

RESPIRATORY PROTECTION PROGRAM

1.0 PURPOSE:

To establish requirements for City of Wilson employees and visiting contractors in the selection, use, and maintenance of respiratory protective equipment as determined necessary to reduce employee exposure to toxic chemical agents, occupational diseases, atmospheric contamination and allow employees to work safely in hazardous work environments. This policy meets all requirements set forth by 29 CFR 1910.134 and its supporting appendices.

2.0 SCOPE

This policy will apply to all City departments and employees who, while performing their duties for the City, may be required to wear respiratory protection. It shall be the responsibility of each department head to ensure that the provisions of this policy are carried out within their respective departments.

3.0 DEFINITIONS

- 3.1 **“AIR-PURIFYING RESPIRATOR”** means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.
- 3.2 **“ATMOSPHERE-SUPPLYING RESPIRATOR”** means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.
- 3.3 **“DEMAND RESPIRATOR”** means an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.
- 3.4 **“EMERGENCY SITUATION”** means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant.
- 3.5 **“END-OF-SERVICE-LIFE INDICATOR (ESLI)”** means a system that warns the respirator user of the approach of the end of adequate respiratory protection, for example, that the sorbent is approaching saturation or is no longer effective.
- 3.6 **“FILTERING FACEPIECE”** (dust mask) means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

- 3.7 **“FIT FACTOR”** means a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.
- 3.8 **“FIT TEST”** means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. (See also Qualitative fit test QLFT and Quantitative fit test QNFT.)
- 3.9 **"HAZARDOUS AREA"** means any department, laboratory, work area where toxic materials are used, and through a spill, mechanical malfunction, process upset, or explosion could release concentrations of vapors, dust, or fumes that could be harmful to health.
- 3.10 **“HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTER”** means a filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.
- 3.11 **“IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)”** means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual’s ability to escape from a dangerous atmosphere.
- 3.12 **“INTERIOR STRUCTURAL FIREFIGHTING”** means the physical activity of fire suppression, rescue or both, inside of buildings or enclosed structures that are involved in a fire situation beyond the incipient stage. (See 29 CFR 1910.155)
- 3.13 **“LOOSE-FITTING FACEPIECE (RESPIRATOR)”** means a respiratory inlet covering that is designed to form a partial seal with the face (i.e., dust mask).
- 3.14 **“OXYGEN DEFICIENT ATMOSPHERE”** means an atmosphere with an oxygen content below 19.5% by volume.
- 3.15 **“PHYSICIAN OR OTHER LICENSED HEALTH CARE PROFESSIONAL (PLHCP)”** means an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by paragraph (e) of this section.
- 3.16 **“QUALITATIVE FIT TEST (QLFT)”** means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual’s response to the test agent.
- 3.17 **“QUANTITATIVE FIT TEST (QNFT)”** means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.
- 3.18 **“SELF-CONTAINED BREATHING APPARATUS (SCBA)”** means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.
- 3.19 **“SUPPLIED-AIR RESPIRATOR (AIRLINE RESPIRATOR, SAR)”** means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

- 3.20 **“TIGHT-FITTING FACEPIECE (RESPIRATOR)”** means a respiratory inlet covering that forms a complete seal with the face.
- 3.21 **“USER SEAL CHECK”** means an action conducted by the respirator user to determine if the respirator is properly seated to the face.

4.0 **RESPONSIBILITIES**

- 4.1 Each department head is responsible for identifying the hazardous areas of their operations and ensuring that the provisions of this policy are carried out.
- 4.2 Employees will use the respiratory protective equipment provided in accordance with instructions provided in training and under the conditions outlined in this policy.
- 4.3 The Safety & Risk Manager, in conjunction with City of Wilson’s Division of Fire, will develop and revise the necessary training program and assist the affected sections in the initial employee training. The Safety & Risk Manager will also monitor the overall compliance with the provisions of this policy.
- 4.4 A list of qualified employees in the use of respirators and/or SCBA's will be maintained in each division head’s office.

