

APPENDIX A

SAMPLE RESPIRATOR PROGRAM

RESPIRATOR PROGRAM EVALUATION CHECK LIST

The following is a sample respirator program:

A B C COMPANY
RESPIRATOR PROGRAM

Purpose:

The purpose of this operating procedure is to ensure the protection of all employees from respiratory hazards, through proper use of respirators. Respirators are to be used only where engineering control of respirator hazards is not feasible, while engineering controls are being installed, or in emergencies.

Responsibility

The company Safety Officer is _____ . He/she is solely responsible for all facets of this program and has full authority to make necessary decisions to ensure success of this program. This authority includes hiring personnel and equipment purchases necessary to implement and operate the program. The Safety Officer will develop written detailed instructions covering each of the basic elements in this program, and is the sole person authorized to amend these instructions.

The ABC Company has expressly authorized the Safety officer to halt any operation of the company where there is danger of serious personal injury. This policy includes respiratory hazards.

Program Elements

1. The Safety Officer will develop detailed written standard operating procedures governing the selection and use of respirators, using the NIOSH Respirator Decision Logic as a guideline. Outside consultation, manufacturer's assistance, and other recognized authorities will be consulted if there is any doubt regarding proper selection and use. These detailed procedures will be included as appendices to this respirator program. Only the Safety Officer may amend these procedures.
2. Respirators will be selected on the basis of hazards to which the worker is exposed. All selections will be made by the Safety Officer. Only MSHA/NIOSH-certified respirators will be selected and used.
3. The user will be instructed and trained in the proper use of respirators and their limitations. Both supervisors and workers will be so instructed by the Safety Officer. Training should provide the employee an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period, and finally to wear it in a test atmosphere. Every respirator wearer will receive fitting instructions, including demonstrations and practice in how the respirator should be worn, how to adjust it, and how

to determine if it fits properly.

Respirators should not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. No employees of A B C, who are required to wear respirators, may wear beards. Also the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors will be evaluated by periodic checks. To assure proper protection, the facepiece fit will be checked by the wearer each time the wearer puts on the respirator. This will be done by following the manufacturer's facepiece-fitting instructions.

4. Where practicable, the respirators will be assigned to individual workers for their exclusive use.
5. Respirators will be regularly cleaned and disinfected. Those issued for the exclusive use of one worker will be cleaned after each day's use, or more often if necessary. Those used by more than one worker will be thoroughly cleaned and disinfected after each use. The Safety Officer will establish a respirator cleaning and maintenance facility and develop detailed written cleaning instructions.
6. The central respirator cleaning and maintenance facility will store respirators in a clean and sanitary location.
7. Respirators used routinely will be inspected during cleaning. Worn or deteriorated parts will be replaced. Respirators for emergency use such as self-contained devices will be thoroughly inspected at least once a month and after each use. Inspection for SCBA breathing gas pressure will be performed weekly.
8. Appropriate surveillance of work area conditions and degree of employee exposure or stress will be maintained.
9. There will be regular inspection and evaluation to determine the continued effectiveness of the program. The Safety Officer will make frequent inspections of all areas where respirators are used to ensure compliance with the respiratory protection programs.
10. Persons will not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The ABC Company physician will determine what health and physical conditions are pertinent. The respirator user's medical status will be reviewed annually.
11. Certified respirators will be used.

John Doe
President, ABC Company

The following is a sample respirator program evaluation checklist:

Respirator Program Evaluation Checklist

In general, the respirator program should be evaluated for each job or at least annually, with program adjustments, as appropriate, made to reflect the evaluation results. Program function can be separated into administration and operation.

A. Program Administration

- _____ (1) Is there a written policy which acknowledges employer responsibility for providing a safe and healthful workplace, and assigns program responsibility, accountability, and authority?
- _____ (2) Is program responsibility vested in one individual who is knowledgeable and who can coordinate all aspects of the program at the jobsite?
- _____ (3) Can feasible engineering controls or work practices eliminate the need for respirators?
- _____ (4) Are there written procedures/statements covering the various aspects of the respirator program, including:
- _____ designation of an administrator;
 - _____ respirator selection;
 - _____ purchase of MSHA/NIOSH certified equipment;
 - _____ medical aspects of respirator usage;
 - _____ issuance of equipment;
 - _____ fitting;
 - _____ training;
 - _____ maintenance, storage, and repair;
 - _____ inspection;
 - _____ use under special condition; and
 - _____ work area surveillance?

