

Appendix A to 437-004-1041, Respiratory Protection – Fit Testing Procedures (Mandatory)

Part I. Acceptable Fit Test Procedures

- A. Fit Testing Procedures – General Requirements. These fit test procedures are mandatory and apply to both Qualitative Fit Tests (QLFT) and Quantitative Fit Tests (QNFT).
- (1) Provide enough respirators so the employee can choose an acceptable model that fits correctly. Be sure they understand that they must select a respirator that gives the best fit.
 - (2) Before the employee selects their respirator you must show them how to put on a respirator, how to position it on their face, how to set the strap tension and how to make sure the fit is acceptable. There must be a mirror for them to use when evaluating the position and fit. This instruction does not replace the required formal training.
 - (3) They must hold each face piece they choose up to their face to find the one with the best fit.
 - (4) Once they choose a mask, have them wear it for at least 5 minutes to evaluate the comfort level. Discuss the points in the following paragraph to assure the worker makes a good evaluation. If they are not familiar with using a particular respirator, have them put it on and take it off several times to assure they make the needed adjustments for a good fit.
 - (5) Assessment of comfort must include a review of the following points with the test subject and allowing the test subject enough 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
 - (6) Use the following criteria to help determine the adequacy of the respirator fit:
 - (a) Chin properly placed;
 - (b) Adequate strap tension, not too tight;
 - (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.
- (7) Have the employee do a user seal check according to Appendix B-1. Before they do the check have them seat the mask by moving their head from side to side and up and down slowly while taking a few deep breaths. If the test fails, have them select another mask.
 - (8) Do not do the test if the employee has any hair (including beard stubble) between the skin and sealing surface. They must alter or remove any clothing or items that interfere with the fit.
 - (9) If the testing employee shows signs of difficult breathing during the test, send them to a PLHCP to evaluate their ability to use a respirator.
 - (10) If the employee finds the fit unacceptable, you must allow them to select another respirator and retest.
 - (11) Exercises. Before beginning the fit test, give the worker a description of the test and advise them of their responsibilities during the test. The description must include the exercises. They must wear the respirator for 5 minutes before the start of the test.
 - (12) During the test the employee must wear any other safety equipment normally required for their work, if it could interfere with the respirator fit.
 - (13) Test Exercises.
 - (a) Employers must perform the following test exercises for all fit testing methods prescribed in this appendix, except for the two modified ambient aerosol CNC quantitative fit testing protocols, the CNP quantitative fit testing protocol, and the CNP REDON quantitative fit testing protocol. For the modified ambient aerosol CNC quantitative fit testing protocols, employers shall ensure that the test subjects (i.e., employees) perform the exercise procedure specified in Part I.C.4(b) of this appendix for full-facepiece and half-mask elastomeric respirators, or the exercise procedure specified in Part I.C.5(b) for filtering facepiece respirators. Employers must ensure that the test subjects (i.e., employees) perform the exercise procedure described in Part I.C.6(b) of this appendix for the CNP quantitative fit testing protocol, or the exercise procedure described in Part I.C.7(b) of this appendix for the CNP REDON quantitative fit-testing protocol. For the remaining fit testing methods, employers shall ensure that the test exercises are performed in the appropriate test environment in the following manner:
 - (1) Normal breathing. In a normal standing position, without talking, the subject must breathe normally.

- (2) Deep breathing. In a normal standing position, the subject must breathe slowly and deeply, taking caution so as not to hyperventilate.
- (3) Turning head side to side. Standing in place, the subject must slowly turn their head from side to side between the extreme positions on each side. The head must be held at each extreme momentarily so the subject can inhale at each side.
- (4) Moving head up and down. Standing in place, the subject must slowly move their head up and down. Instruct the subject to inhale in the up position (i.e., when looking toward the ceiling).
- (5) Talking. The subject must talk out loud slowly and loud enough 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.

- (6) Grimace. The test subject must grimace by smiling or frowning. (This applies only to QNFT testing; it is not for QLFT.)
 - (7) Bending over. The test subject must bend at the waist as if they were to touch their toes. Substitute jogging in place for this exercise in those test environments such as shroud type QNFT or QLFT units that do not permit bending over at the waist.
 - (8) Normal breathing. Same as exercise (1).
- (b) Do each test exercise for 1-minute except for the grimace exercise which is only for 15 seconds. Ask the test subject about the comfort of the respirator upon completion of the procedure. If there are problems, try another respirator. Do not adjust the respirator after the fit test exercises begin. Any adjustment voids the test.

