees whose only use of respirators involves the voluntary use of filtering face pieces (dust masks).

## **28.4 Use of Respirators**

### **28.4.1 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 air flow, 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. Proper use, inspection, fitting, and maintenance of the respirator is the responsibility of the individual to whom the respirator was issued.

#### **28.4.2 Work in a Confined Space**

Chapter 26 of this manual discusses work in confined spaces.

#### **28.4.3 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.

#### **28.4.4 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.

#### **28.4.5 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.

#### **28.4.6 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.

#### **28.4.7 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.

#### **28.4.8 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.

#### **28.4.9 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.

#### **28.4.10 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.
  - All filters and prefilters should be replaced after no more than eight hours of cumulative use.
2. Vapor and gas-removing cartridges and canisters
  - Cartridges and canisters should be changed whenever 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/she should leave the hazardous area immediately and go to a clean area to change out the cartridges.
  - Cartridges or canisters should be replaced after eight hours of use, or more often if necessary.

#### **28.4.11 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.

#### **28.4.12 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 may be allowed and/or required under special circumstances as determined by the Ames Safety Office.
2. Powered air-purifying respirators may be a half-mask, full-face, or hood type, depending on the type of hazard and working conditions.

### **28.5 Respirator User's Inspection Guide**

#### **28.5.1 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.

#### **28.5.2 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.

### **28.5.3 Air-Supplied (Half-Mask or Full-Face) Respirators**

1. Inspect face piece and straps as outlined in section 28.5.2.
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.

### **28.5.4 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.

## **28.6 Respirator Fitting/Testing Procedures**

### **28.6.1 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.

### **28.6.2 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.

Qualitative tests using irritant smoke or other agent approved by the Ames Safety Office shall be conducted and documented on all persons who will wear a negative-pressure respirator. The procedure contained in Section 28.13.9, Irritant Smoke Fit-Testing Procedure, shall be used to fit-test respirators with irritant smoke.

**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.

## 1. Negative-pressure test:

- **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.
- **Inhale** gently so that the face piece collapses slightly, and
- **Hold** breath for ten seconds.
- **If** the face piece remains slightly collapsed and no inward leakage is detected, the respirator fit is adequate.

## 2. Positive-pressure test:

- **Close** off the opening of the exhalation valve by covering with the palm, being careful not to dislodge the face piece.
- **Exhale** gently into the face piece.
- **If** slight positive pressure can be built up inside the face piece without leaking, the respirator fit is considered satisfactory.

A qualitative respirator fit test shall be carried out for each wearer of a negative-pressure and powered air-purifying respirator at least annually. Respirator fit tests are not required for positive-pressure (air-line or SCBA) respirators.

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.

## 28.7 Respirator Inspection, Cleaning, Maintenance, and Storage

### 28.7.1 General

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

### 28.7.2 Cleaning Procedures

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. Remove filters, cartridges, or canisters. Disassemble face pieces 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 (43°C [110°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 (43°C [110°F] maximum), preferably running water. Drain.
4. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:
  - Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43°C (110°F) maximum; or,
  - Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45-percent alcohol) to one liter of water at 43°C (110°F) maximum; or,
  - Other commercially available cleansers 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 (43°C [110°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.
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, zip-lock bag, or container for storage after it has completely dried.

### **28.7.3 Pesticide Contamination**

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

### **28.7.4 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.

### **28.7.5 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, the 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.

## **28.8 Breathing-Air Quality and Supplied Air Systems**

### **28.8.1 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/m<sup>3</sup> total hydrocarbons.
5. No objectionable odors.

### **28.8.2 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.

### **28.8.3 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.

### **28.8.4 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.

### **28.8.5 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.

## **28.9 Respirator Training**

### **28.9.1 Trainer Qualifications**

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

### **28.9.2 Who Requires Training**

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

### **28.9.3 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).

### **28.9.4 Request for Respirator Training**

To schedule respirator training, ARC Form 28, Request for Respirator Training (see section 28.13.10, Respirator Authorization) must be properly prepared.

1. Section I: To be filled out by the employee and the employee's supervisor.
2. 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.
3. Section III: After completion of Section II, the form is forwarded to the Ames Health Unit. The Ames Health Unit performs the respiratory protection medical clearance, which has been scheduled by the employee or supervisor named in Section I.
4. Section IV: This section is completed after successful completion of training and Fit-Testing.