B. Program Operation

(1) Respiratory protective equipment selection

- _____ Are work area conditions and worker exposures properly surveyed?

- _____ Are respirators selected on the basis of hazards to which the worker is exposed?
- _____ Are selections made by individuals knowledgeable of proper selection procedures?
- _____ (2) Are only certified respirators purchased and used; do they provide adequate protection for the specific hazard and concentration of the contaminant?
- _____ (3) Has a medical evaluation of the prospective user been made to determine physical and psychological ability to wear the selected respiratory protective equipment?
- _____ (4) Where practical, have respirators been issued to the users for their exclusive use, and are there records covering issuance?
- (5) Respiratory protective equipment fitting
- _____ Are the users given the opportunity to try on several respirators to determine whether the respirator they will subsequently be wearing is the best fitting one?
- _____ Is the fit tested at appropriate intervals?
- _____ Are those users who require corrective lenses properly fitted?
- _____ Are users prohibited from wearing contact lenses when using respirators?
- _____ Is the facepiece-to-face seal tested in a test atmosphere?
- _____ Are workers prohibited from wearing respirators in contaminated work areas when they have facial hair or other characteristics may cause face seal leakage?
- (6) Respirator use in the work area
- _____ Are respirators being worn correctly (i.e., head covering over respirator straps)?
- _____ Are workers keeping respirators on all the time while in the work area?

(7) Maintenance of respiratory protective equipment

Cleaning and Disinfecting

_____ Are respirators cleaned and disinfected after each use when different people use the same device, or as frequently as necessary for devices issued to individual users?

_____ Are proper methods of cleaning and disinfecting utilized?

Storage

_____ Are respirators stored in a manner so as to protect them from dust, sunlight, heat, excessive cold or moisture, or damaging chemicals?

_____ Are respirators stored properly in a storage facility so as to prevent them from deforming?

_____ Is storage in lockers and tool boxes permitted only if the respirator is in a carrying case or carton?

Inspection

_____ Are respirators inspected before and after each use and during cleaning?

_____ Are qualified individuals/users instructed in inspection techniques?

_____ Is respiratory protective equipment designated as "emergency use" inspected at least monthly (in addition to after each use)?

_____ Are SCBA incorporating breathing gas containers inspected weekly for breathing gas pressure?

_____ Is a record kept of the inspection of "emergency use" respiratory protective equipment?

Repair

_____ Are replacement parts used in repair those of the manufacturer of the respirator?

_____ Are repairs made by manufacturers or manufacturer-trained individuals?

(8) Special use conditions

_____ **Is a procedure developed for respiratory protective equipment usage in atmospheres immediately dangerous to life or health?**

_____ **Is a procedure developed for equipment usage for entry into confined spaces?**

(9) Training

_____ **Are users trained in proper respirator use, cleaning, and inspection?**

_____ **Are users trained in the basis for selection of respirators?**

_____ **Are users evaluated, using competency-based evaluation, before and after training?**

SAMPLE RESPIRATOR INSPECTION RECORD

1. TYPE _____ 2. NO. _____

3. DEFECTS FOUND:

A. Facepiece _____

B. Inhalation Valve _____

C. Exhalation Valve Assembly _____

D. Headbands _____

E. Cartridge Holder _____

F. Cartridge/Canister _____

G. Filter _____

H. Harness Assembly _____

I. Hose Assembly _____

J. Speaking Diaphragm _____

K. Gaskets _____

L. Connections _____

M. Other Defects _____

APPENDIX B
FIT TESTING PROCEDURES

APPENDIX B.1. PROCEDURES FOR FIT CHECKING

The seal of a respirator should be tested prior to entering a contaminated atmosphere by procedures recommended by the manufacturer or by the following fit checks.

Irritant or Odorous Chemical Agent

The wearer is exposed to an irritant smoke, isoamyl acetate vapor, or other suitable test agent easily detectable by irritation, odor, or taste. An air-purifying respirator must be equipped with the appropriate air-purifying element. If the wearer is unable to detect penetration of the test agent, the respirator is probably tight enough.



