A. Purpose
The purpose of the Respiratory Protection Policy is to establish acceptable practices for NIOSH-approved respirator selection, use, and maintenance, as well as procedures for medical clearance and respirator fit testing, in accordance with Occupational Safety and Health Administration (OSHA) Respiratory Protection standard, 29 CFR 1910.134, and Columbia University policy.

B. Applicability/Scope
This policy applies to all Columbia University personnel who are required to use a NIOSH-approved respirator based on workplace airborne hazard exposure assessment performed by Environmental Health & Safety (EH&S), as well as personnel who choose to voluntarily use a respirator when a respirator is not deemed necessary by EH&S to protect against potential airborne hazards.

C. Responsibilities

1. Respirator User
   a. Follow all Respiratory Protection Program requirements.
   b. Receive training via EH&S, Workforce Health & Safety (WHS) or other means specified by EH&S as to why a respirator may be necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator; respirator limitations; how to inspect, put on and remove, use, and check the seals of the respirator; maintenance and storage of the respirator; how to recognize medical signs and symptoms that may limit or prevent the effective use of respirators, such as excessive weight loss or weight gain.
   c. Wear the respirator only for its intended use.
   d. Notify the supervisor/administrator and/or EH&S if any changes to work practices (e.g., hazardous substances, engineering controls, work location, etc.).
   e. Care for the respirator and follow proper use, cleaning or storage requirements.
   f. Inspect the respirator for defects, missing parts, etc., and if found defective, return it to the supervisor. For emergency use respirator follow instructions in Record f Monthly Respirator Inspection Form.
   g. Notify the supervisor and physician or other licensed health care professional (PLHCP) of any change in your physical condition.
   h. Comply with annual medical clearance and fit test requirements.

2. Respirators User’s Supervisor/Administrator
   a. Coordinate a risk assessment of work practices and determination of need for respiratory protection by EH&S. (Complete Respiratory Protection Assessment Form).
   b. Arrange for the medical evaluation of potential respirator users. (Medical Clearance for Respirator Use).
   c. Purchase only NIOSH-approved respirators appropriate for the task.
   d. Coordinate respirator training and fit testing with WHS following a risk assessment performed by EH&S. (How Do I Arrange a Respirator Fit Test)
   e. Assume responsibility and/or appoint a respirator use coordinator within the dept.
   f. Ensure the availability of sufficient type and quantity of respirators and respirator’s filters/chemical cartridges for specific contaminants and work activities and cleaning agents.
   g. Periodically evaluate the effectiveness of the program to ensure that personnel have had valid fit testing, using respirators properly for the task and respirators are clean and maintained properly.
h. Notify EH&S of any changes to work practices that might reduce or increase the respirator user’s potential exposure to an airborne contaminant and subsequently affect the continued need to wear a respirator or the need to wear a different respirator.

3. Physician or other licensed health care professional (PLHCP)
   a. Perform a medical evaluation in accordance with the requirements of all applicable regulations to determine if a potential respirator user is cleared to wear a respirator.
   b. Provide training to respirator users on the proper use and care of respirators
   c. Fit-test respirator users who are cleared by WHS for respirator use
   d. Establish the frequency of follow-up medical evaluations and scope of any tests that may be necessary to support the medical determination.
   e. Maintain records of all medical evaluations as required by the law.

4. Environmental Health and Safety (EH&S)
   a. Establish a University-wide written respiratory protection program as an administrator of the program.
   b. Perform risk assessments to establish a determination of need for a respirator, as necessary or upon request.
   c. Consider hazard elimination and substitution possibilities, as well as engineering and administrative controls, in conjunction with a risk assessment.
   d. Recommend appropriate respiratory protective equipment where the determination of need supports use of a respirator.
   e. Provide training and fit test to users who are not trained and fit tested by PLHCP/WHS.
   f. Maintain respirator training and fit-testing records, as necessary.
   g. Review Respiratory Protection Program, as necessary

D. Definitions
   Detailed description of various words and terms used in this policy are listed under OSHA Respiratory Protection Standard 29 CFR 1910.134

E. Procedures

The use of NIOSH-approved respirators is strictly regulated by the Occupational Safety and Health Administration’s (OSHA) Respiratory Protection Standard, 29 CFR 1910.134. Columbia University has developed this Respiratory Protection Program to comply with OSHA’s regulation and, accordingly, the use of a respirator for protection against potential airborne hazards by personnel at Columbia is permitted only following a formal consultation and work practice/exposure assessment by EH&S or based on specific, pre-defined job classifications or activities (Do I Need to Wear a Respirator).

A work practice/exposure assessment performed by EH&S will determine the potential for exposure to airborne hazards and whether or not a respirator use is required. If a respirator is required, users will be enrolled in this Respiratory Protection Program. Enrollment, as required by OSHA and Columbia University policy, involves an annual medical clearance by a PLHCP, selection, use and maintenance, training and respirator fit-test by WHS or EH&S.
Respiratory Protection Policy

There are few activities performed at Columbia where respirator use is necessary to protect against airborne hazards in excess of recognized occupational exposure limits, especially after modifying work practices and/or introducing engineering controls. Whenever a respirator is deemed necessary by faculty, staff, students or visitors, it is essential that EH&S lead the process for selecting the proper respirator for the user since not all respirators will protect against all potential airborne hazards. As such, the purchase and/or use of any NIOSH-approved respirator, including N-95 respirators, must only occur after a work practice/exposure assessment is performed and EH&S advises on the most appropriate respirator for the specific work activity.