### **28.9.5 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 28.13.11).
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.

### **28.9.6 Respirator Issue**

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

## **28.10 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.

### 28.11 Definitions

1. **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.
2. **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.
3. **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.
4. **Dust:** A solid, mechanically produced particle that is generally greater than one micron in size. Examples of dusts include sawdust, cement, and metal grindings.
5. **Employee exposure:** Exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.
6. **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.
7. **Escape-only respirator:** A respirator intended to be used only for emergency exit.
8. **Filter or air-purifying element:** A component used in respirators to remove solid or liquid aerosols from the inspired air.
9. **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.
10. **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.
11. **Fit-Test:** The use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.
12. **Fume:** A solid condensation particle generally less than one micron in size. An example of a fume is the particles generated by welding operations.
13. **Gas:** A material that has no liquid phase at standard temperature and pressure. Examples of gases include oxygen, nitrogen, and hydrogen.
14. **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.

15. **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.
16. **Loose-fitting face piece:** A respiratory inlet covering that is designed to form a partial seal with the face.
17. **Mist:** A liquid condensation particle that is generally greater than one micron in size. An example of a mist is paint overspray.
18. **National Institute of Occupational Safety and Health (NIOSH):** The governmental agency that assigns approval numbers to respirators.
19. **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.
20. **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.
21. **Oxygen-Deficient Atmosphere:** An atmosphere with an oxygen content below 19.5 percent by volume.
22. **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.
23. **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.
24. **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.
25. **Program Manager:** The single point of contact within NASA ARC or within a contractor with responsibility for overseeing the respiratory protection program.
26. **Self-contained breathing apparatus (SCBA):** An atmosphere-supplying respirator for which the breathing-air source is designed to be carried by the user.
27. **Service life:** The period of time that a respirator, filter, sorbent, or other respiratory equipment provides adequate protection to the wearer.
28. **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.
29. **Vapor:** The gaseous phase of a liquid at room temperature. Examples of materials that create vapors include xylene, toluene, and 1,1,1-trichloroethane.

## 28.12 Authority and References

29 CFR 1910.134 (Respirator Regulations) U. S. Dept. of Labor, Occupational Safety and Health

29 CFR 1910.1001 - 1045 (Chemical Specific Regulations)

CCR 8, Section 5144

American National Standards Institute (ANSI) Standard Z88.2-1992, Practices for Respiratory Protection

## 28.13 Appendices

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**28.13.1 Appendix A: Dust Inhalation Hazard Respirator Selection**

This table is intended to be used only as a general guide to respirator selection according to hazard classification. Since the actual respirator selection will depend on exposure level and duration to chemical stressors (partially represented in the listing below), it is important for the employee to confirm proper respirator selection through his/her supervisor and/or the Safety Office.

<b>Hazard Class/ Specific Hazard</b>	<b>Respirator Use Code** (See section 28.13.6)</b>	<b>Note(s)</b>
Alkaline dusts	1	Nuisance dust
Asbestos	2, 3, 9, 12, 15, 16	16 only for Class I
Beryllium	2, 3, 12, 16	Machining and welding needs are different
Blasting slag	1, 12, 14	1 outside near blasting, 12 inside near blasting, and 14 if blasting
Brass	1, 2	
Bronze	1, 2	
Cadmium	2, 3, 12, 16	Depends on operation and ventilation
Calcium oxide (quicklime)	1, 2, 3	
Carbon black	1, 2, 3	
Cement/concrete	1, 2	Alkaline dust
Chromates	2, 3, 9	9 if component of paint for overspray
Chromium	1, 2, 3	Grinding and welding ventilation requirements vary
Chromium trioxide	1, 2	"Chromic acid"; used in electroplating
Coal	1	
Copper	1, 2	Grinding and welding ventilation requirements may vary
Fiberglass	1, 3	Nuisance dust
Glass wool	1, 3	Same as fiberglass
Lead	2, 3, 12, 16	
Nickel	1, 2	Grinding and welding ventilation requirements vary
Radionuclides	2, 3, 10	Contact health physicist
Silica	1, 12	(Quartz) crystalline or amorphous silica requirements vary
Silver	2	
Sodium cyanide	2	Avoid contact with water and skin
Tin (inorganic)	1	
Wood	1	Hard and soft woods
Zinc	1	Nuisance dust or metal fume

See section 28.13.5. Air-supplied respiratory protection (Codes 12-16) is best when concentrations of workplace chemical stressors are either unknown or are excessively high (i.e., 1000 times the 8-hour time-weighted average concentration). In either case, substitute air-supplied respirators for air-purifying respirators.