FIGURE B-1. Odorous vapor check test

Negative Pressure Test

The wearer can perform this test by himself in the field. The wearer should use this test (Figure B-1) just before entering any toxic atmosphere. It consists merely of closing off the inlet of the canister, cartridge(s), or filter(s) by covering with the palm(s) or replacing the seal(s), or of squeezing the breathing tube so that it does not pass air; inhaling gently so that the facepiece collapses slightly; and holding the breath for 10 seconds. If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator is probably tight enough. This test, of course, can be used only on respirators with tight fitting facepieces.



FIGURE B-2. Negative pressure test

Positive Pressure Test

This test is very like the negative pressure test, and it has the same advantages and limitations. It is conducted by closing off the exhalation valve and exhaling gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage. For some respirators, this method requires that the wearer remove the exhalation valve cover and then carefully replace it after the test, often a difficult task. Removing and replacing the exhalation valve cover often disturbs the respirator fit even more than does the negative pressure test. Therefore, this test should be used sparingly if it requires removing and replacing a valve cover. The test is easy for respirators whose valve cover has a single small port that can be closed by the palm or a finger. The wearer should perform this test (Figure B-2) just before entering any hazardous atmosphere.



FIGURE B-3. Positive pressure test

APPENDIX B.2. QUALITATIVE FIT TEST PROCEDURES

[Note: The following procedures are found in the OSHA Lead Standard (29 CFR 1910.1025) Appendix D.]

This appendix specifies the only allowable qualitative fit test protocols permissible for compliance with paragraph (f)(3)(ii).

I. Isoamyl Acetate Protocol

A. Odor Threshold Screening

1. Three 1-liter glass jars with metal lids (e.g. Mason or Bell jars) are required.
2. Odor-free water (e.g. distilled or spring water) at approximately 25°C shall be used for the solution.
3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. The solution shall be prepared new 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 but may not be connected to the same recirculating ventilation system.
5. The odor test solution is prepared in a second jar by placing 4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.
6. A test blank is prepared in a third jar by adding 500 cc of odor free water.
7. The odor test and test blank jars shall be labeled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically dried off and switched to avoid people thinking the same jar always has the IAA.
8. The following instructions 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 QLFT may not be used.
11. If the test subject correctly identifies the jar containing the odor test solution he may proceed to respirator selection and fit testing.

B. Respirator Selection

1. The test subject shall be allowed to select the most comfortable respirator from a large array of various sizes and manufacturers that includes at least three sizes of elastomeric half facepieces and units of at least two manufacturers.
2. The selection process shall be conducted in a room separate from the fit test chamber to prevent odor fatigue. 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 assess a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This may not constitute his formal training on respirator use, only a review.
3. The test subject should understand that he is being asked to select the respirator which provides the most comfortable fit for him. Each respirator represents a different size and shape and, if fit properly, will provide adequate protection.

4. The test subject holds each facepiece up to his face and eliminates those which are obviously not giving a comfortable fit. Normally, selection will begin with a half-mask and if a fit cannot be found here, the subject will be asked to go to the full-facepiece respirators. (A small percentage of users will not be able to wear any half-mask.)
5. The more comfortable facepieces are recorded; 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 #6 below. If the test subject is not familiar with using a particular respirator, he shall be directed to don the mask several times and to adjust the straps each time, so that he becomes adept at setting proper tension on the straps.
6. Assessment of comfort shall include reviewing the following points with the test subject:
 - o Chin properly placed.
 - o Positioning of mask on nose.
 - o Strap tension.
 - o Fit across nose bridge.
 - o Room for safety glasses.
 - o Distance from nose to chin.
 - o Room to talk.
 - o Tendency to slip.
 - o Cheeks filled out.
 - o Self-observation in mirror.
 - o Adequate time for assessment.
7. The test subject shall conduct the conventional negative and positive-pressure fit checks (e.g. see ANSI Z88.2-1980). Before conducting the negative-or positive-pressure checks, the subject shall be told to "seat" his mask by rapidly moving the head side-to-side and up and down, taking a few deep breaths.
8. The test subject is now ready for fit testing.
9. After passing the fit test, the test subject shall be questioned again regarding the comfort of the respirator. If it has become uncomfortable, another model of respirator shall be tried.
10. The employee shall be given the opportunity to select a different facepiece and be retested if during the first two weeks of on-the-job wear the chosen facepiece becomes unacceptably uncomfortable.