The following procedure will be followed to determine faculty, staff, students and visitors enrollment in the Columbia University Respiratory Protection Program.

1. Requesting a work practice/exposure assessment
   a. Staff can request an assessment through the department/supervisor or directly with EH&S by completing Respiratory Protection Assessment Form.
   b. Facilities staff can request an assessment through the respective Compliance Director at Morningside and CUMC or the Safety Manager at Lamont-Doherty Earth Observatory (LDEO), who can contact EH&S at occusafety@columbia.edu.
   c. Students and visitors can request an assessment through their Principal Investigator (PI), department/supervisor or sponsor, who can contact EH&S at occusafety@columbia.edu.
   d. For specific, pre-defined job classifications or activities where respirator use is standard, users will be enrolled in the program by EH&S (Do I Need a Respirator).

2. Performing a work practice/exposure assessment
   a. EH&S will perform a work practice/exposure assessment in coordination with all stakeholders.
   b. The work practice/exposure assessment will be scheduled to coincide with actual activities causing concern for airborne exposure.
   c. Depending on the results of the work practice/exposure assessment, follow-up/repeat assessments may be needed based on EH&S recommendations or OSHA requirements.

3. Providing recommendations on a work practice/exposure assessment
   a. EH&S will prepare a written report of findings and recommendations from each work practice/exposure assessment.
   b. EH&S will base its written recommendations on the recognized occupational hygiene hierarchy of controls:
      i. Elimination
      ii. Substitution
      iii. Engineering controls
      iv. Administrative controls
      v. Personal Protective Equipment (PPE)
   Since it is often impractical to eliminate work activities, EH&S recommendations typically emphasize substitution practices and engineering controls. Personal protective equipment (PPE), which is often thought of as one of the primary methods of protecting personnel, is in fact considered as a “last line of defense” after other control measures fails to reduce airborne hazards.
concentrations of hazardous substances below recognized occupational exposure limits. EH&S recommendations for respirators will follow recommendations for other primary control measures.

4. Recommending a respirator
   a. If EH&S’s written recommendations for reducing airborne exposure to hazardous substances include the use of a respirator by one or more individuals, such use is subject to the full extent of the OSHA Respiratory Protection standard and Columbia University’s Respiratory Protection Policy.
   b. Personnel in pre-defined job classifications or activities where respirator is recommended must use it for the activities defined in requirements.

5. Obtaining medical clearance to wear a respirator
   a. To comply with the OSHA Respiratory Protection standard and Columbia University’s Respiratory Protection Policy, individuals required to wear a respirator must obtain medical clearance from a PLHCP prior to being issued a respirator or wearing a self-issued respirator at Columbia University or any remote site while conducting activities as a faculty, staff, student or visitor representing Columbia University.
   b. Medical clearance can be obtained from various PLHCPs as outlined in http://www.ehs.columbia.edu/rpp.html for each of Columbia University’s campus.
   c. Following medical clearance from a PLHCP, user must undergo fit-testing before donning a respirator.

6. Performing a respirator fit-test
   a. A respirator medical clearance form, completed by a PLHCP, must be provided to the qualified individual performing the respirator fit-test.
   b. OSHA places some limitations on who can be fit-tested (e.g., individuals with beards that interfere with the seal of the respirator). Refer to http://www.ehs.columbia.edu/rpp.html to review respirator fit-test limitations.
   d. Fit-tests can be performed by various qualified individuals. Refer to http://www.ehs.columbia.edu/rpp.html for fit-test options for each of Columbia University’s campuses.

7. Confirming fit-test registration prior to respirator use
   a. Fit-test records shall be provided to EH&S by the PLHCP so the respirator user can be enrolled in the Columbia University’s Respiratory Protection Program.
   b. Fit-test records must contain relevant information to allow EH&S to enroll respirator users in the Columbia University’s Respiratory Protection Program.
   c. Refer to section H of this policy for fit-test record information that must be provided to EH&S.

8. Voluntary use of a “dust mask” or respirator
a. If it is determined by EH&S that a NIOSH-approved respirator is not required for the task, but an individual still prefers to wear a “mask” for nuisance-level dusts or particulates, a “nuisance dust mask” or surgical-style mask may be a suitable option. These masks are not considered NIOSH-approved respirators, but may be suitable for providing the user added comfort for nuisance-level dust or particulates, and thus can be purchased and used without EH&S approval or enrollment in Columbia’s Respiratory Protection Program. Several options for “nuisance dust masks” and surgical-style masks can be found at [http://www.ehs.columbia.edu/RespiratorSelectionAndUse.html](http://www.ehs.columbia.edu/RespiratorSelectionAndUse.html).