B. Qualitative Fit Test (QLFT) Procedures

(1) General

- (a) The employer must 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 works properly.
- (b) The employer must ensure that QLFT equipment is clean and well maintained so as to operate within its design parameters.

(2) Isoamyl Acetate Procedures

Note: This procedure is not appropriate to use for the fit testing of particulate respirators unless the particulate cartridges can be replaced with organic vapor cartridges for the duration of the test.

- (a) **Odor Threshold Screening.** Odor threshold screening, done without wearing a respirator, is to determine if the individual tested can detect the odor of isoamyl acetate at low levels.
 - (1) You'll need three 1 liter glass jars with metal lids.
 - (2) Use odor-free water (e.g., distilled or spring water) at approximately 25 degrees C. (77 degrees F.) for the solutions.
 - (3) Make the isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution 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. Make a new solution at least weekly.
 - (4) Do the screening test in a room separate from the room used for actual fit testing. Ventilate the two rooms to prevent the odor of IAA from becoming evident in the general room air where testing takes place.
 - (5) Make the odor test solution 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. Shake the solution for 30 seconds and allow it to stand for 2 to 3 minutes so that the IAA concentration above the liquid may reach equilibrium. Use this solution for only 1-day.
 - (6) Make a test blank in a third jar by adding 500 cc of odor-free water.
 - (7) Label the odor test and test blank jar lids (e.g., 1 and 2) for jar identification. Place the labels on the lids so that they can be peeled off periodically and switched to maintain the integrity of the test.

- (8) Type the following instruction on a card and place it 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 has 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) Make the mixtures for the IAA odor detection test in an area separate from where you do the test, in order to prevent olfactory fatigue in the subject.
 - (10) If the test subject cannot correctly identify the jar containing the odor test solution, do not do the IAA qualitative fit test.
 - (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 must 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, make a similar chamber using plastic sheeting. The inside top center of the chamber must have a small hook attached.
 - (2) Each respirator for the fitting and fit testing must have organic vapor cartridges or offer protection against organic vapors.
 - (3) After selecting, donning, and properly adjusting a respirator, the test subject must wear it to the fit testing room. This room must be separate from the room used for odor threshold screening and respirator selection, and must be well-ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.
 - (4) Tape a copy of the test exercises and any prepared text from which the subject is to read to the inside of the test chamber.

- (5) Give the test subject 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 when they enter the test chamber. Have the test subject hang the wet towel on the hook at the top of the chamber. You may substitute an IAA test swab or ampule for the IAA wetted paper towel if the alternative IAA source will generate an IAA test atmosphere with a concentration equivalent to that generated by the paper towel method.
 - (6) Allow 2 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 their 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 a failure. The subject must quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.
 - (8) If the test fails, the subject must return to the selection room and remove the respirator. The test subject must repeat the odor sensitivity test, select and put on another respirator, return to the test area and again begin the fit test procedure in (b)(1) through (7) above. The process continues until they find a respirator that fits right. Should the odor sensitivity test fail, the subject must wait at least a few minutes before re-testing. Odor sensitivity will usually return by this time.
 - (9) If the subject passes the test, demonstrate the efficiency of the test procedure 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, they must remove the saturated towel and return it to the person conducting the test, so that there is no significant IAA concentration build-up in the chamber during subsequent tests. Keep the used towels in a self-sealing plastic bag to prevent contamination of the test area.
- (3) Saccharin Solution Aerosol Procedure
- You must explain the entire screening and testing procedure to the test subject before starting the screening test.
- (a) Taste threshold screening. The saccharin taste threshold screening, done without wearing a respirator, is to determine if the individual being tested can detect the taste of saccharin.

- (1) During threshold screening as well as during fit testing, subjects must 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 wearing a respirator. An enclosure substantially similar to the 3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.
- (2) The test enclosure must 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) Have the test subject put on the test enclosure. Throughout the threshold screening test, the test subject must breathe through their slightly open mouth with tongue extended. Tell the subject to report when they detect a sweet taste.
- (4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor must spray the threshold check solution into the enclosure. Direct the nozzle away from the nose and mouth of the person. Clearly mark this nebulizer to distinguish it from the fit test solution nebulizer.
- (5) Make the threshold check solution by dissolving 0.83 gram of sodium saccharin USP in 100 ml of warm water. You can also put 1 ml of the fit test solution (see (b)(5) below) in 100 ml of distilled water.
- (6) To produce the aerosol, firmly squeeze the nebulizer bulb so that it collapses completely, then release and allow to fully expand.
- (7) Repeat ten squeezes rapidly and then ask the test subject if they can taste the saccharin. The test is over when the test subject reports tasting the sweet taste during the ten squeezes. Note the taste threshold as ten regardless of the number of squeezes actually done.
- (8) If the first response is negative, do ten more squeezes rapidly and ask the test subject if they taste the saccharin. If the test subject reports tasting the sweet taste during the second ten squeezes, the screening test is over. The taste threshold is twenty regardless of the number of squeezes actually done.
- (9) If the second response is negative, do ten more squeezes rapidly and ask the test subject again if they taste the saccharin. If the test subject reports tasting the sweet taste during the third set of ten squeezes, the screening test is over. The taste threshold is thirty regardless of the number of squeezes actually done.