C. *Fit test.*

1. The fit test chamber shall be substantially similar to a clear 55 gallon drum liner suspended inverted over a 2 foot diameter frame, so that the top of chamber is about 6 inches above the test subject's head. 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. The cartridges or masks shall be changed at least weekly.
3. After selecting, donning, and properly adjusting a respirator himself, 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 hook, to prevent general room contamination.
4. A copy of the following test exercises and rainbow (or equally effective) passage shall be taped to the inside of the test chamber:

Test Exercises

- i. Normal breathing
- ii. Deep breathing. Be certain breaths are deep and regular.
- iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.
- iv. Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.
- v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

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 every 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.

vi. Normal breathing.

5. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.
6. 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 three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.
7. Allow two minutes for the IAA test concentration to be reached 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 cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.
8. Each exercise described in No. 4 above shall be performed for at least one minute.
9. If at any time during the test, the subject detects the banana-like odor of IAA, he shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.
10. Upon returning to the selection room, the subject shall remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, etc. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot be fitted with the selection of half-mask respirators, include full-facepiece models in the selection process. When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having him break the face seal and take a breath before exiting the chamber.
12. When the test subject leave the chamber he shall remove the saturated towel, returning it to the test conductor. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag. There is no significant IAA concentration buildup in the test chamber from subsequent tests.
13. Persons who have successfully passed this fit test may be assigned the use of the tested respirator in atmospheres with up to 10 times the PEL of airborne lead. In other words this IAA protocol may be used to assign a protection factor no higher than 10.

II. SACCHARIN SOLUTION AEROSOL PROTOCOL

A. Taste Threshold Screening.

1. Threshold screening as well as fit testing employees shall use 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 movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly of part #FT 14 and FT 15 combined is adequate.
2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.
3. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.
4. The test subject shall don the test enclosure. For the threshold screening test, he shall breathe through his open mouth with tongue extended.
5. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer, 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 or equivalent.

6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C6 below) in 100 cc of water.
7. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely then released and allowed to fully expand.
8. Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.
9. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.
10. If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.
11. The test conductor will take note of the number of squeezes required to elicit a taste response.
12. If the saccharin is not tasted after 30 squeezes (Step 9), the test subject may not perform the saccharin fit test.
13. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.
14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.
15. 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. Respirator Selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with a particular filter cartridge.

C. Fit Test.

1. The fit test uses the same enclosure described in B1 and B2 above.

2. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.
3. The test subject shall don the enclosure while wearing the respirator selected in section A above. This respirator shall be properly adjusted and equipped with a particular filter cartridge.
4. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.
5. A second DeVilbiss Model 40 Inhalation Medication nebulizer 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 or equivalent.
6. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.
7. As before, the test subject shall breathe through the open mouth with tongue extended.
8. The nebulizer is inserted into the hole in front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B10 above).
9. After generation of the aerosol the test subject shall be instructed to perform the following exercise for one minute each:
 - a. Normal breathing.
 - b. Deep breathing. Be certain breaths are deep and regular.
 - c. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.
 - d. Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

2. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.
3. The test subject shall don the enclosure while wearing the respirator selected in section A above. This respirator shall be properly adjusted and equipped with a particular filter cartridge.
4. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.
5. A second DeVilbiss Model 40 Inhalation Medication nebulizer 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 or equivalent.
6. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.
7. As before, the test subject shall breathe through the open mouth with tongue extended.
8. The nebulizer is inserted into the hole in front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B10 above).
9. After generation of the aerosol the test subject shall be instructed to perform the following exercise for one minute each:
 - a. Normal breathing.
 - b. Deep breathing. Be certain breaths are deep and regular.
 - c. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.
 - d. Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

- e. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

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 god at one end. People look, but no one every 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.

10. Every 30 seconds, the aerosol concentration shall be replenished using one-half the number of squeezes as initially (C8).
11. The test subject shall so indicate to the test conductor if at any time during the fiat test the taste of saccharin is detected.
12. If the saccharin is detected the fit is deemed unsatisfactory and a different respirator shall be tried.
13. Successful completion of the test protocol shall allow the use of the tested respirator in contaminated atmospheres up to 10 times the PEL. In other words this protocol may be used to assign protection factors no higher than ten.

III. IRRITANT FUME PROTOCOL

A. Respirator Selection.

Respirators shall be selected as described in section 1B above, except that each respirator shall be equipped with high efficiency cartridges.