b. If an individual chooses to use a NIOSH-approved respirator voluntarily, whether their own or one issued by Columbia University, even after it is determined by EH&S not to be required based on an exposure assessment, EH&S must be consulted before use to ensure Columbia University meets its OSHA obligations in conveying specific information to the user regarding selection, use and maintenance of a voluntary use respirator. This information is covered in OSHA’s Respiratory Protection standard, 29 CFR 1910.134 Appendix D. Refer to Voluntary Use of Filtering Face Piece Respirator for Columbia University’s form. **Note:** individuals voluntarily wearing NIOSH-approved N-95, N-99 or N-100 respirators DO NOT require medical clearance or a fit-test. All other types of respirators use require medical clearance and a fit-test and are subject to the requirements of OSHA’s Respiratory Protection standard, 29 CFR 1910.134, and this Policy.

c. Voluntary use respirators are not required to be provided to faculty, staff, students or visitors, however departments/administrators are permitted to make provisions for providing voluntary use respirators at no cost to the user, as long as such provision and use conforms to OSHA’s Respiratory Protection standard, 29 CFR 1910.134, and this Policy.

9. Receiving respirator training
   a. OSHA requires all respirator users receive training initially before use and at least annually thereafter on the respiratory hazards like contaminants, their routes of entry, control of hazards, regulatory requirements, types of respirators, their selection, proper fit, usage, and maintenance, the limitations and capabilities of the respirator, how to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions; how to inspect, put on and remove, use, and check the seals of the respirator; procedures for maintenance and storage, and how to recognize medical signs and symptoms that may limit or prevent the effective use of respirators.
   b. Training, which at a minimum shall address provisions in the above paragraph of this Policy, shall be provided by a qualified individual performing the fit-test. If such training is not provided by the qualified individual performing the fit-test, EH&S must be contacted by the respirator user or their department/supervisor to arrange for such training through EH&S prior to the use of a respirator.

10. Selecting a respirator and respirator availability
   a. A respirator must be selected based on the anticipated airborne hazard(s). Not all respirators protect against all hazards. Using the incorrect respirator can be dangerous to the user.
b. EH&S and/or the PLHCP will identify the appropriate NIOSH-approved respirator(s) for the anticipated airborne hazard(s). The respirator user shall be fit-tested using only the respirator(s) identified by EH&S and/or the PLHCP.

c. The respirator user shall only wear the respirator brand, model and size respirator(s) with which they were fit-tested and shall only wear the respirator(s) for the work practice/exposure assessment performed by EH&S or the specific, pre-defined job classifications or activities identified by EH&S or the PLHCP.

d. Respirators and all necessary accessories shall be made available to anyone who is required to wear one at no cost to the respirator user. Departments/supervisors are required to make provisions for respirator users to have ready access to an adequate supply of respirators at no cost and without delay. If a required respirator is not available, the respirator user shall not perform the work practices for which the respirator is required until such respirator is made available.

e. If other work practices create potential airborne hazards, EH&S must be contacted to perform an additional work practice/exposure assessment before allowing personnel to work in such environment.

11. Using and caring for a respirator

   a. Respirator use shall be in accordance with the respirator manufacturer’s recommendation, as well as training/instruction received from EH&S and/or PLHCP. Refer to the manufacturer’s user instructions prior to use. Additional information is provided in Appendix 2.

   b. Before use, the respirator user must verify the respirator is in good condition and provides a proper fit.

   c. Disposable respirators (e.g., N-95, N-99 or N-100) shall not be reused. Disposable respirators must be changed in accordance with the manufacturer’s instructions and disposed of at the end of the work day, more frequently if visibly contaminated/soiled.

   d. Reusable respirators must be regularly cleaned and disinfected. Respirators and accessories shall be stored in a sealed container/bag in a sanitary location free of contaminants.

   e. Reusable respirators shall be visually inspected during cleaning. Only trained personnel may replace worn or deteriorated parts with new parts. No attempt should be made to replace components or to make adjustments or repairs beyond the manufacturer's recommendations.

   f. Only clean shaven skin may be in contact with any respirator sealing surfaces. Even a mild growth of facial hair can interfere with a respirator’s seal, compromising its ability to protect the user from airborne hazards.

F. Emergency Contacts

In the event of a hazardous materials emergency during the use of a respirator (e.g., respirator failure, hazardous materials spill), contact EH&S and your campus’s Public Safety Department for immediate assistance. In the event of a medical emergency during the use of a respirator, contact Public Safety to arrange for immediate medical assistance.

1. Environmental Health and Safety (EH&S)

   a. Morningside Campus and Nevis Laboratories  212-854-8749

   b. Medical Center Campus  212-305-6780

   c. Lamont-Doherty Earth Observatory (LDEO)  845-365-8822
2. Public Safety
   a. Morningside Campus       212- 854-5555
   b. Medical Center Campus     212- 305 - 7979
   c. LDEO Campus      845-365-8822
   d. Nevis Campus      212- 854-5555

G. Medical Surveillance
   The purpose of medical clearance is to ensure that personnel have adequate respiratory and cardiovascular fitness prior to wearing a respirator. Once it has been determined that an individual needs respiratory protection, medical clearance from a PLHCP, as referenced in Paragraph E.5 of this Policy, is required.
   Medical surveillance must be repeated at a frequency recommended by the PLHCP, but no less frequently than annual and prior to the required annual respirator fit-test.
   Medical clearance can be obtained from various PLHCPs. Refer to http://www.ehs.columbia.edu/rpp.html for medical clearance options for each of Columbia University’s campuses.

