RESPIRATORY PROTECTION PLAN
Minnesota Nano Center

January 2017
University of Minnesota
Greg Cibuzar, MNC Safety Officer
STATEMENT OF POLICY

The University of Minnesota is committed to maintaining a safe and healthy work environment. Managers and supervisors are responsible for establishing and maintaining good health and safety practices in their respective units.

When employees are exposed or potentially exposed to hazardous air contaminants, the primary method of protecting employees will be to prevent exposures through the judicious use of accepted engineering methods, such as elimination of the hazardous substance or isolation of the process. However, when engineering controls are infeasible, or when they fail to reduce the level of contamination to acceptable levels, or during periods that engineering controls are being implemented, respirators will be provided to, and worn by, employees.

In all cases, the use of respirators will be classified as “required” or “voluntary,” based on exposures and management discretion. Specific portions of the Respiratory Protection Program (RPP) may apply to both mandatory and voluntary use, and other sections will apply to mandatory use, but not voluntary, or vice versa. Each section of the program will clearly delineate this distinction.

This program is intended to conform to Federal and Minnesota laws and specifically comply with the Occupational Safety and Health Administration (OSHA) requirements codified at 29 CFR 1910.134 (Respiratory Protection Standard, revised 10/5/1998), and 29 CFR 1910.139 (M. tuberculosis standard).
RELATED

None.

SCOPE AND APPLICATION

This program applies to all U of M community members and operations.

This program applies to all use of respirators, voluntary or mandatory, regardless of frequency of use, reason for use, duration of use, etc.

Non U of M community members working at the U of M shall observe procedures that are equivalent to or exceed U of M Respiratory Protection Program requirements.
DEFINITIONS

None.

RESPONSIBILITIES

Supervisors and Principal Investigators

Supervisors have the primary responsibility for implementing the Respiratory Protection Program in their work area. Implementation involves:

- Identifying U of M community members and their jobs or tasks which may require respiratory protection, providing this information to the Program Administrator and seeking assistance in evaluation of respiratory hazards.
- Supervising U of M community members to ensure that the Respiratory Protection Program procedures are being followed.
- Purchasing permitted respirators and making them available for authorized use by respirator users.
- Enforcing the proper use of respiratory protection equipment.
- Ensuring that respirators are properly cleaned, maintained, and stored according to this program.
- Ensuring that respirator users under their supervision (including new hires) receive appropriate training, medical evaluation, and annual fit testing.
- Identifying changes in jobs or tasks which may require re-evaluation of respirator use and notifying the Respiratory Protection Program Administrator.
- Maintaining, storing, and monthly inspection of emergency use respirators as required so that they are readily accessible and operational when needed.

Office of Occupational Health and Safety (OHS)

OHS is responsible for developing, implementing, and administering the U of M Respiratory Protection Program. The OHS Respiratory Protection Program Administrator is responsible for:

- Reviewing and updating the written Respiratory Protection Program.
- Coordinating medical evaluation and fit testing services for respirator users.
- Maintaining records on respiratory protective equipment assignments, medical clearances, fit testing, and training.
• Evaluating the overall effectiveness of the respirator program.

Department of Environmental Health and Safety (DEHS)
DEHS is responsible for the following aspects of the U of M Respiratory Protection Program:

- Evaluating respiratory hazards in the work areas.
- Providing consultation to OHS on development and implementation of the Respiratory Protection Program.
- Providing guidance to the supervisor for selecting and purchasing approved respirators.
- Providing training (including refresher sessions) on the proper use, maintenance, and storage of respirators to all respirator users, including emergency Self Contained Breathing Apparatus (SCBA) users.
- Assisting with fit testing for respirator users.
- Transmitting fit testing and training records to OHS.
- Conducting periodic monitoring to assess concentrations of airborne contaminants.
- Conducting periodic inspections of respirator storage and use, and ensuring that these inspections are properly documented.
- Transmitting monitoring and inspection results to Supervisors, Principal Investigators and OHS.

Respirator User

The respirator user is responsible for following the requirements of the written program, including:

- Using the respirator in accordance with the manufacturer’s instructions and the training received.
- Storing, cleaning, maintaining, and guarding against damage to the respirator.
- Reporting any malfunction of the respirator to his/her supervisor.
- Inspecting the respirator before each use.
- Promptly reporting to his/her supervisor or the Respiratory Protection Program Administrator any symptoms of illness that may be related to respirator usage or exposure to hazardous atmospheres.
- Informing the supervisor or Respiratory Protection Program Administrator of operation changes or health status changes that could affect the safe use of the equipment.

Occupational Health Physician or other Licensed Health Care Professional (PLHCP)
The PLHCP is responsible for

- Performing initial and periodic medical evaluations and any necessary follow-up examinations of employees and students to determine their ability to wear a respirator.
- Providing a written evaluation of the employee’s ability to use a respirator to the Respiratory Protection Program Administrator.
- Conducting periodic medical evaluation of respirator users as necessary.
- Maintaining records of medical evaluations.

PROGRAM ELEMENTS

1. Site-specific programs and program administration

1.1 General. Wherever any type of respirator is worn for any reason, frequency, or duration, a formal, written, site-specific program meeting the requirements of 29 CFR 1910.134 (c) (summarized below) is required.

This requirement applies even when respirator use is voluntary (see sections 1.2 and 1.3 of this section).

1.2 Content of program when respirator use is mandatory. When respirator use is mandatory, the written program shall include (as applicable):

- Procedures for selecting respirators for use in the workplace;
- Medical evaluations of employees required to use respirators;
- Fit testing procedures for tight-fitting respirators;
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;
- Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and
- Procedures for regularly evaluating the effectiveness of the program.

1.3 Content of program when respirator use is voluntary. When respirator use is voluntary, the written program may be limited to the following:
• Medical evaluations of employees required to use respirators;
• Respirator cleaning, storage and maintenance so that its use does not present a health hazard to the user.
• Training as outlined in section 8.3 below.

1.4 Program administration. Each location which uses any type of respiratory protection, for any reason, duration, or frequency, must appoint a Respiratory Protection Program Administrator (RPPA). The RPPA must be qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness.

2. Exposure monitoring and respirator selection

2.1 General. To the extent feasible, the U of M will evaluate and document employees’ exposures to airborne contaminants and select respirators appropriate for the type and extent of hazards.

2.2 Exposure monitoring. Whenever community members or their supervisors identify new substances, processes, or equipment that may represent an occupational safety and health hazard, they must contact the Department of Environmental Health & Safety (DEHS) at (612) 626-6002 to request a workplace exposure assessment.

2.3 Voluntary or mandatory use. Based on data collected, the need for respiratory protection will be determined. DEHS must be contacted and conduct a workplace exposure assessment when engineering or procedural changes occur that may affect community members’ exposures.

2.4 Selection of respirators. Selection of a respirator for a specific operation and/or contaminants shall be made by DEHS in consultation with occupational health experts, industrial hygienists, etc. as appropriate. Selection shall be made from a sufficient number of models and sizes to allow proper fit.

The selection of a proper respirator for any given situation shall require evaluation of workplace respiratory hazards, including identification of the following:

• A reasonable estimate of the employee exposures to respiratory hazard(s)
• The contaminant’s chemical state (valence state) and physical form (gas, vapor, particulate, etc.).

Any respirator usage by U of M community members, either required or voluntary, shall be pre-approved by DEHS. U of M community members shall only wear the specific respirator-type(s) for which they were pre-approved.
2.5 **End of Service Life Indicators (ESLI)/Change schedules.** Air purifying respirators worn for protection against gases or vapors must be equipped with an End of Service Life Indicator (ESLI) certified by NIOSH for contaminant at hand. If there is no ESLI for the contaminants encountered, then a written change schedule, based on objective written exposure data will be developed, to ensure that respirators are not worn beyond their useful service life. Cartridge change-out schedules will be developed by DEHS.

2.6 **NIOSH approval and labeling.** Only respirators certified by the National Institute of Occupational Safety and Health (NIOSH) **shall** be selected and all appropriate filters, cartridges, and canisters **shall** be labeled and color coded with the NIOSH approval label. Labeling **shall not** be removed and **shall** remain legible.

2.7 **Cost of respirators.** Employees who are required to wear any type of respirator will have respirators provided to them at no cost. In some cases, employees may wish to wear a respirator voluntarily, or mandatory respirator users may wish to use a respirator which is costlier than the style or model provided. In these cases, the U of M reserves the right to hold the employee financially responsible for the additional cost.

### 3. Medical evaluation and approval

3.1 **General.** Using a respirator, in particular a negative pressure respirator, may place additional physiological burden on employees. This burden may vary with the type of respirator worn, the job and workplace conditions, environmental factors, and more importantly, the medical status of the user.

The U of M will provide medical evaluation to determine the employee’s ability to safely use a respirator before the employee is fit tested, or required or permitted to use a respirator.

3.2 **Information provided to PLHCP prior to evaluation.** The following information will be provided to the PLHCP before the PLHCP makes a recommendation concerning the employee’s ability to use a respirator:

- The type and weight of the respirator to be used.
- The duration and frequency of use (including use for rescue and escape).
- The expected physical work effort.
- Additional protective clothing and equipment to be worn.
- Temperature and humidity extremes that may be encountered.
- A copy of the written respiratory protection program.
Any of the information previously provided to the PLHCP need not be provided for subsequent medical evaluation if the information is the same from employee to employee.

3.3 Initial screening. An initial screening of each respirator user will be made by requiring the user to complete the standard medical questionnaire (see 29 CFR 1910.134, appendix C). Alternatively, the U of M reserves the right to arrange for a medical evaluation that obtains the same information as the questionnaire. Once the employee has completed the questionnaire, it will be forwarded directly and immediately to the HealthPartners Environmental and Occupational Medicine, the University’s occupational health services provider, for review.

3.4 Follow-up initial screening. A follow-up medical evaluation will be provided to any employee who gives a positive response to any question among questions 1 through 8 in section 2, part A of the questionnaire or whose initial medical evaluation demonstrates a need for follow up medical evaluation. The follow up medical evaluation will include any tests, consultations, or diagnostic procedures that the PLHCP deems necessary to make a final determination.

3.5 Periodic follow-up screening. In addition to the initial questionnaire and follow up screening, periodic screening will be provided if/when:

- An employee reports signs or symptoms that are related to ability to wear a respirator.
- A PLHCP, supervisor/PI, program administrator, or other suitably qualified and authorized person believes an employee needs to be re-evaluated.
- Information from the respiratory protection program, including observations made during fit testing or program evaluation, indicated a need for re-evaluation.
- A change in workplace conditions (e.g., physical work load, temperature, humidity, protective clothing, etc.) that may result in a substantial increase in physiological burden.

3.6 Medical determination. The PLHCP will issue a written recommendation regarding the employee’s ability to safely use a respirator. The recommendation will provide only the following information:

- Any limitations on respirator use related to the medical condition of the employee, or related to workplace conditions in which the respirator will be used, including whether or not the employee is medically able to use the respirator.
- The need, if any, for follow-up medical evaluations (annually, bi-annually, etc.)
- A statement that the PLHCP has provided the employee with a copy of the PLHCP’s written recommendation.
3.7 Special provisions for negative pressure respirators. If the employee is required or permitted to wear a negative pressure respirator and the PLHCP observes a medical condition which precludes the employee from wearing a negative pressure respirator, then the U of M will provide to the employee (at no cost) a Powered Air Purifying Respirator (PAPR). If/when subsequent medical evaluation shows that the employee may safely wear a negative pressure respirator, then the U of M may opt to no longer provide the PAPR.