B. Fit Test.

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize him with its characteristic odor.

2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.
3. The test conductor shall review this protocol with the test subject before testing.
4. The test subject shall perform the conventional positive pressure and negative pressure fit checks. Failure of either check shall be cause to select an alternate respirator.
5. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.
6. Advise the test subject that the smoke can be irritating to the eyes and instruct him to keep his eyes closed while the test is performed.
7. The test conductor shall direct the stream of irritant smoke from the tube towards the face seal area of the test subject. He shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.
8. The following exercises shall be performed while the respirator seal is being challenged by the smoke. Each shall be performed for one minute.
 - a. Normal breathing
 - b. Deep breathing. Be certain breaths are deep and regular.
 - c. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.
 - d. Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.
 - e. Talking--slowly and distinctly, count backwards from 100.

- f. Normal breathing
9. If the irritant smoke produces an involuntary reaction (cough) by the test subject, the test conductor shall stop the test. In this case the test respirator is rejected and another respirator shall be selected.
 10. Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube to determine whether he reacts to the smoke. Failure to evoke a response shall void the fit test.
 11. Steps B4, B7, B8 of this protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the irritant smoke.
 12. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to ten times the PEL. In other words this protocol may be used to assign protection factors not exceeding ten.

APPENDIX B.3. QUANTITATIVE FIT TEST PROCEDURES

Except for procedures peculiar to instrument operation and calibration, quantitative respirator fitting tests are practically identical. The following is a suggested procedure for use in all types of test systems.

I. PRELIMINARY CHECKOUT PROCEDURES

- A. Start up and calibrate the test system according to manufacturer's instructions. Be sure that the system is stable and that the aerosol or gas concentration in the enclosure has reached equilibrium.
- B. Inspect all respirators to be used in the tests for defects and cleanness according to the procedures described in this guide.

II. QUANTITATIVE FITTING TEST PROCEDURES

- A. Recheck the respirator before handing it to the test subject, paying particular attention to the sampling probe and line attached to the facepiece.
- B. Describe the test to the subject, making sure that the subject fully understands its purpose, the procedures, and the actions expected.
- C. If the subject is not familiar with wearing respirators, demonstrate correct wearing procedures. The subject's level of expertise usually becomes apparent as the subject puts on the respirator. The untrained or poorly trained subject will put the respirator on incorrectly or be hesitant in movements.
- D. Have the subject put on the respirator, according to manufacturer's instructions. Be sure the subject does not tighten the headstraps to the point of discomfort. Remember that this test should approximate working conditions in which the subject might have to wear the respirator continuously for an hour to two at a time.

In testing a half- or quarter-mask, check its compatibility with safety glasses. If the subject's safety glasses interfere, try other brands of respirators of the same type. The subject may have to wear a full-facepiece, which provides eye protection, if a half- or quarter-mask compatible with safety glasses cannot be found.

- E. Once it has been determined that the respirator is worn properly, the fit can be checked quickly using a qualitative fitting test. Make sure that the correct filter, cartridge, or canister for the particular test is installed in the respirator. Also make sure that the subject pinches off the sampling hose. If leakage is detected, try to determine its source and cause. If the leakage is from a poorly fitting facepiece, try another brand of the same type of respirator. In fact, several different brands of respirators should be made available so the subject can choose the most comfortable, a very important aspect of fitting respirators.
- F. After the best possible qualitative fit has been obtained, the subject enters the test enclosure and connects the sampling hose. If necessary, and without disturbing the facepiece fit, replace the filter, cartridge, or canister used during the qualitative test with the air-purifying element required for the quantitative test. To minimize filter leakage, use high-efficiency particulate filters when the test agent is an aerosol. Allow enough time (2-3 minutes) at this point for the test enclosure concentration to stabilize. Then recheck the test system calibration.
- G. In response to verbal instructions, the subject begins head and facial movements simulating those made during normal work.
- (1) Normal breathing with head motionless for 1 minute;
 - (2) Deep breathing (simulating that during hard work) with head motionless for 30 seconds. Do not prolong this exercise because of the danger of hyperventilation;
 - (3) Turning head slowly up and down while breathing normally, pausing for at least two breaths before changing direction. Continue for at least 1 minute;
 - (4) Moving head slowly up and down while breathing normally, pausing for at least two breaths before changing direction. Continue for at least 1 minute;
 - (5) Reading from a prepared text, slowly and clearly, and loudly enough to be heard and understood by the test operator. Continue for 1 minute;
 - (6) Normal breathing with head motionless for at least 1 minute.