**28.13.2 Appendix B: Mist Inhalation Hazard Respirator Selection**

This table is intended to be used only as a general guide to respirator selection according to hazard classification. Since the actual respirator selection will depend on exposure level and duration to chemical stressors (partially represented in the listing below), it is important for the employee to confirm proper respirator selection through his/her supervisor and/or the Safety Office.

<b>Hazard Class/ Specific Hazard</b>	<b>Respirator Use Code** (See section 28.13.6)</b>	<b>Note(s)</b>
Alkaline mists	1	
Chromic acid	1, 2	Avoid skin contact outside, open areas; enclosed spaces
Epoxy paint	7, 12, 12, 16	
Hydraulic fluid	4, 8, 12	
Hydrochloric acid	5	Gas may be present also
Lacquer spray	7, 12	
Oil mist	1, 7	Type of oil must be known
Phosphoric acid	1, 2	Present as mist
Sodium hydroxide	1, 2	Alkaline mist
Sulfuric acid	1, 5	

See section 28.13.5. Air-supplied respiratory protection (Codes 12-16) is best when concentrations of workplace chemical stressors are either unknown or are excessively high (i.e., 1000 times the 8-hour time-weighted average concentration). In either case, substitute air-supplied respirators for air-purifying respirators.

**28.13.3 Appendix C: Fume Inhalation Hazard Respirator Selection**

This table is intended to be used only as a general guide to respirator selection according to hazard classification. Since the actual respirator selection will depend on exposure level and duration to chemical stressors (partially represented in the listing below), it is important for the employee to confirm proper respirator selection through his/her supervisor and/or the Safety Office.

<b>Hazard Class/ Specific Hazard</b>	<b>Respirator Use Code** (See section 28.13.6)</b>	<b>Note(s)</b>
Beryllium	2, 3, 12	
Brass	2, 3, 12	
Bronze	2, 3, 12	
Cadmium	2, 3, 16	
Chromium	2, 3, 12	
Cobalt	2, 3, 12	
Copper	2, 3, 12, 13	Fume is skin/eye irritant
Iron oxide	2, 3, 13	Nuisance material
Lead	2, 3, 12	
Magnesium oxide	2, 3	Overexposure may cause metal-fume fever
Nickel	2, 3, 12	
Silver	>2, 3	
Zinc oxide	2, 3	Overexposure may cause metal-fume fever

See section 28.13.5. Air-supplied respiratory protection (Codes 12-16) is best when concentrations of workplace chemical stressors are either unknown or are excessively high (i.e., 1000 times the 8-hour time-weighted average concentration). In either case, substitute air-supplied respirators for air-purifying respirators.

#### 28.13.4 Appendix D: Gas/Vapor Inhalation Hazard Respirator Selection

This table is intended to be used only as a general guide to respirator selection according to hazard classification. Since the actual respirator selection will depend on exposure level and duration to chemical stressors (partially represented in the listing below), it is important for the employee to confirm proper respirator selection through his/her supervisor and/or the Safety Office.