3.8 Administration of the questionnaire and other medical evaluations. The medical questionnaire and other medical evaluations will be administrated confidentially during the employee’s normal working hours, or at a time and location convenient to the employee.

4. Fit testing

4.1 General. Before an employee may be required to use any respirator with a positive or negative pressure tight-fitting face piece, the employee must be fit tested with the same make, model, style and size of the respirator that will be used.

4.2 When fit testing is to be provided. Employees using a tight-fitting respirator will be fit tested only after they have been medically approved for respirator use. Employees will be fit tested at their time of initial assignment and at least annually thereafter.

Additional fit testing will be provided when/if the employee reports, or the PLHCP, supervisor/PI, Respiratory Protection Program Administrator, or other qualified person makes visual observations of changes in the employee’s physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

4.3 Fit testing. All fit testing will comply with 29 CFR 1910.134, appendix E and/or the respirator manufacturer instructions.

4.4 Records of fit testing. A record of each fit test will be maintained until the next fit test is required, and will include at least:

- The name or identification of the employee tested.
- Type of fit test performed (i.e. qualitative or quantitative, challenge media, etc.).
- Specific make, model, style, and size of respirator tested.
- Date of test.
- The pass/fail results of qualitative fit tests, or the fit factor and strip chart recording or other recording of the test results for quantitative fit tests.
DEHS or the contracted service provider will provide records of fit testing to the Respiratory Protection Program Administrator in the Office of Occupational Health and Safety.

5. **Use of respirators**

5.1 **Face piece seal protection.** Respirators with tight-fitting face pieces shall not be worn by employees who have:

- Facial hair that comes between the sealing surface of the face piece and the face or that interferes with valve function; or
- Any other condition that interferes with the face-to-face piece seal or valve function.

5.2 **Continuing respirator effectiveness.** Appropriate surveillance will be maintained of work areas and degree of employee exposure and stress. When/if there is a change in work area condition or degree of employee exposure or stress that may result in increased employee exposure or risk, respirator effectiveness will be re-evaluated by DEHS and/or OHS.

5.3 **Procedures for IDLH environments and/or structural fire fighting.** No U of M employee is to knowingly engage in any type of work in an area which is, or is suspected of being, Immediately Dangerous to Life and Health (IDLH); nor is any employee to engage in any type of structural firefighting.

6. **Storage, maintenance, care, and repair of respirators**

6.1 **General.** All respirators will be cared for, cleaned, maintained, stored, and repaired, as directed by the manufacturer.

6.2 **Frequency of cleaning.** The required frequency of cleaning and disinfecting is as follows:

- An individually assigned respirator which is used routinely shall be cleaned as often as necessary to keep it in a sanitary condition.
- Respirators not individually assigned shall be cleaned and disinfected before each use. [EXCEPTION: Respirators kept for emergency/ rescue use or fit-testing shall be cleaned and disinfected after each use]

6.3 **Additional inspection requirements for emergency use respirators.** All Supervisors shall ensure that emergency use respirators are inspected as follows:
Check for proper function before and after each use.

Inspect at least monthly, and in accordance with manufacturer’s recommendations; and certify the respirator by documenting inspection dates, the inspector’s identification, findings, and remedial actions. The documentation shall be provided as a tag or label attached to the respirator’s storage compartment and is included in inspection reports. This information shall be kept until replaced by a subsequent certification.

Emergency escape-only respirators shall be initially inspected before bringing into the workplace for use.

6.4 Additional storage requirements for emergency use respirators. Emergency use respirators shall be stored in compartments or in covers that are clearly marked as containing emergency respirators.

7. Breathing air quality and use

7.1 General. The U of M will ensure that employees using atmosphere-supplying respirators (supplied-air and SCBA) are supplied with breathing gases of high purity.

7.2 Manufacturer’s recommendations. The installation, use, maintenance, storage, inspection, etc. of any supplied air system will comply with manufacturer’s instructions.

7.3 Grade D breathable air. Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:

- Oxygen content (v/v) of 19.5-23.5%;
- Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
- Carbon monoxide (CO) content of 10 ppm or less;
- Carbon dioxide content of 1,000 ppm or less; and
- Lack of noticeable odor.

7.4 Breathing air compressors and prevention of carbon monoxide exposures. Compressors used to supply breathing air to respirators shall be constructed and situated so as to:

- Prevent entry of contaminated air into the air-supply system;
- Minimize moisture content so that the dew point at 1 atmosphere pressure is 10 degrees F (5.56 deg. C) below the ambient temperature;
• Have suitable in-line air-purifying sorbent beds and filters to further ensure breathing air quality. Sorbent beds and filters shall be maintained and replaced or refurbished periodically following the manufacturer’s instructions.
• Have a tag containing the most recent change date and the signature of the person authorized by the employer to perform the change. The tag shall be maintained at the compressor.

For compressors that are not oil-lubricated, carbon monoxide levels in the breathing air shall not exceed 10 ppm. For oil-lubricated compressors, a high-temperature or carbon monoxide alarm, or both, shall be used to monitor carbon monoxide levels. If only high-temperature alarms are used, the air supply shall be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm.

8. Training and communication

8.1 General. The U of M shall provide effective training to employees who are required to use respirators. The training must be comprehensive, understandable, and recur annually or more often if necessary. Employees shall be trained prior to using a respirator in the workplace.

8.2 Training for mandatory users. Training shall consist of, and employees must be able to demonstrate knowledge of, at least the following:

• Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator;
• What the limitations and capabilities of the respirator are;
• 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;
• What the procedures are for maintenance and storage of the respirator;
• How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators; and
• The general requirements of this section.

8.3 Training for voluntary users. Before voluntary respirator use is approved by the Respiratory Protection Program, the U of M community member:

• Must receive initial training in the proper use, care, and limitations of the selected respirator.
• Shall read, sign, and submit the Voluntary Respirator Use Agreement (Appendix A).
8.4 **Retraining.** Retraining shall be administered annually, and when the following situations occur:

- Changes in the workplace or the type of respirator render previous training obsolete;
- Inadequacies in the employee’s knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill; or
- Any other situation arises in which retraining appears necessary to ensure safe respirator use.

**PROGRAM EVALUATION**

The U of M will conduct evaluations of the workplace to ensure that the written Respiratory Protection Program is being properly implemented, and to consult employees to ensure that they are using the respirators properly.

At least annually, a formal, documented review shall be conducted to ensure that the provisions of the current written program are being effectively implemented and that it continues to be effective.

Respirator users shall be regularly consulted to assess the employees’ views on program effectiveness and to identify any problems. Any problems that are identified during this assessment shall be evaluated and corrected when feasible. Factors to be assessed include but are not limited to:

- Respirator fit (including the ability to use the respirator without interfering with effective workplace performance).
- Appropriate respirator selection for the hazards to which the employee is exposed.
- Proper respirator use under the workplace conditions the employee encounters.
- Proper respirator maintenance.
TRANSPORT OF HAZARDOUS GASES

All gases are ordered from either UM Stores, a gas supplier or manufacturer. Gases delivered to the loading dock with delivery coordinated with MNC staff for immediate pickup. Gases delivered to PAN should be delivered to the hazardous gas storage room on the dock. At no time are toxic gas cylinders to be left unattended except in an appropriate gas cabinet or gas storage room.

The purpose of this procedure is to outline the requirements for transporting hazardous gases in the Nanofabrication Center.

PROCEDURES FOR MOVING HAZARDOUS GASES

Staff will be allowed to transport hazardous gases in the Nanofabrication Center. Exceptions to this rule must be approved in advance by the Director of MNC.

- The cylinder cap must be secured in place during transport.
- Cylinders must never be rolled as a means of transportation to a using department.
- Cylinders must be placed on cylinder carts and secured for transport through hallways. Lecture bottles are to be transported in the lecture bottle original packaging.
- A properly vented gas cabinet must be prepared and available prior to actually bringing a toxic gas cylinder into the laboratory. Check to be sure that the gas cabinet exhaust is working properly.
MNC SOP FOR CHANGE-OUT OF HAZARDOUS GASES

❖ GENERAL
  ➢ For the safe change-out of hazardous gas cylinders, the wearing of personal protective equipment by the involved parties is necessary. Additionally for certain gases, two person change-outs and isolation of the change-out area are necessary. In all cases, at least one person performing these procedures must be a member of the MNC staff or approved in advanced by the Safety Officer. This person must have a thorough understanding of the practices and procedures outlined in this document.

❖ PURPOSE
  ➢ The purpose of this specification is to provide safety protective equipment requirements and safety procedures for all hazardous gas cylinder change-outs.

❖ SCOPE
  ➢ This specification shall apply to all individuals who must change-out hazardous compressed gas cylinders in the Nanofabrication Center. Final determinations as to the correct interpretation of this specification’s requirements shall be made by the Director of MNC.

❖ DEFINITIONS
  • Compressed Gas - Any material or mixture contained in the metal gas cylinder with an absolute pressure exceeding 40 pounds per square inch at 70°F, or regardless of the pressure at 70°F, with an absolute pressure exceeding 104 pounds per square inch at 130°F, or any liquid flammable material with a vapor used as a gas source.
  • Corrosive Gas - A gas which burns, irritates or destructively attacks organic tissue. Corrosive gases can be either acidic or basic.
  • Oxidizing Gas - A gas that provides oxygen for reacting with another chemical substance. Oxidizing gases react vigorously with hydrocarbon-based greases and vigorously increase the combustion rate of a burning substance.
  • Inert Gas - A gas that is non-corrosive, non-flammable, non-oxidizing, non-pyrophoric and causes human distress primarily by displacing available oxygen in confined areas.
- **Flammable Gas** - A gas which is flammable in a mixture of 13 percent or less (by volume) with air or the flammable range is wider than 12 percent regardless of the lower limits.
- **Pyrophoric Gas** - A gas which can ignite spontaneously on contact with air.
- **Toxic Gas** - A gas which is extremely detrimental to human health upon inhalation, ingestion or skin contact, or which by generally accepted criteria is designated as such by Occupation Health and Safety.
- **Compressed Gas Cylinder Change-Out** - A procedure whereby a compressed gas cylinder whose contents are piped to a process is turned off and removed from the piping connection and replaced with another cylinder.
- **Face Shield** - A device worn in front of the eyes and a portion of, or all of, the face to supplement protection afforded by a primary protective device.
- **Spectacle, Safety (Safety Glasses)** - A device patterned after conventional type spectacle eyewear but of more substantial construction, either with or without side shields, and with plain or corrective (Rx) lenses of clear or shatter resistant, absorptive filter glass or plastic.
- **Chemical smock** - A smock constructed of a chemically impervious material which affords chemical protection to the wearer's trunk and arms.
- **Chemical glove** - A substantially constructed glove, that is chemically resistant, and affords chemical protection to the wearer.
- **CGA Cap** - A metal cap provided by the vendor to prevent contamination or damage to the inside of the CGA fitting, and which must be removed for connection of a gas cylinder.
- **Chemical coveralls** - Impermeable coveralls which are chemically resistant, and afford protection to the wearer's trunk, arms and legs.
- **Fire-resistant suit** - A suit made of material which is fire resistant (asbestos cloth, aluminized coated rayon, leather, cloth with powdered aluminum).
- **Respirator, airline** - A full face-piece respirator which utilizes an external air source such as a tank to provide breathing air to the wearer, and has a five minute supplementary, self contained emergency supply of air.
### Table of Hazardous Gases Used in MNC Facilities (Jan 2017)

<table>
<thead>
<tr>
<th>Gas and Formula</th>
<th>Conc (%)</th>
<th>Qty (lbs)</th>
<th>Toxic Component wt (lbs)</th>
<th>DOT Class</th>
<th>MNC Hazard Class</th>
<th>IDLH (ppm)</th>
<th>TLV-TWA (ppm)</th>
<th>Location/equipment</th>
<th>Flammability Limits (%)</th>
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<td>Silane SiH₄</td>
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<td>15</td>
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<td>Pyrophoric</td>
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<td>5</td>
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<td>1.4-96 2-96 pyrophoric</td>
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<td>Less than 1</td>
<td>2.3</td>
<td>Flammable</td>
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<td>0.3</td>
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<td>Gas</td>
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<td>Pressure</td>
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1) SAFETY REQUIREMENTS FOR THE CHANGE OUT OF COMPRESSED GASES

1) Inert and Oxidizing Compressed Gases
   i) Person performing change-out shall wear safety spectacles (Face shield over spectacle is recommended).
   ii) No person shall attempt to change-out a compressed gas cylinder unless thoroughly trained in the change out procedure.
   iii) Person changing out cylinder shall wear shoes of a closed toe/closed heel design, heel not greater than 2-1/2” and material of shoe construction - leather or leather like.
   iv) Long trousers are required for person changing out cylinder.