These exercises are more or less "standard" and have been found to provide a meaningful evaluation of respirator performance. Therefore, if they are used, the data can be compared with published information. The times suggested for each are minimal and may be extended if needed to obtain better data.

- H. After the test, the subject leaves the test enclosure and removes the respirator. The operator should then ask about the respirator comfort and note any marks on the subject's face which indicate pressure points. If the test indicated a good fit, any discomfort may be due to a mismatch between the subject and the facepiece or to headstraps that are too tight. Every effort should be made to provide the most comfortable respirator possible.
- I. The test results may be analyzed and the protection level determined by one of two methods. The first involves watching a meter during the test to determine that penetration does not exceed a certain value.

The second, much preferred, method is to record the entire test using a strip chart recorder operated at a chart speed of about 2 inches per minute.

The first information should uniquely identify the test by number, date, subject, and type of respirator. Next comes the test system calibrations after the subject has entered the test enclosure, to establish the maximum span of the penetration-measuring instrument ("100% calibration). This should be done at least twice to ensure that the calibration is correct.

Next follow the five exercises, separated by horizontal lines across the chart. As the penetration-measuring instrument has several ranges, the range should be shown next to the right margin of the chart. When it becomes necessary to change the penetration range, as in the example under turning head from side to side (TH), make a short mark where the change was made and indicate the new scale setting.

Each exercise should be identified by some notation. For example, the following notation could be used on the strip chart recording:

Normal Breathing	NB
Deep Breathing	DB
Turning Head from Side to Side	TH
Moving Head Up and Down	UD
Talking	T

These are suggested notations; others may be used, but they should be consistent.

All the above notations should be made during the test. However, it is neither necessary nor desirable to calculate the penetrations until later. The operator should pay full attention to running the equipment and noting the subject's actions during the test.

The cyclic nature of the recorder trace is a function of the subject's breathing cycle. As this example shows, in an air-purifying respirator with a half-mask, negative air pressure created in the facepiece during inhalation increases the leakage. Exhalation creates slightly positive air pressure, reducing the leakage. Also, the lungs absorb some of the test agent, especially if it is an aerosol, thus reducing the quantity of test agent in the exhaled breath. Consequently, the maximum penetration during inhalation indicates the fraction of ambient concentration which has penetrated the facepiece. Therefore respirator performance is based on the average of the peak penetrations.

After the test, the operator may analyze the recording. This is done, treating each exercise separately, by drawing a line through the inhalation peaks to approximate their average. The midpoint of each line is the "average peak penetration" for the exercise. This number should be entered on the chart for each exercise. Where the penetration changes abruptly, it is usually advantageous to split the data into more than one section and treat each separately.

For example, if five chart divisions under UD show a penetration of 2.55% and three show 3.75%, the average peak penetration for the entire exercise is calculated as follows:

$$\begin{array}{r} 5 \text{ divisions} \times 2.55 = 12.75 \\ \underline{3 \text{ divisions} \times 3.75 = 11.25} \\ 8 \text{ divisions} \qquad \qquad 24.00 \end{array}$$

$$24.00/8 = 3.00\% \text{ peak average penetration.}$$

After the average peak penetration has been calculated for each exercise, the data may be entered on a fitting test record. The record should include the information from the recorder chart which uniquely identifies the test. The record should indicate results of the qualitative pretest, the average peak penetrations calculated for each exercise, the test criterion expressed as the maximum allowable average peak penetration, the test average peak penetration obtained by averaging the average peak penetrations for each exercise, and whether the overall performance was satisfactory or not. This determination is based on the qualitative fit, compatibility with safety glasses, and average penetration.

The subject evaluation of the comfort of the particular respirator is based on the following criteria:

1. VERY COMFORTABLE

Mask can be worn for an indefinite period without becoming unbearably bothersome or painful. No pain points: mask feels comfortable.

2. COMFORTABLE

Mask can be worn for 2 to 4 hours without undue discomfort. Some pressure points with slight discomfort.