5.0 **POLICY**

- 5.1 Employees expected to use respiratory protective equipment, on either a routine or emergency basis, will be trained in its use at initial hire, with refresher training provided on an annual basis. Likewise, prior to be assigned tasks requiring the use of respiratory equipment, supervisors will schedule employees for a medical evaluation by the Safety and Health Office for physical fitness in the use of respirators.
- 5.2 Respiratory protective equipment should not be stored within a hazardous area. It should be placed at stations for emergency use where it is quickly accessible at all times. It should be stored in water-proof/dust-proof compartments and clearly marked.
- 5.3 Respiratory Protective Equipment and associated equipment must provide adequate respiratory protection against the particular hazard to be expected as approved by the Safety and Risk Manager.
- 5.4 Employees will not be assigned to tasks requiring the use of respiratory equipment unless it has been determined that they are physically able to perform the work while using the equipment. (Physical evaluations will be scheduled and done by Safety and Health Office).
- 5.5 Persons using respiratory equipment cannot wear corrective lenses with frames unless an approved fitting has been provided for the respiratory equipment.
- 5.6 Persons using respiratory equipment must not have extra facial hair. Facial hair can affect the seal rendering the respiratory equipment ineffective.

NOTE:

Beards and/or bushy sideburns will not be worn by any employee required to be qualified in respirators or SCBA's.

- 5.7 The City of Wilson will provide respirators, training, and medical evaluations for respirator usage at no cost to the employee.

6.0 PROCEDURES FOR SELECTING RESPIRATORS

- 6.1 Supervisors shall review the work areas under their direction using the Workplace Hazard Assessment technique for all respiratory hazards their employees may encounter.
- 6.2 Upon completion of the Workplace Hazard Assessment the supervisor will match the type of respirator to the actual or potential hazard present. For those hazardous areas where Immediately Dangerous to Life and Health (IDLH) atmospheres are not present, the supervisor may wish to choose the negative pressure respirators. The employee is only authorized the use of atmosphere-supplying respirators (SCBA & SAR) in those areas with an IDLH atmosphere.

NOTE:

Where the respiratory hazard cannot be identified or the employee's exposure cannot be reasonably estimated, the atmosphere shall be considered to be IDLH.

- 6.3 The division head is responsible in making the brand, type, and size of respirator available to the employee. For cost reasons, the purchase of one brand and type of respirator is acceptable provided that brand and type can correctly fit all employees within that workplace. Those employees who cannot properly pass the fit test and check seal the chosen brand masks, are entitled to have other respirator brands made available at no cost to the employee.

NOTE:

All respirators used by City employees must be NIOSH approved. If the supervisor or employee has any doubt as to the certification, contact the supplier or the Safety and Risk Manager before use.

- 6.4 Once the respirator size, style, model and make has been properly fitted to the employee, that employee may not wear any other respirator without again being properly evaluated and fitted to that new additional respirator.
- 6.5 The division head will maintain files on employees and the respirator mask(s) they are qualified to wear. Those files will be kept in the division heads office.

7.0 TYPES OF RESPIRATORS

- 7.1 Filtering facepiece (also includes dust mask): can be used to protect against nuisance dusts and mists that are free of oil. Filtering facepieces rated as high efficiency particulate air filters (HEPA) must be used to protect against TB exposures.

- 7.2 Negative pressure respirator (half facepiece/full facepiece masks w/filter canisters): used to protect against specific fumes, vapors, and chemicals.

NOTE:

Items “1” and “2” above can only be used in non-IDLH atmospheres containing *at least 19.5% and no more than 23% oxygen!* Filtering and negative pressure masks are not to be used in IDLH atmospheres.

NOTE:

Negative pressure respirators can only be used against specific hazards. Employees must read the labels marked and/or match the color on the respirator filter canister to determine applicability to protect against a hazard.

- 7.3 Self-Contained Breathing Apparatus (SCBA): to be used when work is to be performed in an IDLH atmosphere. The SCBA must have a 30 minute or greater air bottle supply to comply with this program.
- 7.4 Supplied-Air Respirators (SAR): is to be used in an IDLH atmosphere, when the employee must have freedom of movement and dexterity or, when the wearing of an SCBA may cause an ignition hazard.

8.0 **TYPES OF FILTERS**

- 8.1 Filter elements have now according to 42 CFR 84, been classified into nine classes of filters (three levels of filter efficiency, with three categories of resistance to filter efficiency degradation). The following may assist the employee in determining the proper class filter.

8.1.1 Filter Efficiency: 95%, 99%, and 99.97%

8.1.2 Filter Efficiency Degradation:

N- Not resistant to oil

R- Resistant to oil

P- Oil proof

- 8.2 Extreme care should be exercised in the selection of the proper canisters for respirators. In addition to the color coding, labels should be affixed to the canister by the manufacturer that specifies the type of protection afforded. The Safety and Risk Manager may be contacted to assist in the selection the proper canister for the job. To assist the employee, a copy of the color table has been placed at the end of this program.