2) Flammable Compressed Gases
   i) Person performing the change-out shall wear safety spectacles (Face shield over spectacles is recommended).
   ii) No person shall attempt to change out a compressed gas cylinder unless thoroughly trained in the change out procedure.
   iii) Person changing out cylinder shall wear shoes of a closed toe/closed heel design, heel not greater than 2-1/2” and material of shoe construction - leather or leather like.
   iv) Long trousers are required for person changing out cylinder.
   v) No non-involved personnel in the same room or area shall be allowed within 10 feet of the change-out procedure. Barring of the means of access shall involve signs or barricades but no egress doors shall be locked.

3) Corrosive Compressed Gases
   i) Person performing change-out shall wear an airline respirator during the removal of the CGA fitting, installation and removal of CGA cap, reconnection of CGA fitting, and re-pressurization of system.
   ii) While wearing a full face-piece airline respirator during the procedure, the use of contact lenses shall be prohibited.
   iii) Person performing change-out shall wear chemical gloves and chemical smock or coverall during procedure.
   iv) No person shall attempt to change out a compressed gas cylinder unless thoroughly trained in the change-out procedure.
   v) Person changing out cylinder shall wear shoes of a closed toe/closed heel design, heel not greater than 2-1/2” and material of shoe construction - leather or leather like.
   vi) Long trousers are required for person changing out cylinder.
   vii) A second person with protective equipment as specified in 6.4.1, 6.4.3, 6.4.5, and 6.5.6 shall be on hand to offer assistance during the change-out procedure.
viii) No non-involved personnel in the same room or area shall be allowed within 20 feet of the change-out procedure. Barring of the means of access shall involve signs or barricades but no egress doors may be locked.

4) Pyrophoric Compressed Gases
   i) Person performing change-out shall wear safety spectacles and a flame-retardant hood and suit, which affords protection of the upper body to the knees at a minimum. This equipment shall be worn during the removal of the CGA fitting installation and removal of the CGA cap, reconnection of the CGA fitting, and re-pressurization of the system.
   ii) Person performing change-out shall wear gloves of a flame-resistant nature.
   iii) No person shall attempt to change out a compressed gas cylinder unless thoroughly trained in the change-out procedure.
   iv) Person changing out cylinder shall wear shoes of a closed toe/closed heel design, heel not greater than 2-1/2" and material of shoe construction - leather or leather like.
   v) Long trousers are required for person changing out cylinder.
   vi) A second person wearing protective equipment as specified in 6.5.1, 6.5.2, 6.5.4, and 6.5.5 shall be on hand to offer assistance during the change-out procedure.
   vii) No non-involved personnel in the same room or area shall be allowed within 20 feet of the change-out procedure. Barring of the means of access shall involve signs and barricades but no egress door may be locked.
   viii) Dichlorosilane change-outs shall require in addition to the above personal protective equipment requirements; the use of an airline respirator by both the person performing the change-out, and the person providing assistance for the change-out.
   ix) Pyrophoric/toxic mixtures shall require the use of flame retardant gear as in 6.5.1, 6.5.4, and 6.5.5 as well as an airline respirator.

5) Toxic Compressed Gases
   i) Person performing change-out shall wear an airline respirator during the removal of the CGA fitting, installation and removal of CGA cap, reconnection of CGA fitting, re-pressurization of system.
   ii) While wearing an airline respirator during the procedure the use of contact lenses shall be prohibited.
   iii) No person shall attempt to change-out a compressed gas cylinder unless thoroughly trained in the change-out procedure.
   iv) Person changing out cylinder shall wear shoes of a closed toe/closed heel design, heel not greater than 2-1/2" and material of shoe construction - leather or leather-like.
   v) Long trousers are required for person changing out cylinder.
vi) A second person wearing protective equipment as specified in 6.6.1, 6.6.4, and 6.6.5 shall be on hand to offer assistance during the change-out procedure.

vii) No non-involved personnel in the same room or area shall be allowed within 20 feet of the change-out procedure. Barring of the means of access shall involve signs and barricades but no egress door may be locked.

2) GAS CYLINDER CHANGE-OUT PROCEDURES

1) For the gas involved, use the table in section 5 to determine the MNC Hazard classification. Based upon this classification, follow the safety requirements as specified in the appropriate part of section 6.

2) Automatic 5 Valve Purge Assemblies
   
i) For information on the Autopurge GSM Gas Safety Monitor (which sits atop the Keller Hall gas cabinets), the Auto-Purge M Multi Purge Controller (MPC), the remote module that connects to the GSM and enables automatic purging of the manifold, refer to the Semigas operating manual on the MNC shared drive safety folder. For Applied Energy Systems cabinets in PAN, refer to operating manual on the MNC shared drive safety folder.

   ii) Procedure
       (1) Connect MPC to GSM, mounting the MPC on the gas cabinet door.
       (2) Press the Service/Purge switch on the GSM, next follow the instructions as displayed on the MPC.
       (3) Shut off the cylinder valve, and then press the yellow ACK acknowledge switch on the MPC. The MPC now will control the procedure (with appropriate acknowledgment from the operator).
       (4) Process gas is removed from the pigtail and manifold and leak tests are performed.
           Pre-purge of the manifold is performed.
       (5) Remove cylinder, install new cylinder.
       (6) MPC tests cylinder connection for leaks.
       (7) Post-purge is performed, consisting of cyclical purges and backfills of the pigtail and high pressure side of manifold.
       (8) Purge gas is removed from the manifold.
       (9) Open cylinder valve and adjust regulator.
MNC SOP FOR USE OF HAZARDOUS GASES

- GENERAL
  - The utilization of toxic, pyrophoric, flammable, oxidizing and corrosive compressed gases in MNC laboratories is necessary. In order to protect personnel and property from the deleterious effects of these compressed gases, as well as meet federal, state and local regulations, certain design criteria must be specified for the piping of systems utilizing these gases.

- PURPOSE
  - The purpose of this specification is to provide the compressed gas system designer with basic design requirements necessary to protect personnel and property.

- SCOPE
  - This specification applies to all hazardous compressed gas processes installed the Nanofabrication Center. The final determination of whether or not a specific compressed gas system meets this specification's requirements will be made by the Director of MNC.

- DEFINITIONS
  - Piping system - The pipe, tubing, flanges, bolting, gaskets, valves, fittings, the pressure containing parts of other components such as expansion joints and strainers and devices which serve such purposes as mixing, separating, stubbing, distributing, metering, filtering or controlling compressed gas flow.
  - Hazardous gas - A gas exhibiting toxic, oxidizing, flammable, pyrophoric or corrosive properties.
  - Toxic Gas - A gas which is extremely detrimental to human health upon inhalation, ingestion or skin contact, or which by generally accepted criteria is designated as such by the Department of Environmental Health and Safety.
  - Oxidizing Gas - A gas which provides oxygen for the reaction with another chemical substance. Oxidizing gases react vigorously with hydrocarbon-based greases and vigorously increase the combustion rate of a burning substance.
  - Flammable Gas - A gas which is flammable in a mixture of 13 percent or less (by volume) with air or the flammable range is wider than 12 percent regardless of the lower limits.
- Pyrophoric Gas - A gas which ignites spontaneously on contact with air.
- Corrosive Gas - A gas which burns, irritates or destructively attacks organic tissue. Corrosive gases can be either acidic or basic and some corrosive gases have oxidizing properties.
- Zone of Local Exhaust - An atmospheric region formed by means of a pressure differential whereby contaminants are captured near the location where they originate or are dispersed.

1. REQUIREMENTS

1.1. Pressure Regulators

1.1.1. Any regulator utilized in a compressed gas system must be constructed of material which is compatible with the specific compressed gas controlled by that regulator. Under no conditions should an adapter be utilized for the fitting of a regulator to a compressed gas cylinder which does not have a compatible CGA.

1.1.2. All regulators containing toxics, flammables, corrosives or pyrophoric gases are to be equipped with a bonnet vent port that is capable of withstanding a diaphragm rupture and or carrying the escaping gases through a piping system to a suitably equipped scrubbing or exhaust system. As an alternative, a tied diaphragm regulator design with intrinsic overpressure safety mechanism may be substituted.

1.1.3. All two stage regulators shall be equipped with a regulator relief device. This device shall be plumbed to a suitably equipped scrubbing/neutralization system. As an alternative, a tied diaphragm regulator design with intrinsic overpressure safety mechanism may be substituted.

1.1.4. All regulators shall be specified by the manufacturer as being "Cleaned for Oxygen Service".

1.2. Piping and Tubing Requirements
1.2.1. All hazardous gas piping must be of the double containment design with the volume between the inner pipe containing the hazardous gas, and the outer, containment pipe, connected to a cabinet vented to the lab exhaust system.

1.2.2. Where hazardous gas piping passes through walls or floors, it should be protected against chafing or movement by appropriately sized sleeves and clamps. Pipe openings in fire walls must be resealed without compromising the rating of the fire wall. No fitting connections shall be made inside a wall, floor or ceiling penetration.

1.2.3. All piping must be placed in locations which can be readily inspected. Hidden chaseways or plenums must be avoided.

1.2.4. The gas content of the pipelines shall be readily identifiable by appropriate labeling with the name of the gas contained. Such labeling shall be by means of metal tags, stenciling, stamping or adhesive labels in a manner that is legible and permanently affixed. These labels shall be placed every 10 feet along the pipeline and at all locations where the pipeline enters and exits a partition, floor, or ceiling.

1.2.5. All components of the piping system are to be so mounted so as to provide easy access and removal for repair without the movement of any gas cabinet or back panel.

1.2.6. Piping and fittings shall comply with service piping as incorporated into the American National Standard Code for Pressure Piping, Chemical Plant and Petroleum Refinery Piping, ANSI B 31.3. A copy of this standard shall be kept on file by the Department of Environmental Health and Safety.

1.2.7. Piping components such as regulators, filters, valves, packing and seating materials that are not compatible with the gases employed shall not be utilized in such a manner that they will be in contact with the gas stream. For example, brass, monel or viton would not be used with ammonia, nor would aluminum be used with hydrogen chloride, etc.. Care must be taken to consider all components including synthetic materials as well as the metals used. Consult component vendor for compatibility information.