Hazard Class/ Specific Hazard	Respirator Use Code** (See section 28.13.6)	Note(s)
Acetic acid	8, 10	10 if mist is also present
Acetone	4, 12	None required if used in small amounts
Adhesives (contains naphtha, toluene, xylene)	4, 12	None required if used in small amounts
Alcohols (except methanol)	4, 12	Not required if used in small amounts
Ammonia	6, 12, 16	Eye irritation
Argon (in voids/spaces)	15, 16	
Carbon dioxide	12, 15	Asphyxiant in high concentration
Carbon monoxide	12, 15, 16	Asphyxiant
Chlorine	5, 8, 12, 18	
Enamel spray	4, 7, 12	12 in enclosed spaces
Ethyl alcohol (ethanol)	4, 12	None required if used in small amounts
Formaldehyde	4, 12, 15, 16	
Freons	15, 16	For spill cleanup
Gasoline	4, 15, 16	
Hydrochloric acid	1, 5, 12	Mist and vapor can exist together
Hydrogen cyanide	12, 15, 16	Skin absorption can occur
Isocyanates	12	Medical evaluation of employee needed, see polyurethanes
Kerosene	4	
Lacquer spray	7, 12	
Mercury	12	
Methano	12	Skin absorption can occur
Methylamine	6, 12	
Methyl ethyl ketone	4, 12	
Methyl isobutyl ketone	4, 12	
Mineral spirits	4	Same as Stoddard Solvent (PD680)
Naphtha	4	
Nitrogen	15, 16	Asphyxiant
Oxygen deficiency	15, 16	Asphyxiant

Hazard Class/ Specific Hazard	Respirator Use Code** (See section 28.13.6)	Note(s)
Ozone	12	
Phenol	4	Skin absorption can occur
Polyurethanes	12	See isocyanates
Stoddard solvent	4	This is PD680 (mineral spirits)
Styrene monomer	4 or 12	Ventilation needs may vary
Sulfur dioxide	5	
Sulfuric acid	1, 5	Mists and vapors can exist together
Toluene	4	
Trichloroethylene	4, 12	
Tricresyl phosphate esters	4, 12	Present in some hydraulic fluids
Varnish	7, 12	
Xylene	4	

See section 28.13.5 Air-supplied respiratory protection (Codes 12-16) is best when concentrations of workplace chemical stressors are either unknown or are excessively high (i.e., 1000 times the 8-hour time-weighted average concentration). In either case, substitute air-supplied respirators for air-purifying respirators.

**28.13.5 Appendix E: Operation Hazard Respirator Selection**

This table is intended to be used only as a general guide to respirator selection according to operation. Since the actual respirator selection will depend on exposure level and exposure duration to chemical stressors in various work settings (partially represented in the listing below), it is important for the employee to confirm proper respirator selection through his/her supervisor and/or the Safety office.

Hazard Class/ Specific Hazard	Hazard	Respirator Use Code** (See section 28.13.6)	Note(s)
Abrasive blasting outside, inside, or confined spaces	Dust	1, 12, 14	
Asbestos ripout (Class I)	Dust	16	
Beryllium; cutting	Dust	2, 12	
Machining	Metal		
Brazing; poor ventilation	Metal fume	2, 3, 12	
Cadmium alloy and/or confined space	Metal fume	3, 12	
Carbon arcing	Metal fume	2, 3, 13	
Carbon arcing, confined space, and toxic coating	Metal fume and organic vapor	2, 3, 12, 13	Carbon arcing in confined space requires airline respirator even without toxic coating
Chlorine gas (cylinder leak, etc.)	Gas	15	
Cleaning tanks, maintenance of	Mist	7, 12	
Coal tar pitch indoor melting	Organic vapor	12	

Hazard Class/ Specific Hazard	Hazard	Respirator Use Code** (See section 28.13.6)	Note(s)
Cutting by torch; indoors, poor ventilation, confined spaces	Metal fume	2, 13	
Cutting, grinding, buffing, scaling	Dust	1, 2, 12	
Emergency entry; life hazardous spaces	Oxygen deficiency	15, 16	
Fiberglass installation	Dust	1, 3, 12	Requirements can vary
Freon spill clean-up	Vapor	4, 12	Includes use of Freon 113
Handling liquid chemicals	Mist	1	
Hydraulic fluid maintenance	Mist vapor	4, 12	
Inert or nontoxic gases; nitrogen, helium, argon	Gas	15, 16	
Insecticides, herbicides, and rodenticides	Mist vapor	11, 12	
Insulation work, gasket cutting, and lagging (non-asbestos)	Dust	1	
Isocyanates paint	Organic	12	
Foam in place	Vapor, paint		
Packaging	Mist, isocyanate		
Lead burning, bonding	Metal fume	12, 16	
Lead sawing	Dust	2	
Metal spray	Metal fume	2, 3	
Organic phosphate insecticides	Mist vapor	11, 12	
Organotin; pouring or brushing	Vapo	4	
Oxygen deficiency	Gas	15, 16	
Paint stripping; light concentration, heavy concentration confined spaces	Mist vapor	4, 5	
Painting; brushing, interior spray, touch-up spray extensive and/or confined spaces	Mist vapor	4, 7, 7, 12	Brushing, touch-up spray, spray painting/confined spaces
Paraffin fume	Fume	2, 3	
Rubber solvent; light concentration	Vapor	4	
Rubber solvent; heavy concentration, and/or confined spaces	Vapor	4, 12	
Ripout, asbestos	Dust	15	
Sanding or cutting plywood	Dust	1	
Silica; exposure other than sandblasting	Dust	1	Heavy concentrations in confined space could require 12
Silver soldering	Fume	2, 12	