H. Recordkeeping
   1. At a minimum, the records should include the following information, as outlined in the OSHA standard:
      a. Name and/or identification of the person fit tested
      b. Specific make, model, size and type of respirator fit tested.
      c. Date and type of fit test QLFT or QNFT) performed.
      d. Challenge agent used for QLFT fit testing and results as pass/fail (for QNFT keep fit test chart strip).
      e. Medical clearance certificate from a healthcare provider.
   2. EH&S shall maintain training and fit testing records as required by regulations.
   3. Healthcare provider shall maintain all medical records as required by the law.
   4. Supervisor shall maintain records of inspection and maintenance of respirators.
   5. Records shall be made available to the employees upon a written request.
   6. Records shall be maintained for the duration specified by OSHA standard 1910.134.

I. Appendices
   1. Qualitative (QLFT) and Quantitative (QNFT) Fit-Testing Protocol
   2. Procedures for Cleaning and Sanitizing Respirators
   3. Types of Respirators: Description and Limitations

J. Forms          N/A

K. References
   2. NIOSH Guide to the Selection and Use of Particulate Respirators (Certified under 42 CFR 84)
      http://www.cdc.gov/niosh/docs/96-101/
   3. NIOSH Guide to Industrial Respiratory Protection
Appendix 1

QUALITATIVE (QLFT) AND QUANTITATIVE (QNFT) FIT-TESTING PROTOCOL

QUALITATIVE (QLFT) FIT-TESTING PROTOCOL

I. Requirements
Before any kind of fit-testing is done, each test subject must have written approval from the Healthcare provider attesting that the individual is physically able to wear a respirator.

II. Procedure
Saccharin solution, Bitrix solution or Irritant smoke can be used for both types of respirators. Air-purifying respirators should be tested with a commercially available challenging agent appropriate for the test

Adequate ventilation should be provided when carrying out tests to prevent contamination of the room; or they should be conducted in a room that is not used for selection and fitting. The test subject should keep his/her eyes closed during the test to avoid irritation in sensitive individuals.

The following procedure for fit-testing should be followed:

A. Respirator Selection
1. Only NIOSH approved respirators should be recommended for use.
2. The test subject should be allowed to select, from a variety of respirators, the one that is most comfortable.
3. Preferably, the fitting process should be conducted in a room separate from the fit test room to prevent contamination of the room. Prior to the selection, the test subject should be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension, and how to assess "comfort".
4. Assessment of comfort will include reviewing the following points with the test subject:
   • proper chin placement
   • positioning of mask on nose
   • strap tension
   • fitting across nose bridge
   • room for safety glasses
   • distance from nose to chin
   • room to talk
   • tendency to slip
   • cheeks filled out
   • self-observation in mirror
   • adequate time for assessment
5. The test subject will conduct the conventional positive-and negative-pressure fit cheeks (e.g. see ANSI Z88.1-1980), as described below. Before conducting these cheeks, the subject will be told to seat the mask by rapidly moving the head side-to-side and up and down, taking a few deep breaths.
6. At this time, the test subject is ready for fit-testing.
7. After passing the fit-test, the test subject will be questioned again regarding the comfort of the respirator. If it has become uncomfortable, another model should be tried.

B. Negative Pressure Test
This test should be conducted by the test subject after the selection of a comfortable respirator. It consists of

closing off the inlet of the canister, cartridge, or filter (by covering with the palms or replacing the seals, or by

squeezing the breathing tube so that air does not go through), then inhaling gently so that the facepiece collapses
slightly, and holding the breath for ten seconds. If the facepiece remains slightly collapsed and no leakage is
detected, the respirator is considered tight enough. This test can be used only on respirators with tight-fitting

facepiece.

C. Positive Pressure Test
Very much like the negative pressure test, this test is conducted by closing off the exhalation valve and exhaling

gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be build up inside the

facepiece without any evidence of outward leakage. The test has some limitations. depending on the type of

respirator selected, which should be considered before making the test.

B. Fit-Testing
1. Each respirator used for fitting and fit-testing will be equipped with organic vapor cartridges or

offer protection against organic vapors. The cartridges will be changed periodically.

2. After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the

fit-testing room.

3. Each test subject is given a sensitivity check of the challenging agent to determine whether the

subject reacts to the agent. Failure to evoke a response voids the fit-test.

4. Each test subject will wear the respirator until feel comfortable in use, before starting the fit-test.

5. The test subject should perform the following exercises for about one minute:

   a. Normal breathing
   b. Deep breathing
   c. Turning head from side-to-side, taking care that the movement is complete, the respirator is
      not bumped on the shoulders, and inhalation is done at either side.
   d. Nodding head up and down, with complete motions at a frequency of one per second and
      making sure that the respirator remains tight.
   e. Talking. Talk aloud and slowly for several minutes.
   f. Normal breathing.