1.2.8. The minimum acceptable standard for tubing is to be Fully Annealed Type 316L seamless stainless steel hydraulic tubing ASTM A-269 or equivalent, hardness Rb
80 or less. Tubing is to be free of scratches. Suitable for bending and flaring, 0.035" wall thickness, 1/4" O.D. with a minimum working pressure of 5906 PSIG. Allowable working pressure loads calculated from S values as specified in ANSI B31.3. Tubing of larger O.D. is acceptable in select cases for multiple vent lines and headers, however, 1/4" O.D. is the preferred maximum diameter. Where the use rate is low and 1/8 inch stainless steel tubing is feasible, this is preferable to 1/4 inch. For specialized situations, tubing not meeting the above criteria may be substituted provided approval for the tubing is obtained from the Director of MNC.

1.2.9. Pigtails and tubing used for the connection of source cylinders shall contain a coil of tubing (with a 4" diameter minimum) or approved equivalent suitable to act as a means of vibration isolation and to provide for adaptation or accommodation to a variation in cylinder height of three inches. CGA or cylinder inlet connections so affixed shall be welded to the pigtail. This requirement applies to rigid tubing only.

1.2.10. Piping and equipment will be installed so as to accommodate, in an unimpeded manner, the installation of either 52 inch or 55 inch tall cylinders as a standard. Connecting pigtails must be provided to accommodate height variations in cylinders of three inches in all cases and a variation in diameter of one inch.

1.2.11. Teflon tape is to be used at all pipe thread joints with particular care being paid not to overlap tape at the fitting ends so as to expose tape to the gas stream. The use of pastes and greases (even of "inert" composition) is not permitted.

1.3. Purging and Venting

1.3.1. Systems containing process gases shall be capable of being purged at the cylinder CGA connection interface so as to provide:
1.3.2. personnel protection from exposure during cylinder changes.
1.3.3. process protection through minimization of contamination by ambient air impurities.
1.3.4. the capability for "cycle" or dilution purging by repeated pressurization and relief is required. Delivery of or introduction of the purge gases as close to the cylinder valve and CGA fitting as is practical is required.
1.3.5. Inert gas purge cylinders are required for use for all purge gas sources. House purge gas (nitrogen or other) is not permitted. Purge gas systems may feed compatible systems only. That is, classic separating of groups will be observed which requires the separation of flammables, oxidizers, toxics, corrosives, and pyrophoric systems. As an example, one purge cylinder shall not be used to purge, in common, phosphine and silane, or more obviously ammonia and hydrogen chloride, etc. House purge gas is permitted for vacuum generators on purge assemblies.

1.3.6. Purge line effluents from toxics, pyrophorics, flammables and corrosives are to be exhausted through the appropriate laboratory vent system.

1.4. Excess Flow Control

1.4.1. Excess flow control in the form of a fail safe, positive flow shut off mechanism shall be provided as close to the source of high pressure (or cylinder control valve) as is practicable; to shut off flow due to a rupture in piping. This requirement is mandatory on all toxic, pyrophoric, flammable and corrosive gases. It is recommended for oxidizing gases, but not required.

1.5. Valves and Shut Offs

1.5.1. A means of positive shut off is to be provided in the gas cabinet downstream of the control regulator that will facilitate maintenance of the system without contamination of process lines due to component removal for maintenance or replacement.

1.5.2. Only valves constructed with a metal to metal seal such as packless diaphragm or bellows type are acceptable. The use of packed valves on systems containing toxic, pyrophoric, flammable or corrosive gases is not permitted.

1.6. Pressure Relief

1.6.1. Pressure relief is required on all process gas systems downstream of the regulator to be installed between the regulator low pressure chamber and any manual or automatic shut off so as to relieve any over pressure attained as a result of regulator failure. As an alternative, a tied diaphragm regulator design with intrinsic overpressure safety mechanism may be substituted.
1.7. Fittings

1.7.1. All non-welded fittings on all hazardous gas lines are to be contained within the zone of local exhaust. There are to be no fittings utilized on any part of the hazardous gas distribution system that are outside of a zone of local exhaust control. The only exception to this rule is the house distribution systems for hydrogen and oxygen.

1.7.2. Components utilized for hazardous gas systems shall maximize the use of welds in their fabrication. They shall be so fabricated that removal for repair and/or replacement of major components may be facilitated. The use of Ultraseal (Parker) or VCO, VCR (Crawford) or comparable type fittings for this purpose is required. The use of conventional compression type ferrule fittings is to be discouraged, and only permitted where the preferred fitting is not manufactured. Welds used in systems containing corrosive gases are to be kept to an absolute minimum, especially where crevice corrosion is viewed to be problematical.

1.8. Emergency Shut Down

1.8.1. All systems containing toxic, flammable, corrosive, or pyrophoric gases will be equipped with pneumatically controlled, intrinsically safe or explosion proof means of emergency shut down as close to the cylinder source as is practicable. Control is to be external to the cabinet and should be situated at the exit(s) as well as directly on the system.

1.9. Leak Testing of System

1.9.1. The equipment will be so designed as to stand a static check under high purity nitrogen or helium pressure by blanking off the "process leads" and pressurizing with nitrogen or helium up to 1.5 times the designed working pressure of the delivery side of the systems. The integrity of the vent lines is to be tested separately by using a bubble leak check on all fittings and welded connections. A record of the tests will be provided in written form to the Director of MNC. The method of leak check shall be by use of a reliable method so as to preclude the possibility of inboard or outboard leakage greater than on the order of 10-7 cubic centimeters per second.
1.10. Special Pyrophoric/Flammable Gas Requirements

1.10.1. Operating pressure within any pyrophoric gas line shall not exceed 15 psig without prior approval from the Director of MNC.

1.10.2. A limiting orifice, if available from gas supplier will be installed in all pyrophoric gas cylinders. This orifice will restrict flow given a major failure.

1.10.3. All potentially pyrophoric process effluent shall be combusted in a combustion-oxidation system and transported in metal pipe to the scrubber or other suitable building system. Alternative systems may be incorporated where nonfeasibility of combustion-oxidation systems is demonstrated to the Director of MNC.

1.10.4. Gas cabinets containing pyrophorics or flammables shall be vented in metal pipe to the facility roof or scrubber.

1.11. Scrubber Maintenance

1.11.1. A schematic diagram of each scrubber currently in use of the Nanofabrication Center is attached at the end of this section.

1.11.2. A maintenance schedule, including names of persons responsible, shall be developed for each scrubber and approved by the Director of MNC.

1.11.2.1. LPCVD Scrubber (Keller room 1-146 Area 1)

Delatech model 857 CDO
Appendices

Appendix A: Voluntary Use of Respirators

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 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.

Voluntary Use Agreement Form

Employee Name: ____________________________________________

Department: ___________________________  Employee ID#: ____________

I have read and understood the information provided above regarding voluntary respirator use.

__________________________________________  _______________________
Employee Signature  Date
## Appendix B: Training Documentation

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### Training outline

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator;
- What the limitations and capabilities of the respirator are;
- 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;
- What the procedures are for maintenance and storage of the respirator;
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators; and
- The general requirements of this section.

### Other topics discussed

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Appendix C: Medical Evaluation Questionnaire for General Respirator Use

To the employer:
Answers to questions in Section 1, and to question 9 in Section 2 of Part A, do not require a medical examination.

To the employee:
Can you read (circle one): Yes / No

Your employer must allow you to answer this questionnaire during normal working hours, or at a time and place that is convenient to you. To maintain your confidentiality, your employer or supervisor must not look at or review your answers, and your employer must tell you how to deliver or send this questionnaire to the health care professional who will review it.

Part A. Section 1. (Mandatory) The following information must be provided by every employee who has been selected to use any type of respirator (please print).

1. Today’s date: ________________________________

2. Your name: ________________________________

3. Your age (to nearest year): ____________________

4. Sex (circle one): Male/Female

5. Your height: ________ ft. ________ in.

6. Your weight: __________ lbs.

7. Your job title: ________________________________

8. A phone number where you can be reached by the health care professional who reviews this questionnaire (include the Area Code):

____________________________________________________________________

9. The best time to phone you at this number:

____________________________________________________________________
10. Has your employer told you how to contact the health care professional who will review this questionnaire (circle one): Yes / No

11. Check the type of respirator you will use (you can check more than one category):
   a. _____ N, R, or P disposable respirator (filter-mask, non-cartridge type only)
   b. _____ Other type (for example, half- or full-facepiece type, powered-air purifying, supplied-air, self-contained breathing apparatus).

12. Have you worn a respirator (circle one): Yes / No
   If "yes," what type(s):
   _______________________________________________________

**Part A. Section 2.** (Mandatory) Questions 1 through 9 below must be answered by every employee who has been selected to use any type of respirator (please circle "yes" or "no").

1. Do you currently smoke tobacco, or have you smoked tobacco in the last month: Yes / No

2. Have you ever had any of the following conditions?
   a. Seizures (fits): Yes / No
   b. Diabetes (sugar disease): Yes / No
   c. Allergic reactions that interfere with your breathing: Yes / No
   d. Claustrophobia (fear of closed-in places): Yes / No
   e. Trouble smelling odors: Yes / No

3. Have you ever had any of the following pulmonary or lung problems?
   a. Asbestosis: Yes / No
   b. Asthma: Yes / No
   c. Chronic bronchitis: Yes / No
   d. Emphysema: Yes / No
   e. Pneumonia: Yes / No
   f. Tuberculosis: Yes / No
   g. Silicosis: Yes / No
   h. Pneumothorax (collapsed lung): Yes / No
   i. Lung cancer: Yes / No
4. Do you currently have any of the following symptoms of pulmonary or lung illness?

a. Shortness of breath: Yes / No
b. Shortness of breath when walking fast on level ground or walking up a slight hill or incline: Yes / No
c. Shortness of breath when walking with other people at an ordinary pace on level ground: Yes / No
d. Have to stop for breath when walking at your own pace on level ground: Yes / No
e. Shortness of breath when washing or dressing yourself: Yes / No
f. Shortness of breath that interferes with your job: Yes / No
g. Coughing that produces phlegm (thick sputum): Yes / No
h. Coughing that wakes you early in the morning: Yes / No
i. Coughing that occurs mostly when you are lying down: Yes / No
j. Coughing up blood in the last month: Yes / No
k. Wheezing: Yes / No
l. Wheezing that interferes with your job: Yes / No
m. Chest pain when you breathe deeply: Yes / No
n. Any other symptoms that you think may be related to lung problems: Yes / No

5. Have you ever had any of the following cardiovascular or heart problems?

a. Heart attack: Yes / No
b. Stroke: Yes / No
c. Angina: Yes / No
d. Heart failure: Yes / No
e. Swelling in your legs or feet (not caused by walking): Yes / No
f. Heart arrhythmia (heart beating irregularly): Yes / No
g. High blood pressure: Yes / No
h. Any other heart problem that you’ve been told about: Yes / No

6. Have you ever had any of the following cardiovascular or heart symptoms?

a. Frequent pain or tightness in your chest: Yes / No
b. Pain or tightness in your chest during physical activity: Yes / No
c. Pain or tightness in your chest that interferes with your job: Yes / No
d. In the past two years, have you noticed your heart skipping or missing a beat: Yes / No

e. Heartburn or indigestion that is not related to eating: Yes / No

f. Any other symptoms that you think may be related to heart or circulation problems: Yes / No

7. Do you currently take medication for any of the following problems?

a. Breathing or lung problems: Yes / No

b. Heart trouble: Yes / No

c. Blood pressure: Yes / No

d. Seizures (fits): Yes / No

8. If you’ve used a respirator, have you ever had any of the following problems? (If you’ve never used a respirator, check the following space and go to question 9:)

a. Eye irritation: Yes / No

b. Skin allergies or rashes: Yes / No

c. Anxiety: Yes / No

d. General weakness or fatigue: Yes / No

e. Any other problem that interferes with your use of a respirator: Yes / No

9. Would you like to talk to the health care professional who will review this questionnaire about your answers to this questionnaire: Yes / No

Questions 10 to 15 below must be answered by every employee who has been selected to use either a full-facepiece respirator or a self-contained breathing apparatus (SCBA). For employees who have been selected to use other types of respirators, answering these questions is voluntary.