Hazard Class/ Specific Hazard	Hazard	Respirator Use Code** (See section 28.13.6)	Note(s)
Solvent cleaning (PD680, Freon 113 Carburetor Cleaner)	Mist	4, 8	Depends on ventilation
Voids/spaces/tanks; untested or tagged unsafe	Gas	15, 16	
Welding; indoors, with poor ventilation, confined spaces with or without ventilation	Metal Fume	2, 3, 13	
Woodworking soft/hard wood	Dust	1	

See section 28.13.5. Air-supplied respiratory protection (Codes 12-16) is best when concentrations of workplace chemical stressors are either unknown or are excessively high (i.e., 1000 times the 8-hour time-weighted average concentration). In either case, substitute air-supplied respirators for air-purifying respirators.

**28.13.6 Appendix F: Respirator Type and Use Code Number**

Respirator Type	NIOSH Approval Number	Use Code Number
<b>1. Air-Purifying-Particulate Removing Filter Respirators</b>		
-- Dust/Mist Filter (N95, R95, P95) (does not apply to disposable paper masks)	TC-42C or TC-21C	1
-- High-Efficiency Filter (N100, R100, P100)	TC-42C or TC-21C	2
-- Powered Air-Purifying Respirator (Dust/Mist/Fume/High-Efficiency Filter)	TC-42C or TC-21C	3
<b>2. Air-Purifying-Gas/Vapor/Chemical Cartridge/Canister Respirators</b>		
-- Organic-Vapor Cartridge	TC-23C	4
-- Acid Gas Cartridge	TC-23C	5
-- Ammonia/Methylamine Cartridge	TC-23C	6
<b>3. Air-Purifying-Combination Particulate/Vapor/Gas-Removing Respirators</b>		
-- Paint/Lacquers/Enamel Mists Cartridge/Filter	TC-23C	7
-- Acid Gas/Organic-Vapor Cartridge	TC-23C	8
-- Organic Vapor/High-Efficiency Filter Combination	TC-23C	9
-- Organic Vapor/Acid Gas High Efficiency Filter Combination	TC-23C	10
-- Pesticide Combination Cartridge	TC-23C	11
<b>4. Atmosphere-Supplying Respirators</b>		
-- Air-Line Respirator (Type C, Full-Face Piece)	TC-19C	12
-- Air-Line Respirator (Type C, Welders Face Piece)	TC-19C	13
-- Air-Line Respirator (Type CE, Sandblasters Hood)	TC-19C	14
-- Self-Contained Breathing Apparatus (SCBA)	TC-19C	15
-- Combination Air-line/SCBA Respirator	TC-19C	16