6. If the challenging agent causes the test subject to taste or cough, the test should be stopped, the

respirator rejected, and another one tried.

7. Each test subject who passes the fit test shall be provided appropriate documentation advising that

the test is valid only for a year. S/he should provide copies of this document to their supervisor for

their record.

QUANTITATIVE FIT TEST (QNFT) PROTOCOLS

1. General
   a. The university shall ensure that persons administering QNFT are able to calibrate equipment and
      perform tests properly, recognize invalid tests, calculate fit factors properly and ensure that test
      equipment is in proper working order.
b. The university shall ensure that QNFT equipment is kept clean, and is maintained and calibrated according to the manufacturer's instructions so as to operate at the parameters for which it was designed.

2. Ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol.

EH&S uses Portacount for QNFT. The ambient aerosol condensation nuclei counter (CNC) quantitative fit testing (Portacount™) protocol quantitatively fit tests respirators with the use of a probe. The probed respirator is only used for quantitative fit tests. A probed respirator has a special sampling device, installed on the respirator that allows the probe to sample the air from inside the mask. A probed respirator is required for each make, style, model, and size that the employer uses and can be obtained from the respirator manufacturer or distributor. The CNC instrument manufacturer, TSI Inc., also provides probe attachments (TSI sampling adapters) that permit fit testing in an employee's own respirator. A minimum fit factor pass level of at least 100 is necessary for a half-mask respirator and a minimum fit factor pass level of at least 500 is required for a full facepiece negative pressure respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

3. Portacount Fit Test Requirements.

   a. Check the respirator to make sure the sampling probe and line are properly attached to the facepiece and that the respirator is fitted with a particulate filter capable of preventing significant penetration by the ambient particles used for the fit test (e.g., NIOSH 42 CFR 84 series 100, series 99, or series 95 particulate filter) per manufacturer's instruction.

   b. Instruct the person to be tested to don the respirator for five minutes before the fit test starts. This purges the ambient particles trapped inside the respirator and permits the wearer to make certain the respirator is comfortable. This individual shall already have been trained on how to wear the respirator properly.

   c. Check for the following conditions for 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 the respirator to slip; Self-observation in a mirror to evaluate fit and respirator position.

   d. Have the person wearing the respirator do a user seal check. If leakage is detected, determine the cause. If leakage is from a poorly fitting facepiece, try another size of the same model respirator, or another model of respirator.

   e. Follow the manufacturer's instructions for operating the Portacount and proceed with the test.

   f. The test subject shall be instructed to perform the exercises in section I. A. 14. of Appendix A

   g. After the test exercises, 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 unacceptable, another model of respirator shall be tried.


   a. The Portacount will automatically stop and calculate the overall fit factor for the entire set of exercises. The overall fit factor is what counts. The Pass or Fail message will indicate whether or not the test was successful. If the test was a Pass, the fit test is over.

   b. Since the pass or fail criterion of the Portacount is user programmable, the test operator shall ensure that the pass or fail criterion meet the requirements for minimum respirator performance in OSHA Standard 1910.134, Appendix A.
c. A record of the test needs to be kept on file, assuming the fit test was successful. The record must contain the test subject's name; overall fit factor; make, model, style, and size of respirator used; and date tested.
PROCEDURE FOR CLEANING AND SANITIZING A RESPIRATOR

The following procedures may be used for cleaning and sanitizing respirators. Unless the manufacturer's instructions specify differently:

a. When necessary, remove the following components of respirators-inlet covering assemblies before cleaning and sanitizing.
   i. Filter, cartridge, canisters;
   ii. Speaking diaphragms;
   iii. Any components recommended by the respirator manufacturer.
b. Wash respiratory-inlet covering assemblies in warm (49 °C or 120 °F maximum temperature) cleaner sanitizer solution. A stiff bristle (not wire) brush may be used to facilitate removal of dirt or other foreign material.
c. Rinse respiratory inlet covering assemblies in clean, warm (49 °C or 120 °F.) water.
d. Drain all water and air-dry the respiratory-inlet covering assemblies.
e. Clean and sanitize all parts removed from respiratory-inlet covering as recommended by the manufacturer.
f. Hand-wipe respiratory-inlet covering assemblies, all parts, and all gaskets and valve seal surfaces with damp lint-free cloth as needed to remove water residue and all foreign materials.
g. Inspect parts and report to the supervisor if found to be damaged or
h. Attach new filters, cartridges, and canisters to respiratory-inlet covering.
i. Visually inspect and, where possible, test parts and respirator assemblies for proper function.
j. Place assembled respirators in appropriate containers for storage.

2. Strong cleaning and sanitizing agents and many solvents can damage rubber or elastomeric respirators parts. These materials must be used with caution.

3. Alternatively, respirators may be washed in a detergent solution and then sanitized by immersion in sanitizing solution. Some solutions that have proven effective are:
   a. a hypochlorite solution (50 ppm chlorine), a two minute immersion;
   b. an aqueous iodine solution (50 ppm iodine), two minute immersion; or
   c. a quaternary ammonium solution (200 ppm of quaternary ammonium compounds in water with less than 500 ppm total hardness), two minute immersion.