9.0 **PROCEDURES FOR PROPER USE**

- 9.1 Respiratory equipment used on a routine basis will be cleaned and disinfected after each use. Respirator equipment maintained for emergency use will be cleaned and disinfected after each use or as often as conditions may warrant. Employees will be instructed in cleaning procedures during the training program.

- 9.2 Under no circumstances are negative-pressure respirators or gas masks to be used in fire fighting operations or in dense smoke.
- 9.3 Before using a respirator, it should be inspected for the tightness of fittings and connections, conduction of face piece, headband, valves, connecting tube, and canister.
- 9.4 A continuous flow air line respirator constructed so it will cover the wearer's head, neck and shoulders to protect him/her from rebounding abrasive will be worn when using abrasive blasting agents.
- 9.5 Whenever a City employee using an SCBA or SAR respirator is in atmospheres immediately dangerous to life or health (IDLH), one or more standby persons with an SCBA will be positioned at the nearest location where fresh air is available for emergency rescue. Employees must use the "buddy system" and have visual, voice, or walkie-talkies. **No one will enter a hazardous environment alone** (*This procedure does not pertain to firefighters engaged in interior structural firefighting*).
- 9.6 Firefighters wearing SCBA's in interior structural firefighting will employ the "Two in, Two out" system at all times. Firefighters entering into structures to fight fires must remain in visual or voice contact with one another at all times. As a precautionary rule, at least two other firefighters will wait outside the hazardous area with SCBA's and retrieval equipment as a back-up in case of extended work time or rescue. Further information can be obtained from the City of Wilson, Division of Fire's Standard Operating Procedures.
- 9.7 Breathing air for SCBA's and SAR's will be of high purity. Compressed and liquid oxygen shall meet the US Pharmacopoeia requirements medical or breathing air and compressed breathing air shall meet at least the requirements of Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specifications for Air, G-7.1-1989 to include:
- 9.7.1 Oxygen content (v/v) of 19.5-23.5%;
- 9.7.2 Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
- 9.7.3 Carbon monoxide (CO) content of 10 ppm or less;
- 9.7.4 Carbon dioxide content of 1,000 ppm or less; and
- 9.7.5 Lack of noticeable odor.

NOTE:

Wilson City Fire, or a qualified distributor/supplier capable of meeting the requirements set forth in #6 above, will be the only entities allowed to refill SCBA or SAR bottles/air supplies.

- 9.8 Cylinders used to supply breathing air to respirators meet the following requirements:
- 9.8.1 Cylinders are tested and maintained as prescribed in the Shipping Container Specification Regulations of the DOT 49 CFR part 173 and part 178;

- 9.8.2 Cylinders purchased breathing air have a certificate of analysis from the supplier that the breathing air meets the requirements for Grade D breathing air; and
- 9.8.3 The moisture content in the cylinder does not exceed a dew point of -50 deg.F (-45.6 deg.C) at 1 atmosphere.

10.0 **MEDICAL CRITERIA FOR USE OF RESPIRATORS**

- 10.1 City employees will be medically evaluated prior to wearing any respirator. As part of the City's health and wellness program, employees whose positions require the use of a respirator will have an initial evaluation in the hiring process. Additional medical evaluations will occur during the following:
 - 10.1.1 an employee reports medical signs or symptoms that are related to ability to use a respirator;
 - 10.1.2 a PLHCP, supervisor, or the Safety and Risk Manager determines that an employee needs to be reevaluated;
 - 10.1.3 information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee reevaluation; or
 - 10.1.4 a change occurs in workplace conditions (e.g., physical work effort, protective clothing, temperature) that may result in a substantial increase in the physiological burden placed on the employee.
- 10.2 Employees will be given a written medical questionnaire at each evaluation. A follow-up medical examination will be provided for an employee who gives a positive response to any question among questions 1 through 8 in Section 2 of Part A of the City of Wilson OSHA Respirator Medical Evaluation Questionnaire or, whose initial medical examination demonstrates the need for a follow-up medical examination. A copy of the medical questionnaire has been attached at the end of these procedures.
- 10.3 In addition to the medical evaluation, the following information must be provided to the PLHCP before the PLHCP can make a recommendation concerning the employee's ability to use a respirator:
 - 10.3.1 the type and weight of the respirator to be used;
 - 10.3.2 the duration and frequency of respirator use;
 - 10.3.3 the expected physical work effort;
 - 10.3.4 additional protective clothing and equipment to be worn; and,
 - 10.3.5 temperature and humidity extremes that may be encountered.