### 28.13.7 Appendix G: List Of Gaseous Materials for Which Air-Purifying Cartridges Should NOT Be Used

Note: Only Partial List

2-Acetylaminofluorene	Acetylene	Acetylene tetrabromide
Acrolein	Acrylamide	Acrylonitrile
Allyl chloride	Allyl glycidyl ether	Allyl propyl disulfide
2-aminopyridine	Aniline	Antimony hydroxide
Argon	Arsine	Benz (A) Pyrene
Benzidene	Benzyl Chloride	Beta-naphthylamine
Beta-propialactone	Bis-chloromethyl ether	Boron tribromide
Boron trifluoride	Bromine	Bromoform
Butane	tert-Butyl Chromate	Butyl glycidylester
Butyl ketone	Camphor	Carbaryl (sevin)
Carbon dioxide	Carbon monoxide	Carbon tetrabromide
Carbon tetrachloride	Carbonyl chloride	Chlorodiphenyl (PCBs)
Chlorinated diphenyl oxide	Chlorinated trifluoride	Chlorine dioxide
Chlorine trifluoride	Chloroacetone	Chloroacetyl chloride
Chlorobromomethane	Chlorodifluoromethane	Chloroform
Chloromethyl methyl ether	Chloroprene	Chlorotrifluoroethane
Chromyl chloride	Cobalt carbonyl	Cobalt hydrocarbonyl
Cyanides	Cyanogen	Cyanogen chloride
Cyclohexane	Cyclohexene dioxide	Cyclopentane
Decaborane	Demeton (Septox)	Diazomethane
Diborane	Dibromochloropropane	1,2-Dibromoethane
Dibutyl phosphate	3,3-Dichlorobenzidine	1,1-Dichloro-1-nitroethane
Dichlorodifluoromethane (Freon 12)	1,2-Dichloroethane	Dichloromonofluoromethane (Freon 21)
1,3-Dichloropropane	2,2-Dichloropropionic Acid	Dichlorotetrafluoroethane (Freon 114)
Dichlorvos (DDVP)	Diethylamino ethanol	Diethylene triamine
Difluorodibromomethane (Freon 12B2)	Diglycidyl ether	Diisobutylene
Diisopropylamine	Dimethyl acetamide	4-Dimethylaminoazo-benzene
Dimethyl carbamyl chloride	Dimethylaniline	Dimethyl formamide
Dimethyl sulfate	Dinitrotoluene	Dioxane
Diopropylene glycol methyl ether	Diphenylbenzenes	Diphenylmethane diisocyanate
Dipropylene glycol methyl ether	Divinyl benzene	Epichlorohydrin
EPN	Ethane	Ethanol
2-Ethoxyethanol	Ethylamine	Ethyl bromide
Ethylene chlorohydrin	Ethyl chloride	Ethyl silicate
Ethylene imine	Ethylene dibromide	Ethylene dichloride
Ethylene glycol dinitrate	Ethylene oxide	N-ethylmorpholine
Fluorine	Fluorotrichloromethane (Freon 11)	Formaldehyde

Formamide	Formic Acid	Furfural
Germanium tetrahydride	Glycidol	Halothane
Helium	Heptachlor	Heptanone
Hexachlorobutadiene	Hexachloroethane	Hexachloronaphthalene (Halowax 1014)
Hexadiene	Hexafluoroacetone	Hexamethyl diisocyanate (HMDI)
Hexane	Hexone	Hydrazine
Hydrogen	Hydrogen arsenide	Hydrogen cyanide
Hydrogen fluoride	Hydrogen peroxide (90%)	Hydrogen sulfide
Iodine	Iron pentacarbonyl	Isooctyl alcohol
Isophorone diisocyanate	Isopropoxyethanol	Isopropyl glycidyl ether
Ketene	Krypton	LPG
Inorganic mercury	Mesityl oxide	Methacrylic acid
Methane	Methanol	Methyl acetate
Methyl acetylene	Methyl acrylate	Methyl alcohol
Methyl bromide	Methyl cellosolve	Methyl chloride
Methyl ethyl ketone peroxide	Methyl formate	Methyl hydrazine
Methyl iodide	Methyl isocyanate	Methyl parathion
Methylacrylonitrile	Methylal	Methylamine
Methylchloromethyl ether	4,4'-Methylene-bis-(2-chloroaniline)	Methylene bis (4-cyclohexylisocyanate)
Methylene chloride	4,4'-Methylene dianiline	Methyl bisphenyl isocyanate (MDI)
Monomethyl aniline	Morpholine	Neon
Nickel carbonyl	Nicotine	Nitric acid
Nitric oxide	para-Nitroaniline	Nitrobenzene
Nitroethane	Nitrogen	Nitrogen dioxide
Nitrogen trifluoride	Nitroglycerin	Nitrogen oxides
Nitromethane	Nitropropane	Nitrotoluene
Nitrous oxide	Octachloronaphthalene	Organo (alkyl) mercury
Osmium tetroxide	Oxygen difluoride	Ozone
Pentaborane	Pentachloronaphthalene	Pentane
Perchloroethylene	Perchloromethyl mercaptan	Perchloryl fluoride
Phenol	Phenyl phosphine	p-Phenylene diamine
Phosdrin (Mevinphos)	Phosgene	Phosphine
Phosphorous oxychloride	Phosphorous pentachloride	Phosphorous pentasulfide
Phosphorous trichloride	Piperidine	Propane
Propargyl alcohol	Propylene imine	Propylene glycol dinitrate
Propylene oxide	n-Propyl nitrate	Quinone
Selenium hexafluoride	Silane	Silicon tetrahydride
Sodium azide	Stibine	Sulfur chloride
Sulfur hexafluoride	Sulfur monochloride	Sulfur pentafluoride
Sulfur tetrafluoride	Sulfuryl fluoride	TEDP
Tellurium hexafluoride	TEPP	1,1,1,2-Tetrachloro 2,2-difluoroethane
1,1,2,2-Tetrachloro 1,2-difluoroethane (Freon 112)	1,1,2,2-Tetrachloroethane	Tetrachloronaphthalene