4. Different concentrations of quaternary ammonium salts are required to achieve a sanitizing solution with waters of various hardness. Inflammation of the user's skin (dermatitis) may occur if the quaternary ammonium compounds are not completely rinsed from the respirator. The hypochlorite and iodine solutions are unstable and break down as time progresses; they may cause deterioration of rubber or other elastomeric parts and may be corrosive to metallic parts. Immersion times should not be extended beyond the mentioned time periods, and the sanitizers must be thoroughly rinsed from the respirator parts. Manufacturer's recommendations should be observed.

5. Respirators may become contaminated with toxic materials. If the contamination is light, normal cleaning procedures should provide satisfactory decontamination; otherwise separate decontamination steps may be required before cleaning.
Appendix 3

TYPES OF RESPIRATORS
DESCRIPTION AND LIMITATIONS

I. INTRODUCTION
Respirators are divided into classes or types; air purifying and air supplying. In addition, these devices may be either tight-fitting, usually in the form of a face piece which covers at least the nose and mouth, or loose-fitting, which covers the head and, in some cases, the body. An important aspect of respirator operation and classification is the pressure within the face piece. The face piece pressure may be above or below the outside air pressure. If face piece pressure is lower than the outside air pressure, it is classified as negative; if above, it is positive. The concept of negative and positive pressure operation is extremely important when considering potential contaminant leakage into the respirator.

A. Tight-fitting Respirators
A tight-fitting respirator usually has a face piece of molded rubber or plastic that adheres to the skin of the wearer. These units are usually available in three categories—quarter mask, half mask, and full-face mask.

B. Loose-fitting Respirators
In this case, a hose that is attached to a helmet or suit supplies breathing air. The air could be supplied from an external source or from a tank worn by the individual. For this type of unit, it is important that a sufficient quantity of air be provided to the wearer to ensure that there is an outward flow of air so that contaminants do not enter the breathing zone.

C. Negative-Pressure Respirators
This type of respirator must have a tight-fitting face piece. Air-purifying respirators are the most common negative pressure devices, although some air-supplied respirators also operate in the negative pressure mode. These air-purifying devices may be further divided into two major classes—aerosol removing, and vapor and gas removing. In the former case, the removal process depends primarily on the size of the aerosol, regardless of the aerosol composition. In the latter case, the vapor or gas is absorbed onto an activated charcoal media or chemical, which may be selective in the material absorbed.

1. Aerosols are removed from the breathing air by a variety of filters. All filtration mechanisms depend on passing the air through a fibrous media of some type. The mechanisms of impaction, interception, and diffusion are directly related to the size of the aerosol and the filter medium being used. Along with mechanical entrapment methods such as air impaction, various additives can be applied to the filter medium to increase efficiency. The most common additive is a resin with a high dielectric constant. As particles lodge on the filter, breathing resistance increases. This factor creates an excellent end of service-life indicator.

2. Dust and mist filters. Almost all approved dust filters also have an approval for mist. While some disposable respirators are made of fiberglass, most other dust/mist filters are made either of synthetic fibers, resin-impregnated wool, or synthetic fiber felt materials. The fiber media for disposables are usually thinner than the dust/mist filters.

3. Fume filters are used for protection against metal fumes such as those generated by welding. They are being replaced by high efficiency filters—thin sheets of filter material with small fiber diameter and high resistance to flow per unit area. The high efficiency filter must be 99.97 percent efficient against 0.3 um dactyl phthalate aerosol. The high efficiency filter was originally designed for use in atmospheres containing radioactive particulates. However, its efficiency has made it popular for use
with all highly toxic particulates.

4. Gas and vapor sorption respirators use a chemical bed either to adsorb or absorb the contaminant in question. The danger with this method is that of possible breakthrough of the chemical in question before the work period is completed. The most effective technique to counter this hazard is to calculate a conservative breakthrough time and change cartridges or connectors at that time. Ideally, cartridges should be disposed of after each day's activity.

5. Universal canisters type N does not offer the same duration of protection from a specific contaminant as does a canister that is designed for the contaminant in question. Universal canisters should be replaced after each use and they should never be used if only one specific contaminant is expected.

6. Pesticide cartridges and canisters were at one time tested against various pesticides. This program is no longer in existence. Now they are tested to prove whether they furnish protection against aerosols as well as organic vapors.

7. Combination. Cartridges and canisters are also designed to be combined to protect against aerosols and organic vapors. However, the size and weight of these cartridges may cause breakage of the face seal on most half-face respirators. A full-face respirator should be used when these types of cartridges are required. The issue of combination cartridge leakage will be determined by ANFT.

D. Air Supplied Respirators

This type of unit depends on air or oxygen supplied from an external source. The air or oxygen can be supplied in a demand, pressure demand, or continuous mode. When wearers of this type of respirator carry their own air or oxygen source, the unit is classified as either a closed circuit or open circuit breathing apparatus.