10. Have you ever lost vision in either eye (temporarily or permanently): Yes / No

11. Do you currently have any of the following vision problems?

a. Wear contact lenses: Yes / No

b. Wear glasses: Yes / No

c. Color blind: Yes / No

d. Any other eye or vision problem: Yes / No

12. Have you ever had an injury to your ears, including a broken ear drum: Yes / No
13. Do you currently have any of the following hearing problems?
   a. Difficulty hearing: Yes / No
   b. Wear a hearing aid: Yes / No
   c. Any other hearing or ear problem: Yes / No

14. Have you ever had a back injury: Yes / No

15. Do you currently have any of the following musculoskeletal problems?
   a. Weakness in any of your arms, hands, legs, or feet: Yes / No
   b. Back pain: Yes / No
   c. Difficulty fully moving your arms and legs: Yes / No
   d. Pain or stiffness when you lean forward or backward at the waist: Yes / No
   e. Difficulty fully moving your head up or down: Yes / No
   f. Difficulty fully moving your head side to side: Yes / No
   g. Difficulty bending at your knees: Yes / No
   h. Difficulty squatting to the ground: Yes / No
   i. Difficulty climbing a flight of stairs or a ladder carrying more than 25 lbs: Yes / No
   j. Any other muscle or skeletal problem that interferes with using a respirator: Yes / No

**Part B.** Any of the following questions, and other questions not listed, may be added to the questionnaire at the discretion of the health care professional who will review the questionnaire.

1. In your present job, are you working at high altitudes (over 5,000 feet) or in a place that has lower than normal amounts of oxygen: Yes / No

   If "yes," do you have feelings of dizziness, shortness of breath, pounding in your chest, or other symptoms when you're working under these conditions: Yes / No

2. At work or at home, have you ever been exposed to hazardous solvents, hazardous airborne chemicals (e.g., gases, fumes, or dust), or have you come into skin contact with hazardous chemicals: Yes / No

   If "yes," name the chemicals if you know them:
3. Have you ever worked with any of the materials, or under any of the conditions, listed below:

a. Asbestos: Yes / No
b. Silica (e.g., in sandblasting): Yes / No
c. Tungsten/cobalt (e.g., grinding or welding this material): Yes / No
d. Beryllium: Yes / No
e. Aluminum: Yes / No
f. Coal (for example, mining): Yes / No
g. Iron: Yes / No
h. Tin: Yes / No
i. Dusty environments: Yes / No
j. Any other hazardous exposures: Yes / No

If "yes," describe these exposures:

4. List any second jobs or side businesses you have:

5. List your previous occupations:

6. List your current and previous hobbies:

7. Have you been in the military services? Yes / No
If "yes," were you exposed to biological or chemical agents (either in training or combat): Yes / No

8. Have you ever worked on a HAZMAT team? Yes / No

9. Other than medications for breathing and lung problems, heart trouble, blood pressure, and seizures mentioned earlier in this questionnaire, are you taking any other medications for any reason (including over-the-counter medications): Yes / No

If "yes," name the medications if you know them:

_____________________________________________________
_____________________________________________________
_____________________________________________________

10. Will you be using any of the following items with your respirator(s)?

a. HEPA Filters: Yes / No
b. Canisters (for example, gas masks): Yes / No
   3. Cartridges: Yes / No

11. How often are you expected to use the respirator(s) (circle "yes" or "no" for all answers that apply to you)?:

a. Escape only (no rescue): Yes / No
b. Emergency rescue only: Yes / No
c. Less than 5 hours per week: Yes / No
d. Less than 2 hours per day: Yes / No
e. 2 to 4 hours per day: Yes / No
f. Over 4 hours per day: Yes / No

12. During the period you are using the respirator(s), is your work effort:

a. Light (less than 200 kcal per hour): Yes / No

   If "yes," how long does this period last during the average shift:___________hrs.,___________mins.
Examples of a light work effort are sitting while writing, typing, drafting, or performing light assembly work; or standing while operating a drill press (1-3 lbs.) or controlling machines.

b. Moderate (200 to 350 kcal per hour): Yes / No

If "yes," how long does this period last during the average shift:__________hrs.__________mins.

Examples of moderate work effort are sitting while nailing or filing; driving a truck or bus in urban traffic; standing while drilling, nailing, performing assembly work, or transferring a moderate load (about 35 lbs.) at trunk level; walking on a level surface about 2 mph or down a 5-degree grade about 3 mph; or pushing a wheelbarrow with a heavy load (about 100 lbs.) on a level surface.

c. Heavy (above 350 kcal per hour): Yes / No

If "yes," how long does this period last during the average shift:__________hrs.__________mins.

Examples of heavy work are lifting a heavy load (about 50 lbs.) from the floor to your waist or shoulder; working on a loading dock; shoveling; standing while bricklaying or chipping castings; walking up an 8-degree grade about 2 mph; climbing stairs with a heavy load (about 50 lbs.).

13. Will you be wearing protective clothing and/or equipment (other than the respirator) when you’re using your respirator: Yes / No

If "yes," describe this protective clothing and/or equipment:

________________________________________________________________________

________________________________________________________________________

14. Will you be working under hot conditions (temperature exceeding 77 deg. F): Yes / No

15. Will you be working under humid conditions: Yes / No

16. Describe the work you’ll be doing while you’re using your respirator(s):
17. Describe any special or hazardous conditions you might encounter when you’re using your respirator(s) (for example, confined spaces, life-threatening gases):


18. Provide the following information, if you know it, for each toxic substance that you’ll be exposed to when you’re using your respirator(s):

   a. Name of the first toxic substance:

       _______________________________________________________

   b. Estimated maximum exposure level per shift:

       _______________________________________________________

   c. Duration of exposure per shift:

       _______________________________________________________

   d. Name of the second toxic substance:

       _______________________________________________________

   e. Estimated maximum exposure level per shift:

       _______________________________________________________

   f. Duration of exposure per shift:

       _______________________________________________________
g. Name of the third toxic substance:

_____________________________________________________

h. Estimated maximum exposure level per shift:

_____________________________________________________

i. Duration of exposure per shift:

_____________________________________________________

j. The name of any other toxic substances that you’ll be exposed to while using your respirator:

_____________________________________________________

_____________________________________________________

_____________________________________________________

19. Describe any special responsibilities you’ll have while using your respirator(s) that may affect the safety and well-being of others (for example, rescue, security):

_____________________________________________________

_____________________________________________________

_____________________________________________________

Appendix D: Medical Certification

I have examined ____________________________ to determine his/her physical fitness to use respiratory protective equipment. The following restrictions, if any, apply:

______________________________________________________________________________
______________________________________________________________________________

At this time, I find no physical reason to prohibit my patient from participating in programs which may require the use of respirators.

I have discussed the results of this examination with the employee.

Attending Physician________________________________________
Date________________

ANNUAL REPORT OF FIT TEST AND RESPIRATOR ISSUED

Based on the Physicians Certification and the employees’ potential workplace exposure, this employee was fit tested with the respirator issued to him/her.

______________________________________________________________
Respirator manufacturer, model, size

______________________________________________________________
Test agent, protection factor (if determined)

Industrial Hygienist__________________________________________
Date_______________

SEMI-ANNUAL RECORD OF FIT TEST AND RESPIRATOR ISSUED

Based on the Physicians Certification and the employees’ potential workplace exposure, this employee was fit tested with the respirator issued to him/her.

______________________________________________________________
Respirator manufacturer, model, size

______________________________________________________________
Test agent, protection factor (if determined)
Industrial Hygienist

Date
Appendix E: Fit Testing Procedures

Part I. OSHA-Accepted Fit Test Protocols

A. Fit Testing Procedures-General Requirements

The employer shall conduct fit testing using the following procedures. The requirements in this appendix apply to all OSHA-accepted fit test methods, both QLFT and QNFT.

1. The test subject shall be allowed to pick the most acceptable respirator from a sufficient number of respirator models and sizes so that the respirator is acceptable to, and correctly fits, the user.

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 an acceptable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This instruction may not constitute the subject’s formal training on respirator use, because 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 acceptable fit. Each respirator represents a different size and shape, and if fitted and used properly, will provide adequate protection.

4. The test subject shall be instructed to hold each chosen face piece up to the face and eliminate those that obviously do not give an acceptable fit.

5. The more acceptable face pieces are noted in case the one selected proves unacceptable; 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 the following item A.6. 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 a review of the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

   a. Position of the mask on the nose
      b. Room for eye protection
      c. Room to talk
      d. 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
   a. Adequate strap tension, not overly tightened
   b. Fit across nose bridge
   c. Respirator of proper size to span distance from nose to chin
   d. Tendency of respirator to slip
   e. Self-observation in mirror to evaluate fit and respirator position.

8. The test subject shall conduct a user seal check, either the negative and positive pressure seal checks described in Appendix G3 of this section or those recommended by the respirator manufacturer which provide equivalent protection. Before conducting the negative and positive pressure checks, 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 user seal check tests.

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, mustache or sideburns which cross the respirator sealing surface. Any type of apparel which interferes with a satisfactory fit shall be altered or removed.

10. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician or other licensed health care professional, as appropriate, to determine whether the test subject can wear a respirator while performing her or his duties.

11. If the employee finds the fit of the respirator unacceptable, the test subject shall be given the opportunity to select a different respirator and to be retested.

12. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's 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 5 minutes before the start of the fit test.

13. The fit test shall be performed while the test subject is wearing any applicable safety equipment that may be worn during actual respirator use which could interfere with respirator fit.

14. Test Exercises. The following test exercises are to be performed for all fit testing methods prescribed in this appendix, except for the CNP method. A separate fit testing exercise regimen is contained in the CNP protocol. The test subject shall perform exercises, in the test environment, in the following manner:
   a. Normal breathing. In a normal standing position, without talking, the subject shall breathe normally.
   a. Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as not to hyperventilate.
b. 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.

c. 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).

d. 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.

Rainbow Passage
When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

e. Grimace. The test subject shall grimace by smiling or frowning. (This applies only to QNFT testing; it is not performed for QLFT)

f. 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 QNFT or QLFT units that do not permit bending over at the waist.

g. Normal breathing. Same as exercise (1).

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 unacceptable, another model of respirator shall be tried. The respirator shall not be adjusted once the fit test exercises begin. Any adjustment voids the test, and the fit test must be repeated.

B. Qualitative Fit Test (QLFT) Protocols

1. General

   a. The employer shall ensure that persons administering QLFT are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and ensure that test equipment is in proper working order.
b. The employer shall ensure that QLFT equipment is kept clean and well maintained so as to operate within the parameters for which it was designed.

2. Isoamyl Acetate Protocol

Note: This protocol is not appropriate to use for the fit testing of particulate respirators. If used to fit test particulate respirators, the respirator must be equipped with an organic vapor filter.

- Odor Threshold Screening
  - Odor threshold screening, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of isoamyl acetate at low levels.
  1. Three 1 liter glass jars with metal lids are required.
  2. Odor-free water (e.g., distilled or spring water) at approximately 25 deg. C (77 deg. F) shall be used for the solutions.
  3. The isoamyl acetate (IAA) (also known at isopentyl acetate) stock solution is prepared by adding 1 ml of pure IAA to 800 ml of odor-free water in a 1 liter jar, closing the lid and shaking for 30 seconds. A new solution shall be prepared at least weekly.
  4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well-ventilated to prevent the odor of IAA from becoming evident in the general room air where testing takes place.
  5. The odor test solution is prepared in a second jar by placing 0.4 ml of the stock solution into 500 ml of odor-free water using a clean dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.
  6. A test blank shall be prepared in a third jar by adding 500 cc of odor-free water.
  7. The odor test and test blank jar lids shall be labeled (e.g., 1 and 2) for jar identification. Labels shall be placed on the lids so that they can be peeled off periodically and switched to maintain the integrity of the test.
  8. The following instruction shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds."
Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil.”