Tetraethyl lead	Tetramethyl lead	Thioglycolic acid
Thionyl chloride	Toluene diisocyanate (TDI)	Tributyl phosphate
1,1,2-Trichloroethane	1,1,2-Trichloro-1,2,2-trifluoroethane	Trichloroethylene
Trichlorofluoropropane	Trichloronaphthalene	Triethylamine
Trifluorobromomethane	Trinitrotoluene	Vinyl bromide
Vinyl chloride		

**28.13.8 Appendix H: The New 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.**

### 28.13.9 Appendix I: Irritant Smoke Fit-Testing Procedure

#### General

The employer shall include the following provisions in the fit-test procedures. All testing is to be conducted annually.

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least three sizes of elastomeric face pieces of the type of respirator that is to be tested, i.e., three sizes of Half-Mask; or three sizes of full face piece. Respirators of each size must be provided from at least two manufacturers.
2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension, and how to determine a comfortable fit. This instruction may not constitute the subject's formal training on respirator use; it is only a review.
3. The test subject shall be informed that he/she is being asked to select the respirator that provides the most comfortable fit. Each respirator represents a different size and shape, and if fitted, maintained, and used properly, will provide substantial protection.
4. The test subject shall be instructed to hold each face piece up to the face and eliminate those that obviously do not give a comfortable fit.
5. The more comfortable face pieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in item 6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.
6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:
  - Position of the mask on the nose;
  - Room for eye protection;
  - Room to talk; and
  - Position of mask on face and cheeks.
7. The following criteria shall be used to help determine the adequacy of the respirator fit:
  - Chin properly placed
  - Adequate strap tension, not overly tightened;
  - Fit across nose bridge;
  - Respirator of proper size to span distance from nose to chin;
  - Tendency of respirator to slip; and
  - Self-observation in mirror to evaluate fit and respirator position.
8. The test subject shall conduct the negative- and positive-pressure fit checks as described below. Before conducting the negative- or positive-pressure test, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another face piece shall be selected and retested if the test subject fails the fit-check tests.
  - Positive-pressure test. Close off the exhalation valve and exhale gently onto the face piece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the face piece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

- Negative-pressure test. Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s). Inhale gently so that the face piece collapses slightly, and hold the breath for ten seconds. If the face piece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.
9. The test shall not be conducted if there is any hair growth between the skin and the face piece sealing surface, such as stubble beard growth, beard, or long sideburns that cross the respirator sealing surface. Any type of apparel that interferes with a satisfactory fit shall be altered or removed.
  10. If a test subject exhibits difficulty in breathing during the tests, he/she shall be referred to a physician trained in respiratory disease or pulmonary medicine to determine whether the test subject can wear a respirator while performing his/her duties.
  11. The test subject shall be given the opportunity to wear the successfully fitted respirator for a period of two weeks. If at any time during this period the respirator becomes uncomfortable, the test subject shall be given the opportunity to select a different face piece and to be retested.
  12. The employer shall maintain a record of the fit-test administered to an employee. The record shall contain at least the following information:
    - Name of employee;
    - Type of respirator;
    - Brand, size of respirator; and
    - Date of test.
  13. Prior to the commencement of his/her fit-test, the test subject shall be given a description of the Fit-Test and the test subject responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least five minutes before the start of the Fit-Test.
  14. The test subject shall be instructed to keep his/her eyes closed.
  15. The test operator shall direct the stream of irritant smoke from the smoke tube toward the face-seal area of the test subject, using the low flow pump or the squeeze bulb. The test operator shall begin at least 12 inches from the face piece and move the smoke stream around the whole perimeter of the mask. The operator shall gradually make two more passes around the perimeter of the mask, moving to within six inches of the respirator.
  16. If the person being tested has not had an involuntary response and/or detected the irritant smoke, proceed with the test exercises.
  17. Test Exercises. The test subject shall perform exercises in the test environment in the manner described below:
    - **Normal breathing.** In a normal standing position, without talking, the subject shall breathe normally.
    - **Deep breathing.** In a normal standing position, without talking, the subject shall breathe slowly and deeply, taking care so as to not hyperventilate.
    - **Turning head side to side.** Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.
    - **Moving head up and down.** Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).