3. BARELY COMFORTABLE

Mask can be worn for approximately 1/2 to 1 hour without intolerable discomfort. Some discomfort from pressure.

4. UNCOMFORTABLE

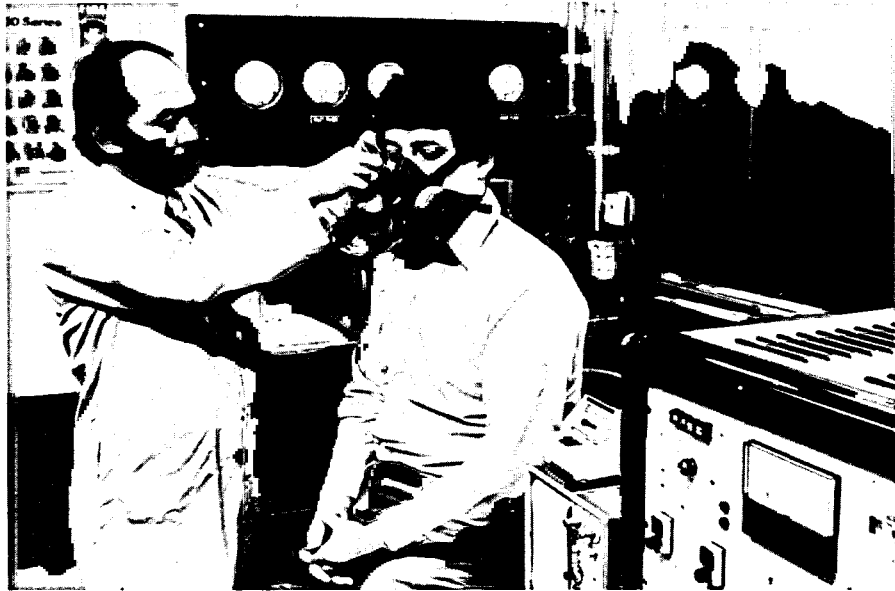
Mask can be tolerated for the period of the test only.

5. INTOLERABLE

Mask cannot be worn at all without discomfort.

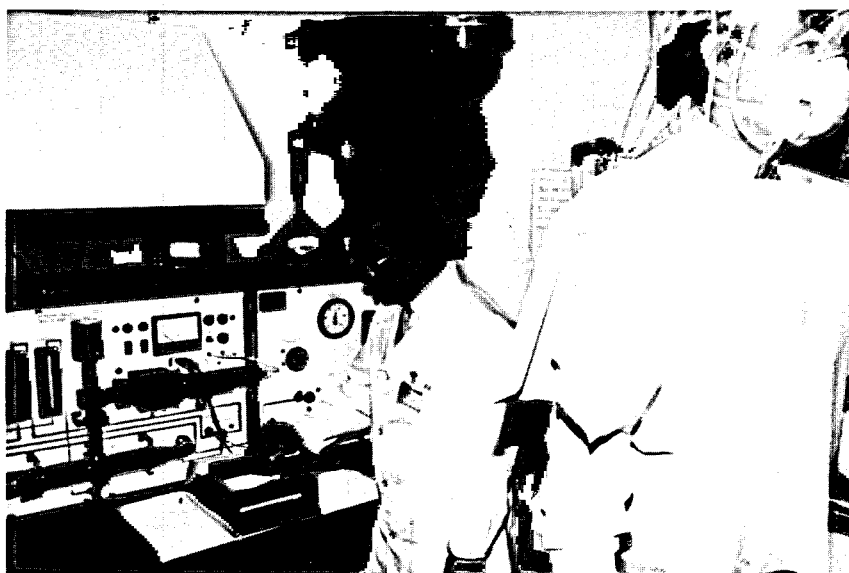
All other factors being equal, final choice of a respirator should be based on comfort. A worker should not be required to wear a device he considers "uncomfortable" or "intolerable." He may wear a "barely comfortable" respirator if the proposed usage is intermittent for short periods.

In summary, the above is a suggested procedure for conducting a quantitative respirator fitting test, evaluating the results, and recording the data meaningfully, without laborious record keeping. Moreover, the data will be compatible with those from other work.



Photograph Courtesy of North Safety Products

FIGURE B-4. Checking fit prior to doing quantitative fit testing



Photograph Courtesy of Gerson Co., Inc.

FIGURE B-5. Quantitative fit testing of a single-use respirator