11.0 FIT TESTING

- 11.1 Fit testing will be performed for all employees prior to wearing any respirator. Employees must be fit tested to the same make, model, style, and size of respirator that will be used.
- 11.2 The preferred method Citywide will be the qualitative test method. Employees using SCBA and/or SAR equipment are also to use the Qualitative fit test and accomplish this by temporarily converting the SCBA facepiece to a negative pressure respirator.
- 11.3 Fit tests must be performed *annually* and when changes occur in the employee's physical condition that could affect respirator fit. Such conditions include, but not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body.

NOTE:

Employees must be fit tested to *each* respirator of size, style, model and make they may wear within their work place. It is permissible to be qualified and fit tested to multiple respirators.

12.0 MAINTENANCE, STORAGE, INSPECTION AND DISPOSAL OF RESPIRATORS

- 12.1 Only a qualified person will repair respirators and SCBA's. A qualified person is an employee who has been trained by the manufacturer, the distributor (vendor) trained by the manufacturer, or the manufacturer itself. Respiratory equipment is not to be tampered with or modified in any form from the original manufacturer's specifications and design.
- 12.2 City of Wilson's Division of Fire will be the selected organization that monitors and tracks all repairs of SCBA and SAR systems throughout the City. All City organizations using SCBA and SAR's will coordinate the inspection and repair of these systems at initial purchase and throughout the service life of the equipment with the Division of Fire's maintenance employees. The cost of replacement and/or repair will be allocated back to the owning organization. All SCBA and SAR equipment will be properly marked for maintenance tracking prior to being put into use.
- 12.3 Respirators shall be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the facepiece and exhalation valve.
- 12.4 Damaged respirators will be immediately taken out of service and repaired, if possible. If not possible, the respirator will be labeled and destroyed. Dust masks can be placed in a trash receptacle or biohazard bag, if applicable. Rubberized face fitting respirators in addition to the above requirement must be cut up or mangled so as not to provide a proper seal. SCBA tanks will be labeled and taken out of service.
- 12.5 Filtering elements failing a visual inspection or expired past the service life will be immediately taken out of service and replaced.
- 12.6 Respirators and SCBA's maintained for emergency use will be inspected on a **monthly** basis. A record of these inspections, along with an inspection checklist, will be kept inside

the respirator storage area or SCBA carrying case. (if appl.) These checklists can be obtained from the distributor.

- 12.7 Respirators frequently used on a day to day basis will be inspected **prior to use** as well as on a monthly basis. Firefighters will inspect their SCBA equipment **at the beginning of their shift** and after each use.
- 12.8 Respirators will be inspected as required in accordance with Appendix B-2 at the end of this policy. Division heads may develop their own specific inspection checklist provided it meets or exceeds criteria in Appendix B-2.

13.0 **TRAINING FOR RESPIRATOR USE**

- 13.1 For all training involving respirator use by City employees, the training will include instruction on:
 - 13.1.1 Why the respirator is necessary;
 - 13.1.2 How improper fit, usage, or maintenance can compromise the protective effect of the respirator;
 - 13.1.3 Limitations and capabilities of the respirator;
 - 13.1.4 Proper use in emergency situations and during malfunctions;
 - 13.1.5 Inspection, installation, removal, and proper seal checks;
 - 13.1.6 Proper maintenance and storage;
 - 13.1.7 Recognition of medical signs and symptoms that may limit or prevent the effective use of respirators; and
 - 13.1.8 General requirements of this program.
- 13.2 Retraining will be administered ***annually and when the following situations occur:***
 - 13.2.1 Changes in the workplace or type of respirator render previous training obsolete;
 - 13.2.2 Inadequacies in the employee's knowledge or use of the respirator indicate that the employee has not retained the required understanding or skill;
 - 13.2.3 Any other situation arises in which retraining appears necessary to ensure safe respirator use.
- 13.3 All training will be documented and kept in the division head's office.

14.0 VOLUNTARY USE OF RESPIRATORY EQUIPMENT (not required by this policy)

- 14.1 Employees wishing to use respiratory equipment where hazards exist at lower levels below permissible exposure limits are encouraged to do so, but must adhere to the following requirements. Employees must:
- 14.1.1 Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
 - 14.1.2 Choose respirators certified by NIOSH for use to protect against the contaminant of concern.
 - 14.1.3 Not wear respirators into atmospheres containing contaminants for which their respirator is not designed to protect against.
 - 14.1.4 Keep track of individual respirator and do not mistakenly use someone else's respirator.
- 14.2 Employees using *tight fitting* respiratory equipment not mandated by this standard procedure *must be medically able* to use that respirator. Therefore, even with voluntary use, employees must be scheduled for a medical review prior to use of any tight fitting respiratory equipment.