1. In the demand mode, a negative pressure is required inside the face piece to open a valve and permit air to enter the respirator. The negative pressure may draw contaminated air through any gaps in the face-to-face seal.

2. The pressure-demand mode allows a positive pressure to build up inside the face. Thus, any leaks in the face-to-face seal will result in air flowing out of the facemask. This feature will prevent any contaminated air from entering the facemask as long as the maximum flow rate of the regulator is not exceeded as a result of rigorous activity by the wearer.

3. In the continuous mode, air is constantly flowing to the respirator user, usually from an air compressor or compressed air tank. The flow must be regulated so that the user gets as much air as he needs, as well as additional airflow sufficient to maintain the pressure inside the mask.

4. An open circuit SCBA consists of a compressed air tank, an airline and regulator, and a face from which the expired air is exhausted to the outside environment.

5. A closed circuit SCBA does not exhaust the expired air to the outside. After the carbon dioxide has been removed from the exhaled air, it is placed in a breathing bag internal to the unit. At that point, oxygen is injected into the breathing bag and mixed with the expended air. This atmosphere is then supplied to the user.

E. Powered Air-Purifying Respirators (PAPR)

Essentially, the powered devices are air-purifying respirators with an electrically operated blower inserted between the face and the air-purifying element to provide the energy necessary to force air through the air-purifying unit and into the face piece. These respirators, however, are for air-purifying only and must never be used in an oxygen-deficient atmosphere.

II. TYPES OF RESPIRATORS

A. AIR-PURIFYING RESPIRATORS
a. **General Description**
Half-mask, full-face piece, or mouthpiece respirators equipped with air purifying units (filter, cartridge, or canister) to remove gases, vapors, and particulate matter from the ambient air prior to its inhalation. Some air-purifying respirators are blower-operated and provide respirable air to the face piece, helmet, or hood.

b. **General Limitations**
   i. Air-purifying respirators do not protect against oxygen-deficient atmospheres or against skin irritation by, or absorption through the skin, of airborne contaminants.
   ii. The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the designed efficiency and maximum concentration for which the unit is effective. The protection provided by these respirators is dependent on canister, cartridge, filter-type, concentration of contaminant, and the wearer's respiratory rate. As a limit, all chemical cartridges, as well as any universal chemical canisters, should preferably be discarded after each day's use. The proper type of cartridge, canister, or filter must be selected for the particular atmosphere and conditions.
   iii. Air-purifying respirators may cause discomfort and objectionable resistance to breathing, and are of limited value in an atmosphere immediately dangerous to life and health (IDLH).

1. **Gas and Vapor Removing Respirators**
   a. **Description**
Packed sorbent beds (cartridge or canister) remove single gases or vapors (e.g., chlorine gas), a single class of gases or vapors (e.g. organic vapors), or a combination of two or more classes of gases and vapors (e.g. acid gases, organic vapors, ammonia, and carbon monoxide) by absorption, chemical reaction or a combination of these methods.

b. **Limitations**
No protection is provided against particulate contaminants, unless specified on canister or cartridge label. Their use should be avoided in atmospheres where the contaminants lack sufficient warning properties (e.g. odor, taste, or irritation).

2. **Particulate-Removing Respirators**
   a. **Description**
These include all completely assembled respirators designed for use as respiratory protection during entry into a hazardous particulate atmosphere that contains adequate oxygen to support life. They are equipped with filters to remove a single type of particulate matter (e.g. dust) or a combination of particulate matter (e.g. dust and fumes) from air.

b. **Limitations**
   i) **Half-Mask Face pieces**
Fabric covering is permissible only in atmosphere of coarse dusts and mists of low toxicity. No protection is provided for the eyes.
   ii) **Mouthpiece Respirator**
Nose clip must be firmly in place to prevent nasal breathing. Mouth breathing prevents the detection of any incidental vapor contaminants by odor. No protection is provided for the eyes.

3. **Combination Gas, Vapor, and Particulate Removing Respirators**
   a. **Description**
Includes all the devices discussed having either canisters or cartridges with filters for protection against dusts, mists, fumes, gases, and vapors. These include respirators that have been tested against lacquer and enamel mists.
Respiratory Protection Policy

9.07

(b) Limitations
The same limitations, as discussed for the other devices, also apply to the combination device, with the exception that it protects against gases, vapors and particulates.

4. Powered Air-Purifying Respirators (PAPR)

(a) Description
Air is drawn through a filter by a pump before it is delivered to the wearer. This air stream has the advantage of providing a cooling effect in warm temperatures. These respirators do not restrict mobility.

(b) Limitations
They are bulky, complex in design, and need continual maintenance as for example, replacement of air-purifying elements. The battery has a limited life and the blower will have to be replaced periodically. Out-of-doors use presents special problems if hot or very cold air is supplied to the respiratory inlet covering.

B. ATMOSPHERE SUPPLYING RESPIRATORS

(a) General Description
A respirable atmosphere is supplied independent of the ambient air surrounding the wearer. These devices provide protection against oxygen deficiency and most toxic atmospheres.