9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be performed.

11. If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

a. Isoamyl Acetate Fit Test

1. The fit test chamber shall be a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject’s head. If no drum liner is available, a similar chamber shall be constructed using plastic sheeting. The inside top center of the chamber shall have a small hook attached.

2. Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors.

3. After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well-ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

4. A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

5. Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 ml of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber. An IAA test swab or ampule may be substituted for the IAA wetted paper towel provided it has been demonstrated that the alternative IAA source will generate an IAA test atmosphere with a concentration equivalent to that generated by the paper towel method.

6. Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to
talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the test exercises; or to demonstrate some of the exercises.

7. If at any time during the test, the subject detects the banana-like odor of IAA, the test is failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

8. If the test is failed, the subject shall return to the selection room and remove the respirator. The test subject shall repeat the odor sensitivity test, select and put on another respirator, return to the test area and again begin the fit test procedure described in (b) (1) through (7) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait at least 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

9. If the subject passes the test, the efficiency of the test procedure shall be demonstrated by having the subject break the respirator face seal and take a breath before exiting the chamber.

10. When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test, so that there is no significant IAA concentration buildup in the chamber during subsequent tests. The used towels shall be kept in a self-sealing plastic bag to keep the test area from being contaminated.

3. Saccharin Solution Aerosol Protocol

The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

. Taste threshold screening.

The saccharin taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of saccharin.

1. During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the
3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.

2. The test enclosure shall have a \( \frac{3}{4} \)-inch (1.9 cm) hole in front of the test subject’s nose and mouth area to accommodate the nebulizer nozzle.

3. The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a sweet taste.

4. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. The nozzle is directed away from the nose and mouth of the person. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

5. The threshold check solution is prepared by dissolving 0.83 gram of sodium saccharin USP in 100 ml of warm water. It can be prepared by putting 1 ml of the fit test solution (see (b)(5) below) in 100 ml of distilled water.

6. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand

7. Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted. If the test subject reports tasting the sweet taste during the ten squeezes, the screening test is completed. The taste threshold is noted as ten regardless of the number of squeezes actually completed.

8. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted. If the test subject reports tasting the sweet taste during the second ten squeezes, the screening test is completed. The taste threshold is noted as twenty regardless of the number of squeezes actually completed.

9. If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted. If the test subject reports tasting the sweet taste during the third set of ten squeezes, the screening test is completed. The taste threshold is noted as thirty regardless of the number of squeezes actually completed.

10. The test conductor will take note of the number of squeezes required to solicit a taste response.
11. If the saccharin is not tasted after 30 squeezes (step 10), the test subject is unable to taste saccharin and may not perform the saccharin fit test.

Note to paragraph 3. (a): If the test subject eats or drinks something sweet before the screening test, he/she may be unable to taste the weak saccharin solution.

12. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

13. Correct use of the nebulizer means that approximately 1 ml of liquid is used at a time in the nebulizer body.

14. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

a. Saccharin solution aerosol fit test procedure.

1. The test subject may not eat, drink (except plain water), smoke, or chew gum for 15 minutes before the test.

2. The fit test uses the same enclosure described in 3. (a) above.

3. The test subject shall don the enclosure while wearing the respirator selected in section I. A. of this appendix. The respirator shall be properly adjusted and equipped with a particulate filter(s).

4. A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

5. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 ml of warm water.

6. As before, the test subject shall breathe through the slightly open mouth with tongue extended, and reports if he/she tastes the sweet taste of saccharin.

7. The nebulizer is inserted into the hole in the front of the enclosure and an initial concentration of saccharin fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20 or 30 squeezes) based on the number of squeezes required to elicit a taste response as noted during the screening test. A minimum of 10 squeezes is required.

8. After generating the aerosol, the test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.
9. Every 30 seconds the aerosol concentration shall be replenished using one half the original number of squeezes used initially (e.g., 5, 10 or 15).

10. The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected. If the test subject does not report tasting the saccharin, the test is passed.

11. If the taste of saccharin is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried and the entire test procedure is repeated (taste threshold screening and fit testing).

12. Since the nebulizer has a tendency to clog during use, the test operator must make periodic checks of the nebulizer to ensure that it is not clogged. If clogging is found at the end of the test session, the test is invalid.

4. BitrexTM (Denatonium Benzoate) Solution Aerosol Qualitative Fit Test Protocol

The BitrexTM (Denatonium benzoate) solution aerosol QLFT protocol uses the published saccharin test protocol because that protocol is widely accepted. Bitrex is routinely used as a taste aversion agent in household liquids which children should not be drinking and is endorsed by the American Medical Association, the National Safety Council, and the American Association of Poison Control Centers. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

Taste Threshold Screening.

The Bitrex taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of Bitrex.

1. During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches (30.5 cm) in diameter by 14 inches (35.6 cm) tall. The front portion of the enclosure shall be clear from the respirator and allow free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts #14 and #15 combined, is adequate.

2. The test enclosure shall have a \( \frac{3}{4} \) inch (1.9 cm) hole in front of the test subject’s nose and mouth area to accommodate the nebulizer nozzle.
3. The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his or her slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a bitter taste.

4. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the Threshold Check Solution into the enclosure. This Nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

5. The Threshold Check Solution is prepared by adding 13.5 milligrams of Bitrex to 100 ml of 5% salt (NaCl) solution in distilled water.

6. To produce the aerosol, the nebulizer bulb is firmly squeezed so that the bulb collapses completely, and is then released and allowed to fully expand.

7. An initial ten squeezes are repeated rapidly and then the test subject is asked whether the Bitrex can be tasted. If the test subject reports tasting the bitter taste during the ten squeezes, the screening test is completed. The taste threshold is noted as ten regardless of the number of squeezes actually completed.

8. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the Bitrex is tasted. If the test subject reports tasting the bitter taste during the second ten squeezes, the screening test is completed. The taste threshold is noted as twenty regardless of the number of squeezes actually completed.

9. If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the Bitrex is tasted. If the test subject reports tasting the bitter taste during the third set of ten squeezes, the screening test is completed. The taste threshold is noted as thirty regardless of the number of squeezes actually completed.

10. The test conductor will take note of the number of squeezes required to solicit a taste response.

11. If the Bitrex is not tasted after 30 squeezes (step 10), the test subject is unable to taste Bitrex and may not perform the Bitrex fit test.

12. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

13. Correct use of the nebulizer means that approximately 1 ml of liquid is used at a time in the nebulizer body.
14. The nebulizer shall be thoroughly rinsed in water, shaken to dry, and refilled at least each morning and afternoon or at least every four hours.

   a. Bitrex Solution Aerosol Fit Test Procedure.
      1. The test subject may not eat, drink (except plain water), smoke, or chew gum for 15 minutes before the test.
      2. The fit test uses the same enclosure as that described in 4. (a) above.
      3. The test subject shall don the enclosure while wearing the respirator selected according to section I. A. of this appendix. The respirator shall be properly adjusted and equipped with any type particulate filter(s).
      4. A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.
      5. The fit test solution is prepared by adding 337.5 mg of Bitrex to 200 ml of a 5% salt (NaCl) solution in warm water.
      6. As before, the test subject shall breathe through his or her slightly open mouth with tongue extended, and is instructed to report if he/she tastes the bitter taste of Bitrex.
      7. The nebulizer is inserted into the hole in the front of the enclosure and an initial concentration of the fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20 or 30 squeezes) based on the number of squeezes required to elicit a taste response as noted during the screening test.
      8. After generating the aerosol, the test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.
      9. Every 30 seconds the aerosol concentration shall be replenished using one half the number of squeezes used initially (e.g., 5, 10 or 15).

   10. The test subject shall indicate to the test conductor if at any time during the fit test the taste of Bitrex is detected. If the test subject does not report tasting the Bitrex, the test is passed.
   11. If the taste of Bitrex is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried and the entire test procedure is repeated (taste threshold screening and fit testing).

5. Irritant Smoke (Stannic Chloride) Protocol
This qualitative fit test uses a person's response to the irritating chemicals released in the "smoke" produced by a stannic chloride ventilation smoke tube to detect leakage into the respirator.

General Requirements and Precautions

1. The respirator to be tested shall be equipped with high efficiency particulate air (HEPA) or P100 series filter(s).
2. Only stannic chloride smoke tubes shall be used for this protocol.
3. No form of test enclosure or hood for the test subject shall be used.
4. The smoke can be irritating to the eyes, lungs, and nasal passages. The test conductor shall take precautions to minimize the test subject's exposure to irritant smoke. Sensitivity varies, and certain individuals may respond to a greater degree to irritant smoke. Care shall be taken when performing the sensitivity screening checks that determine whether the test subject can detect irritant smoke to use only the minimum amount of smoke necessary to elicit a response from the test subject.
5. The fit test shall be performed in an area with adequate ventilation to prevent exposure of the person conducting the fit test or the build-up of irritant smoke in the general atmosphere.

a. Sensitivity Screening Check

The person to be tested must demonstrate his or her ability to detect a weak concentration of the irritant smoke.

1. The test operator shall break both ends of a ventilation smoke tube containing stannic chloride, and attach one end of the smoke tube to a low flow air pump set to deliver 200 milliliters per minute, or an aspirator squeeze bulb. The test operator shall cover the other end of the smoke tube with a short piece of tubing to prevent potential injury from the jagged end of the smoke tube.
2. The test operator shall advise the test subject that the smoke can be irritating to the eyes, lungs, and nasal passages and instruct the subject to keep his/her eyes closed while the test is performed.
3. 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 irritating properties and to determine if he/she can detect the irritating properties of the smoke. The test operator shall carefully direct a small amount of the irritant smoke in the test subject's direction to determine that he/she can detect it.
b. Irritant Smoke Fit Test Procedure

1. The person being fit tested shall don the respirator without assistance, and perform the required user seal check(s).
2. The test subject shall be instructed to keep his/her eyes closed.
3. 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.
4. If the person being tested has not had an involuntary response and/or detected the irritant smoke, proceed with the test exercises.
5. The exercises identified in section I.A. 14. of this appendix shall be performed by the test subject while the respirator seal is being continually challenged by the smoke, directed around the perimeter of the respirator at a distance of six inches.
6. If the person being fit tested reports detecting the irritant smoke at any time, the test is failed. The person being retested must repeat the entire sensitivity check and fit test procedure.
7. Each test subject passing the irritant smoke test without evidence of a response (involuntary cough, irritation) shall be given a second sensitivity screening check, with the smoke from the same smoke tube used during the fit test, once the respirator has been removed, to determine whether he/she still reacts to the smoke. Failure to evoke a response shall void the fit test.
8. If a response is produced during this second sensitivity check, then the fit test is passed.

C. Quantitative Fit Test (QNFT) Protocols

The following quantitative fit testing procedures have been demonstrated to be acceptable:

1. Quantitative fit testing using a non-hazardous test aerosol (such as corn oil, polyethylene glycol 400 [PEG 400], di-2-ethyl hexyl sebacate [DEHS], or sodium chloride) generated in a test chamber, and employing instrumentation to quantify the fit of the respirator
2. Quantitative fit testing using ambient aerosol as the test agent and appropriate instrumentation (condensation nuclei counter) to quantify the respirator fit
3. Quantitative fit testing using controlled negative pressure and appropriate instrumentation to measure the volumetric leak rate of a face piece to quantify the respirator fit.