NOTE:

Those employees whose only use of respirators involve the voluntary use of filtering facepieces (dust masks), within an atmosphere having exposure limits set below OSHA standards, are not required to be include in this written respiratory program (to include; fit test, medical evaluation).

- 14.3 Employees must ensure that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user.

15.0 PROGRAM EVALUATION

This program will be reviewed on an annual basis for overall effectiveness. Department heads and supervisors will review this program with their employees and determine if changes are needed. Items to review are: changes in hazards found in the workplace, changes in procedures which require respirator protection, changes in procedures which affect employee exposure or stress, and changes in operations which affect emergency procedures.

CITY OF WILSON

Appendix A to § 1910.134: Fit Testing Procedures (Mandatory)

A. FIT TEST 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 facepiece up to the face and eliminate those that obviously do not give an acceptable fit.
5. The more acceptable facepieces 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:
 - (a) Chin properly placed;
 - (b) Adequate strap tension, not overly tightened;
 - (c) Fit across nose bridge;

- (d) Respirator of proper size to span distance from nose to chin;
 - (e) Tendency of respirator to slip;
 - (f) 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 B-1 of this section or those recommended by the respirator manufacturer which provide equivalent protection to the procedures in Appendix B- 1. 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 facepiece 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 facepiece 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.
 - (b) Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as not to hyperventilate.
 - (c) 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.

- (d) 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).
- (e) 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.

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

(a) 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 as 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.

(b) 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.

- (a) **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 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.

(b) 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 report 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. Bitrex™ (Denatonium Benzoate) Solution Aerosol Qualitative Fit Test Protocol

The Bitrex™ (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.

(a) 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 # 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 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.

(b) 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 be 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.

(a) 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.

(b) 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.

(c) 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 facepiece 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:

- 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;
- Quantitative fit testing using ambient aerosol as the test agent and appropriate instrumentation (condensation nuclei counter) to quantify the respirator fit;
- Quantitative fit testing using controlled negative pressure and appropriate instrumentation to measure the volumetric leak rate of a facepiece 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

(a) 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 facepiece cavity at least 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 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.

(b) 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 facepiece 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 facepiece 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. This procedure is described in the following equation:

$$\text{Overall Fit Factor} = \frac{\text{Number of exercises}}{1/ff1 + 1/ff2 + 1/ff3 + 1/ff4 + 1/ff5 + 1/ff6 + 1/ff7 + 1/ff8}$$

Where ff1, ff2, ff3, etc. are the fit factors for exercises 1, 2, 3, etc.

- (9) The test subject shall not be permitted to wear a half mask or quarter facepiece respirator unless a minimum fit factor of 100 is obtained, or a full facepiece 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 TM) protocol quantitatively fit tests respirators with the use of a probe. The probed respirator is only used for quantitative fit tests.

A probed respirator has a special sampling device, installed on the respirator, that allows the probe to sample the air from inside the mask. A probed respirator is required for each make, style, model, and size that the employer uses and can be obtained from the respirator manufacturer or distributor. The CNC instrument manufacturer, TSI Inc., also provides probe attachments (TSI sampling adapters) that permit fit testing in an employee's own respirator.

A minimum fit factor pass level of at least 100 is necessary for a half-mask respirator and a minimum fit factor pass level of at least 500 is required for a full facepiece negative pressure respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) **Portacount Fit Test Requirements.**

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

(b) 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 facepiece to generate and then maintain a constant negative pressure inside the facepiece. 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 facepiece as a method for determining the facepiece 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 facepiece at a pre-selected constant pressure. The facepiece fit is expressed as the leak rate through the facepiece, 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 facepiece respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) 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 -- 15 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.

(b) 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.

(c) 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.

CITY OF WILSON

RESPIRATOR CLEANING PROCEDURES (Mandatory)

These procedures are provided for employee use when cleaning respirators and are general in nature. Division Heads, as an alternative, may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees, provided such procedures are as effective as those listed here in Appendix B. Equivalent effectiveness simply means that the procedures used must accomplish the objectives set forth in Appendix B, i.e., must ensure that the respirator is properly cleaned and disinfected in a manner that prevents damage to the respirator and does not cause harm to the user.

I. Procedures for Cleaning Respirators

1. 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.
2. Wash components in warm (43 deg. C [110 deg. F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.
3. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain.
4. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:
 - a. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43 deg. C (110 deg. F); or,
 - b. 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 deg. C (110 deg. F); or,
 - c. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.
5. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. 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.
6. Components should be hand-dried with a clean lint-free cloth or air-dried.
7. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.
8. Test the respirator to ensure that all components work properly.