- **Talking.** The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.
- **Grimace.** The test subject shall grimace by smiling or frowning.
- **Bending over.** The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type units that prohibit bending at the waist.
- **Normal breathing.** Same as the first exercise. Each test exercise shall be performed for one minute except for the grimace exercise, which shall be performed for 15 seconds. The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become uncomfortable, another model of respirator shall be tried.

### **Irritant Fume Protocol**

1. The respirator to be tested shall be equipped with P100 or high-efficiency particulate air (HEPA) filters.
  2. The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its characteristic odor.
  3. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach one end of the smoke tube to a low-flow air pump set to deliver 200 milliliters per minute.
  4. Advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep his/her eyes closed while the test is performed.
  5. The test conductor shall direct the stream of irritant smoke from the smoke tube toward the face-seal area of the test subject. He/she shall begin at least 12 inches from the face piece and gradually move to within one inch, moving around the whole perimeter of the mask.
  6. The exercises identified in section 28.13.9, General, item 17 shall be performed by the test subject while the respirator seal is being challenged by the smoke.
  7. Each test subject who passes the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube after the respirator has been removed to determine whether he/she reacts to the smoke. Failure to evoke a response shall void the Fit-Test.
  8. The Fit-Test shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agent.
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28.13.10 Appendix J: Respirator Authorization

	<b>REQUEST FOR RESPIRATOR TRAINING</b>
<b>SECTION I: Employee Work Information</b>	
NAME (Last, First, Middle Initial) _____ SOCIAL SECURITY NO. _____	
ORG CODE _____	CONTRACTOR _____ MAIL 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 _____	
<b>SECTION II: (To be completed by Industrial Hygienist)</b>	
I certify that I have reviewed the above described work operations.	
INDUSTRIAL HYGIENIST NAME (Print and Sign) _____ DATE _____	
<b>SECTION III: (To be completed by the approving physician)</b>	
I certify that I have examined as necessary, (minimum: history, FEV <sub>1</sub> , 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 _____	
<b>SECTION IV: TRAINING AND FIT TESTING</b>	
Employee attended respiratory training class on: _____ Test Score _____	
Employee was qualitatively fit-tested on _____ using irritant smoke with the following equipment worn:	
<input type="checkbox"/> Half-face Respirator <input type="checkbox"/> Full-face Respirator <input type="checkbox"/> Other _____	<input type="checkbox"/> MSA <input type="checkbox"/> North <input type="checkbox"/> 3M <input type="checkbox"/> Other _____
<input type="checkbox"/> X-Small <input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large	
TRAINOR NAME (Print and Sign) _____ DATE _____	
<small>EMPLOYEE STATEMENT: I have been trained in the following areas: the limitations and proper use of a respirator, APT cartridge selection, pre-use inspection, positive and negative pressure fit testing, the use, cleaning, and maintenance of APT. I understand that I am responsible for using the respirator in areas or conditions requiring pre-use inspection, positive and negative pressure fit test, proper cleaning, maintenance, and storage, reporting respiratory malfunctions or damage to the supervisor, having the contaminated area immediately reclassified, ensuring adequate airflow, or if I can smell or taste chemicals.</small>	
EMPLOYEE SIGNATURE _____ DATE _____	

28.13.11 Appendix K: 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	
_____	_____
Health & Safety Signature	Date

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

END OF DOCUMENT