1. General
   a. The employer 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 employer 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. Generated Aerosol Quantitative Fit Testing Protocol
   Apparatus
   1. Instrumentation. Aerosol generation, dilution, and measurement systems using particulates (corn oil, polyethylene glycol 400 [PEG 400], di-2-ethyl hexyl sebacate [DEHS] or sodium chloride) as test aerosols shall be used for quantitative fit testing.
   2. Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without disturbing the test agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the test agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.
   3. When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high efficiency particulate air (HEPA) or P100 series filter supplied by the same manufacturer.
   4. The sampling instrument shall be selected so that a computer record or strip chart record may be made of the test showing the rise and fall of the test agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers that integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.
   5. The combination of substitute air-purifying elements, test agent and test agent concentration shall be such that the test subject is not exposed in excess of an established exposure limit for the test agent at any time during the testing process, based upon the length of the exposure and the exposure limit duration.
6. The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g., where the respirator is probed), a free air flow is allowed into the sampling line at all times, and there is no interference with the fit or performance of the respirator. The in-mask sampling device (probe) shall be designed and used so that the air sample is drawn from the breathing zone of the test subject, midway between the nose and mouth and with the probe extending into the face piece cavity at least \( \frac{1}{4} \) inch.

7. The test setup shall permit the person administering the test to observe the test subject inside the chamber during the test.

8. The equipment generating the test atmosphere shall maintain the concentration of test agent constant to within a 10 percent variation for the duration of the test.

9. The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event and its being recorded.

10. The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

11. The exhaust flow from the test chamber shall pass through an appropriate filter (i.e., high efficiency particulate or P100 series filter) before release.

12. When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

13. The limitations of instrument detection shall be taken into account when determining the fit factor.

14. Test respirators shall be maintained in proper working order and be inspected regularly for deficiencies such as cracks or missing valves and gaskets.

a. Procedural Requirements.

   1. When performing the initial user seal check using a positive or negative pressure check, the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these pressure checks.

   2. The use of an abbreviated screening QLFT test is optional. Such a test may be utilized in order to quickly identify poor fitting respirators that passed the positive and/or negative pressure test and reduce the amount of QNFT time. The use of the CNC QNFT
instrument in the count mode is another optional method to obtain a quick estimate of fit and eliminate poor fitting respirators before going on to perform a full QNFT.

3. A reasonably stable test agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain types of test units, the determination of the test agent's stability may be established after the test subject has entered the test environment.

4. Immediately after the subject enters the test chamber, the test agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full face piece respirator.

5. A stable test agent concentration shall be obtained prior to the actual start of testing.

6. Respirator restraining straps shall not be over-tightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonably comfortable fit typical of normal use. The respirator shall not be adjusted once the fit test exercises begin.

7. The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full face piece respirators. The test subject shall be refitted and retested.

8. Calculation of fit factors.

i. The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration measured inside the respirator for each test exercise except the grimace exercise.

ii. The average test chamber concentration shall be calculated as the arithmetic average of the concentration measured before and after each test (i.e., 7 exercises) or the arithmetic average of the concentration measured before and after each exercise or the true average measured continuously during the respirator sample.

iii. The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

A. Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers that calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.
B. Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

C. Integration by calculation of the area under the individual peak for each exercise except the grimace exercise. This includes computerized integration.

D. The calculation of the overall fit factor using individual exercise fit factors involves first converting the exercise fit factors to penetration values, determining the average, and then converting that result back to a fit factor.

9. The test subject shall not be permitted to wear a half mask or quarter face piece respirator unless a minimum fit factor of 100 is obtained, or a full face piece respirator unless a minimum fit factor of 500 is obtained.

10. Filters used for quantitative fit testing shall be replaced whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media.

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

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 face piece negative pressure respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

Portacount Fit Test Requirements.

1. Check the respirator to make sure the respirator is fitted with a high-efficiency filter and that the sampling probe and line are properly attached to the face piece.

2. 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.

3. Check 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.

4. 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 face piece, try another size of the same model respirator, or another model of respirator.

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

6. The test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.

7. 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. Portacount Test Instrument.

1. 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.

2. 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 this Appendix.

3. 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.

4. Controlled negative pressure (CNP) quantitative fit testing protocol.

   The CNP protocol provides an alternative to aerosol fit test methods. The CNP fit test method technology is based on exhausting air from a temporarily sealed respirator face piece to generate and then maintain a constant negative pressure inside the face piece. The rate of air exhaust is controlled so that a constant negative pressure is maintained in the respirator during the fit test. The level of pressure is selected to replicate the mean inspiratory pressure that causes leakage
into the respirator under normal use conditions. With pressure held constant, air
flow out of the respirator is equal to air flow into the respirator. Therefore,
measurement of the exhaust stream that is required to hold the pressure in the
temporarily sealed respirator constant yields a direct measure of leakage air flow
into the respirator. The CNP fit test method measures leak rates through the face
piece as a method for determining the face piece fit for negative pressure
respirators. The CNP instrument manufacturer Dynatech Nevada also provides
attachments (sampling manifolds) that replace the filter cartridges to permit fit
testing in an employee’s own respirator. To perform the test, the test subject
closes his or her mouth and holds his/her breath, after which an air pump
removes air from the respirator face piece at a pre-selected constant pressure.
The face piece fit is expressed as the leak rate through the face piece, expressed as
milliliters per minute. The quality and validity of the CNP fit tests are
determined by the degree to which the in-mask pressure tracks the test pressure
during the system measurement time of approximately five seconds.
Instantaneous feedback in the form of a real-time pressure trace of the in-mask
pressure is provided and used to determine test validity and quality. A
minimum fit factor pass level of 100 is necessary for a half-mask respirator and a
minimum fit factor of at least 500 is required for a full face piece respirator. The
entire screening and testing procedure shall be explained to the test subject prior
to the conduct of the screening test.

CNP Fit Test Requirements.
1. The instrument shall have a non-adjustable test pressure of 15.0
   mm water pressure.
2. The CNP system defaults selected for test pressure shall be set at--
   1.5 mm of water (-0.58 inches of water) and the modeled
   inspiratory flow rate shall be 53.8 liters per minute for performing
   fit tests.

(Note: CNP systems have built-in capability to conduct fit testing
that is specific to unique work rate, mask, and gender situations
that might apply in a specific workplace. Use of system default
values, which were selected to represent respirator wear with
medium cartridge resistance at a low-moderate work rate, will
allow inter-test comparison of the respirator fit.)

3. The individual who conducts the CNP fit testing shall be
   thoroughly trained to perform the test.
4. The respirator filter or cartridge needs to be replaced with the CNP test manifold. The inhalation valve downstream from the manifold either needs to be temporarily removed or propped open.

5. The test subject shall be trained to hold his or her breath for at least 20 seconds.

6. The test subject shall don the test respirator without any assistance from the individual who conducts the CNP fit test.

7. The QNFT protocol shall be followed according to section I. C. 1. of this appendix with an exception for the CNP test exercises.

a. **CNP Test Exercises.**

   1. Normal breathing. In a normal standing position, without talking, the subject shall breathe normally for 1 minute. After the normal breathing exercise, the subject needs to hold head straight ahead and hold his or her breath for 10 seconds during the test measurement.

   2. Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply for 1 minute, being careful not to hyperventilate. After the deep breathing exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during test measurement.

   3. Turning head side to side. Standing in place, the subject shall slowly turn his or her head from side to side between the extreme positions on each side for 1 minute. The head shall be held at each extreme momentarily so the subject can inhale at each side. After the turning head side to side exercise, the subject needs to hold head full left and hold his or her breath for 10 seconds during test measurement. Next, the subject needs to hold head full right and hold his or her breath for 10 seconds during test measurement.

   4. Moving head up and down. Standing in place, the subject shall slowly move his or her head up and down for 1 minute. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling). After the moving head up and down exercise, the subject shall hold his or her head full up and hold his or her breath for 10 seconds during test measurement. Next, the subject shall hold his or her head full down and hold his or her breath for 10 seconds during test measurement.

   5. 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 for 1 minute. After
the talking exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement.

6. Grimace. The test subject shall grimace by smiling or frowning for 15 seconds.

7. Bending Over. The test subject shall bend at the waist as if he or she were to touch his or her toes for 1 minute. Jogging in place shall be substituted for this exercise in those test environments such as shroud-type QNFT units that prohibit bending at the waist. After the bending over exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement.

8. Normal Breathing. The test subject shall remove and re-don the respirator within a one-minute period. Then, in a normal standing position, without talking, the subject shall breathe normally for 1 minute. After the normal breathing exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement. 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 a respirator shall be tried.

b. CNP Test Instrument.

1. The test instrument shall have an effective audio warning device when the test subject fails to hold his or her breath during the test. The test shall be terminated whenever the test subject failed to hold his or her breath. The test subject may be refitted and retested.

2. A record of the test shall 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.
Appendix F: Capabilities and Limitations of Respirators

Air Purifying Respirators

Air purifying respirators do not protect against oxygen deficient atmospheres. Air-purifying respirators also do not protect against airborne contaminants that cause skin irritation.

Atmospheres that are immediately dangerous to life or health (IDLH) cannot safely be entered with filtering respirators. Use of air-purifying respirators is limited to conditions where exposures can be quantified and respirator effectiveness can be assured.

Protection against a contaminant depends on both the ability of the air purifying filter and the face piece seal. For a gas and vapor filter cartridge, the maximum air concentration for which the air purifying element is designed is listed on the label.

Maximum design protection cannot be achieved unless the face piece is carefully fitted to the wearer's face. A tight fit is necessary to prevent inward leakage of contamination.

The time period over which protection is provided depends on canister, cartridge, or filter type; concentrations of contaminant; humidity levels in the ambient atmosphere; and the wearer's respiratory rate. The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. For airborne chemical contaminants, an end of service life indicator must be provided on filter cartridge or the employing department must implement a cartridge change schedule. Cartridge change must be addressed in the respirator use Safe Operating Procedure (SOP).

Breathing resistance can be a problem with non-powered air-purifying respirators. Resistance may cause discomfort or aggravate a medical condition. Powered respirators minimize the problems associated with breathing resistance.

Prescription spectacles may not work with respirator face pieces. However, special spectacles or spectacle holders are available.

Additional notes for vapor and gas removing respirators:

Particulate contaminants are not efficiently removed by a chemical cartridge without a supplemental filter.
Temperature rise in canister or cartridge indicates that a gas or vapor is being removed from the inspired air. An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

Avoid using filtering respirators in atmospheres where contaminants lack warning properties such as distinct odor, taste, or irritation at concentrations below a health limit such as a Threshold Limit Value (TLV).

**Atmosphere Supplying Respirators**

Atmosphere supplying respirators provide protection against oxygen deficiency and toxic atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions.

Atmosphere supplying respirators are required in atmospheres that are immediately dangerous to life or health (IDLH). Atmosphere supplying respirators are also required when contaminants cannot be identified or air concentrations reasonably estimated.

Skin irritation by materials such as ammonia and hydrogen chloride, or sorption of toxic materials such as hydrogen cyanide, tritium, or organic phosphate pesticides is not prevented unless other protective clothing is worn.

Face pieces present special problems to individuals required to wear prescription lenses. Prescription spectacles are available to fit inside the face piece.