(b) General Limitations
Except for the supplied-air suit, no protection is provided against skin irritation by materials such as ammonia and hydrochloric acid (HCl), or against absorption through the skin of such materials as hydrocyanic acid (HCN), tritium, or organophosphate pesticides. Face pieces present special problems for individuals required to wear prescription lenses.

1. Self-Contained Breathing Apparatus

(a) Description
Includes all completely assembled, portable, self-contained devices designed for use as respiratory protection during entry into and/or escape from hazardous atmospheres. The wearer carries a supply of air, oxygen, or oxygen-generating material. Its use is permissible in atmospheres immediately dangerous to life or health (IDLH).

(i) Closed-circuit apparatus
An apparatus of the type in which the exhalation is rebreathed by the wearer after the carbon dioxide has been effectively removed and a suitable oxygen concentration restored by a compressed or liquid oxygen source or an oxygen-generating solid.

(ii) Open-circuit apparatus
An apparatus of the following types from which exhalation is vented to the atmosphere and not rebreathed.

(x) Demand type apparatus
An apparatus in which the pressure inside the face piece in relation to the immediate environment is positive during exhalation and negative during inhalation. The demand value permits oxygen or air-flow only during inhalation.

(y) Pressure-demand type apparatus
An apparatus in which the pressure inside the face piece in relation to the immediate environment is positive during both exhalation and inhalation. A warning device is provided to inform the wearer when the service-life is at a low level.

(b) Limitations
The period of protection is limited by the amount of air or oxygen, the ambient atmospheric pressure, and the
workload. Those SCBAs designed only for escape (self-rescue) from an IDLH atmosphere provide only a few minutes of service. The chief limitations of SCBAs are their weight and bulk, their limited service-life, and the training required for their maintenance and safe use.

i) Closed-circuit apparatus
   The closed-circuit operation conserves oxygen and permits longer service-life.

ii) Open-circuit demand and pressure demand
   The demand type features a negative pressure in the face piece on inhalation whereas the pressure-demand type maintains a positive pressure in the face piece and is less likely to permit inward leakage of contaminants.

2. Supplied-Air Respirators
   a. Description
      The air is supplied from an uncontaminated source through a hose. The source could be either a hand or motor-operated air blower or compressed air.
   b. Limitations
      The hose restricts the wearer’s movements and he must return to a respirable atmosphere by retracing his route of entry. The hose may be severed or pinched off or the source may fail.

i) Hose mask
   There are two types of hose mask with blower; hand-operated or a motor driven blower; and there is a hose mask without blower, where the wearer provides the motivating force to pull air through the hose. The hose inlet must be located in a respirable atmosphere. Blower could fail, or hose pinched off. The length of hose may restrict application of the device.

ii) Air-line Respirators
   These are of the continuous flow type, the demand type, or the pressure demand type. The respirable air is supplied through a hose from a compressor or compressed air cylinder. The hose is attached to the wearer by belt and a flow control value is provided to govern the rate of air-flow. These respirators provide no protection if air supply fails. Some contaminants, such as tritium, may penetrate the material of an air-line suite. Other contaminants, such as fluorine, may react chemically with the material of an air-line suite and damage it.

G. EMERGENCY EGRESS RESPIRATORS

1. Combination Supplied-Air/Air-purifying Respirators
   a. General Description
      These may be either air-purifying or air-supplying. The air-purifying variety usually consists of a mouthpiece device with nose clamp and small canister, or a tight-fitting gas mask with full-face piece, air hose, and large canister. Air-supplying devices are usually continuous flow devices with a universal hood over the user's head, or light weight short service-time demand SCBA type units which utilize a full, tight-fitting face piece. Continuous-flow devices may use compressed air or generate oxygen.
   b. General Limitations
      i. The mouthpiece-nose clamp device affords no protection for the wearer's eyes. In addition, this device must be used with extreme care— if the nose-clamp is not properly positioned; the protection received by the wearer may be reduced.
      ii. A gas mask should be used for escape from and not for entry into an IDLH atmosphere. The gas mask has the same limitations as any air-purifying respirator; if the full-face piece does not fit properly due to improper size, facial hair, or eyeglasses, the protection factor of this device will be reduced. These devices may not be used in an oxygen deficient atmosphere.
      iii. The continuous-flow self-contained breathing apparatus with a universal hood will eliminate problems with improper fitting. However, many individuals experience difficulty slipping the plastic bag neck seal
over their heads. This device is subject to over-breathing effects since it is a continuous-flow device. Because the air flow is insufficient to supply the needs of a wearer who becomes extremely excited and attempts a rapid egress from a dangerous situation, most manufacturers of these devices recommend that an individual stay calm and walk away from a serious situation. US Air Force tests on these devices show that, under rapid egress conditions, the oxygen in the hood drops to a dangerously low level while the level of carbon dioxide increases. Since the hood is not tight-fitting, contaminants migrate up through the neck seal if the wearer over breathes the unit. If this type of unit is over-stressed in an oxygen deficient atmosphere, oxygen levels within the hood are further reduced.

iv. Short service time-demand and pressure-demand SCBA escape units are bulky and some individuals may find them uncomfortable. Proper face fit is important, especially with the demand units.