**Special notes for Self-Contained Breathing Apparatus (SCBA).**

The period over which the device will provide protection is limited by the amount of oxygen in the apparatus. Heavy work also reduces service time.

SCBA devices are heavy and bulky.

Special training is required for their maintenance and safe use. A SOP must be written for SCBA use.

**Special notes for Supplied-Air Respirators (SAR).**

Air supply for work is not limited to the quantity the individual can carry and the devices are relatively lightweight.
Use is limited to atmospheres from which the wearer can escape unharmed without the air of the respirator unless an auxiliary air supply is provided for escape.

Movement of the wearer is restricted in by the hose. The wearer must return to a respirable atmosphere by retracing the route of entry.

The hose is subject to being severed or pinched off.

Air-line suits may protect against atmospheres that irritate the skin or that may be absorbed through the unbroken skin. However, some contaminants, such as tritium, may penetrate the material of an air-line suit and limit its effectiveness. Other contaminants, such as fluorine, may react chemically with the material of an air-line suit and damage it.
Appendix G: Respirator Wearer Training

Training must be comprehensive, understandable, and recur annually, and more often if workers are observed in violation of safe procedures. When respirator use is non-mandatory, provide the information to workers that is in Appendix A "Voluntary Use of Respirators."

Workers must not perform tasks requiring use of a respirator to prevent overexposure to an air contaminant, unless they are trained about an applicable Safe Operating Procedure.

Training shall be conducted in a manner that is understandable to the employee. Before an employee uses a respirator in the workplace, provide necessary training. Retrain employees annually.

Retrain employees whenever there appears to be a need, for example;

1. When significant changes in workplace procedures are planned
2. When an employee fails to perform adequately
3. When an employee asks for more training

After training, employees must be able to demonstrate knowledge of at least the following:

1. Why a respirator is necessary
2. How improper fit, usage, or maintenance can reduce the protective ability of the respirator
3. What are the limitations and capabilities of the respirator
4. How to effectively use the respirator in emergency situations
5. What to do if a respirator malfunctions
6. How to inspect, put on and use, and remove the respirator
7. How to check the seals of the respirator
8. What are the procedures for maintenance
9. Where should the respirator be stored
10. What are medical signs and symptoms that may limit a workers respirator use
Appendix H: Inspection and Maintenance of Filtering Respirators

Caution:

1. Replace HEPA cartridges when breathing resistance has increased.
2. Replace immediately organic vapor, acid gas, ammonia or other similar cartridges when an odor is detected.

Before and after each use, all respirators must be inspected for the following:

1. Tightness of connections and condition of the face piece
2. Head straps or head harnesses must be examined for: breaks; loss of elasticity; broken or malfunctioning buckles and attachments; and excessively worn head-harness slippage.
3. Valves and valve sets
4. Connecting tube and canisters, air or oxygen cylinders
5. Rubber or elastomeric parts for pliability, distortion or deterioration
6. Regulators, fittings and gauges

Disposable Respirators Supplementary inspection information

1. Check for holes in the filter or damage to sorbent such as loose charcoal granules.
2. Check straps for elasticity and deterioration.
3. Check metal nose clip for rust or deterioration.

Air Purifying Respirators

1. Check valves (exhalation and inhalation) for holes, distortion, cracks, or dirt. Remove the exhalation valve cover and examine the valve for foreign material such as detergent residue, dust particles, or human hair under the valve seat; cracks, tears, or distortion in the valve material; improper insertion of the valve body in the face piece; cracks, breaks, or chips in the valve body, particularly in the sealing surface; defective or missing valve cover; and improper insertion of the valve into the valve body.
2. Check filters, cartridges and canisters for dents, corrosion and expiration dates. Check for incorrect installation, loose connections, worn or missing gaskets, or cross-threading in the holder; expired shelf-life date on cartridge or canister; cracks or dents in the outside case of filter, cartridge, or canister; and evidence of prior use of sorbent cartridge or canister, indicated by the absence of sealing material, tape, foil, or the like, over the inlet.
3. Check for cracked or badly scratched lenses in full face pieces; incorrectly mounted full face piece lens, or broken or missing mounting clips.
4. Check for cracked or broken air-purifying element holders, badly worn threads, or missing gaskets.
5. Corrugated breathing tubes, if present, should be examined for: broken or missing end connectors, gaskets, or "O"rings; missing or loose hose clamps; and deterioration. Deterioration can be determined by stretching the breathing tube and looking for cracks.
6. The harness of a front or back mounted gas mask must be examined for damage to the canister holder that may prevent its being held securely in place.
Appendix I: SCBA Respirator Periodic Inspection and Maintenance

Date:_________________________________

Location: __________________________

Respirator ID #:_____________________

Cylinder #:_________________________

Cylinder Pressure PSIG:______________

Note:

SCBA respirators must be inspected for defects after each use, and at least once monthly if it is not used. The equipment must be repaired as necessary, cleaned and disinfected, and then stored properly to assure that it is maintained in satisfactory working condition. A record must be kept of inspection dates and findings.

If any defects are found, DO NOT use the equipment until it has been repaired by an authorized technician. In many cases, repairs by a factory authorized service center may be necessary. The manufacturer of the equipment must be contacted to obtain specific inspection and maintenance instructions. The manufacturer’s instructions must be incorporated into this checklist or must be used to modify it.

General

1) Is main or reserve air tank filled? ______  ______  ______

2) Is unit clean? ______  ______  ______

3) Are all straps on the face piece and backpack fully extended, hooked up and in good condition? ______  ______  ______

4) Case and Cover; Free of dents or heat damage? ______  ______  ______

5) Have air tanks been hydrostatically tested recently? - Check the manufacturer’s recommendation for frequency; standard steel ______  ______  ______
cylinders must be tested and internally inspected every 3 years.

<table>
<thead>
<tr>
<th>Facepiece</th>
<th>Yes</th>
<th>On Order</th>
<th>Serviced</th>
</tr>
</thead>
<tbody>
<tr>
<td>6) Face piece Lens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Is it without nicks, scratches, or abrasions which would impair outward visibility, or, deep gouges/ cracks which would reduce impact resistance?</td>
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<tr>
<td>7) Head strap Buckles</td>
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<td></td>
</tr>
<tr>
<td>1. Have crushed, bent, or corroded buckles been replaced?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Have damaged, loosened rivets or other fasteners been repaired?</td>
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<td></td>
<td></td>
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<tr>
<td>8) Mask Rims</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1. Are rim screws securely tightened?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Have deformed broken rim pieces been replaced?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9) Inlet Nozzle</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1. If there is sticking evident while exhaling through the exhalation valve, has it been corrected?</td>
<td></td>
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<td></td>
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<tr>
<td>2. Check the following inlet devices:</td>
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<td></td>
<td></td>
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<tr>
<td>Screws securing the nozzle</td>
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</tbody>
</table>
Clamps securing the low pressure hose to the nozzle.

Exhalation valve seat

Damage to the nozzle body such as warping, or cracking.

Nozzle spring.

10) Face piece Skirt

1. Have sealing lips been checked for cuts, gouges, punctures, tears and nicks?

2. Have materials that are hardening or deteriorating been checked?

11) Convoluted Low Pressure Hose

1. Have cuts, nicks or punctures in the hose been repaired?

2. Has rubber been checked for age or heat-induced cracking, crazing, or hardening?

3. Are crushed, broken or cracked parts of quick connect repaired?

12) Head strap Spider

1. Is abrasion or nicking of head strap legs repaired?

2. Is there age or heat induced hardening of the rubber?
## Second Stage Regulator

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<table>
<thead>
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<tbody>
<tr>
<td>13) Valves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Are both main and bypass valves operational?</td>
<td></td>
<td></td>
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<tr>
<td>2. Does the one way quick connect valve assembly operate smoothly, if present?</td>
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<tr>
<td>3. Is the main valve open, and the bypass valve closed?</td>
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<tr>
<td>4. Is the selector lever, if present, in the &quot;demand on&quot; position?</td>
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</table>

## Pressure gauge

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<th></th>
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<tbody>
<tr>
<td>1. Is it operational? The lens is clear, pointer to zero, and there is no needle deformation.</td>
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</table>

## Hose and fittings

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<tbody>
<tr>
<td>15) Hose and fittings; No damaged threads or worn out slots on quick connect adapter?</td>
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</tbody>
</table>

## Audible Alarm, First Stage Regulator, and Intermediate Pressure hose

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<tbody>
<tr>
<td>17) The bell alarm works. Has debris or water under the bell or dents or deformation of bell been corrected?</td>
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</tr>
</tbody>
</table>
18) The hose and end connectors are in good condition. Has abrasion or damage to hose been repaired?

19) Are retaining rings securely fastened to end connectors?

20) The threads and fittings are in good condition.

21) The "O" rings or other gaskets are flexible.

22) Backpack
   1. Cylinder holder properly functions.
   2. Cylinder is secure in frame and band.
   2. Buckles, shoulder straps and waist belt stitching of webbing is in good condition.

23) Air Cylinder
   1. External inspection shows no dents, gouges, blisters, or discolored paint.
   2. There is no external damage to cylinder valve.
   3. Hand wheel and ratchet mechanism operates smoothly.

**Backpack and Air Cylinder**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>On Order</th>
<th>Serviced</th>
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</table>

Comments:
Appendix J: User Seal Check

An individual who uses a tight-fitting respirator must perform a user seal check to ensure that an adequate seal is achieved each time the respirator is put on. Either the positive and negative pressure checks listed in this appendix, or the respirator manufacturer's recommended user seal check method shall be used. User seal checks are not substitutes for qualitative or quantitative fit tests.

A. Facepiece Positive and/or Negative Pressure Checks

Positive Pressure Check

Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires 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 Check

Close off the inlet opening of the canister or cartridge(s) by covering it with the palm of the hand(s) or by replacing the filter seal(s). Inhale gently so that the facepiece collapses slightly, and hold your breath for ten seconds. The design of the inlet opening of some cartridges cannot be effectively covered with the palm of the hand, which requires that the test be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove. If the facepiece remains in its slightly collapsed condition, and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

B. Manufacturer's Recommended User Seal Check Procedures

The respirator manufacturer's recommended procedures for performing a user seal check may be used instead of the positive and/or negative pressure check procedures, provided that the employer demonstrates that the manufacturer's procedures are equally effective in detecting seal leakage compared to the positive pressure and negative pressure checks described above.
Appendix K: Respirator Cleaning Procedures

These procedures are provided for employer use when cleaning respirators. They are general in nature. The employer may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees. The procedure must ensure that the respirator is cleaned and disinfected in a manner that prevents damage to the respirator and does not cause harm to the user.

Procedures for Cleaning Respirators

A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.
B. 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.
C. Rinse components thoroughly in clean, warm (43° C [110° F] maximum), preferably running water. Drain.
D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:
   1. 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); or,
   2. 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% alcohol) to one liter of water at 43° C (110° F); or,
   3. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.
E. 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 facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.
F. Components should be hand-dried with a clean lint-free cloth or air-dried.
G. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.
H. Test the respirator to ensure that all components work properly.
Appendix L: Storage of Respirators

A. Ensure that respirators are stored carefully, in order to protect them from dust, harmful chemicals, sunlight, excessive heat or cold, and moisture. Effective storage measures include:
   1. Zippered plastic bags.
   2. Plastic containers with tight-fitting lids, such as freezer containers.
   3. Cans and jars with tight fitting lids.

B. Pack or store the respirator so that the face piece and exhalation valves will rest in a normal position. Do not hang the respirator by its straps. Careful placement will ensure that proper function is not be impaired by distortion of the respirator or its straps.

C. Emergency use respirators should be stored where they are easily accessible. Their location should be clearly marked.