- (10) The test conductor will take note of the number of squeezes required to solicit a taste response.
- (11) If the test subject cannot taste saccharin after 30 squeezes they 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, they may be unable to taste the weak saccharin solution.

- (12) If the test subject gives a taste response, ask them to take note of the taste for reference in the fit test.
 - (13) Correct use of the nebulizer uses approximately 1 ml of liquid at a time in the nebulizer body.
 - (14) Thoroughly rinse the nebulizer in water, shake it dry, and refill it at least each morning and afternoon or at least every 4 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 as in 3.(a) above.
 - (3) The test subject must put on the enclosure while wearing the respirator selected in section I.A.. They must properly adjust the respirator and it must have a particulate filter(s).
 - (4) Use a second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent to spray the fit test solution into the enclosure. Clearly mark this nebulizer to distinguish it from the screening test solution nebulizer.
 - (5) Make the fit test solution by adding 83 grams of sodium saccharin to 100 ml of warm water.
 - (6) As before, the test subject must breathe through the slightly open mouth with tongue extended, and report if they taste the sweet taste of saccharin.
 - (7) Insert the nebulizer into the hole in the front of the enclosure and spray an initial concentration of saccharin fit test solution 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. The minimum is 10 squeezes.
 - (8) After generating the aerosol, tell the test subject to perform the exercises in section I.A.13.

- (9) Replenish the aerosol concentration every 30 using one half the original number of squeezes used initially (e.g., 5, 10 or 15).
 - (10) The test subject must indicate to the test conductor if at any time during the fit test they taste saccharin. If the test subject does not report tasting the saccharin, the test is successful.
 - (11) If they taste the saccharin, the fit is unsatisfactory and a failure. Try a different respirator and repeat the entire test procedure (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 Procedure
- The Bitrex™ (Denatonium benzoate) solution aerosol QLFT procedure uses the published saccharin test procedure because that procedure is widely accepted. Bitrex is a taste aversion agent used in household liquids that children should not drink and is endorsed by the American Medical Association, the National Safety Council, and the American Association of Poison Control Centers. Explain the entire screening and testing procedure to the test subject before the screening test.
- (a) Taste Threshold Screening.
- The Bitrex taste threshold screening, done without wearing a respirator, is to determine if the person being tested can detect the taste of Bitrex.
- (1) During threshold screening as well as during fit testing, subjects must 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 must 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 must 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 must put on the test enclosure. Throughout the threshold screening test, the test subject must breathe through his or her slightly open mouth with tongue extended. Tell the subject to report when they detect a bitter taste.

- (4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the spray the Threshold Check Solution into the enclosure. Clearly mark this Nebulizer to distinguish it from the fit test solution nebulizer.
 - (5) Make the Threshold Check Solution by adding 13.5 milligrams of Bitrex to 100 ml of 5 percent salt (NaCl) solution in distilled water.
 - (6) To produce the aerosol, firmly squeeze the nebulizer bulb so that the bulb collapses completely, and then release it and allow it to fully expand.
 - (7) Repeat the initial ten squeezes rapidly and then ask the test subject if they taste the Bitrex. If the test subject tastes the bitter taste during the ten squeezes, the screening test is over. The taste threshold is ten regardless of the number of squeezes actually done.
 - (8) If the first response is negative, repeat ten more squeezes rapidly and ask the test subject if they taste the Bitrex. If the test subject tastes the bitter taste during the second ten squeezes, the screening test is over. The taste threshold is twenty regardless of the number of squeezes actually done.
 - (9) If the second response is negative, do ten more squeezes rapidly and ask the test subject if they taste the Bitrex. If the test subject tastes the bitter taste during the third set of ten squeezes, the screening test is over. The taste threshold is as thirty regardless of the number of squeezes actually done.
 - (10) The test conductor will take note of the number of squeezes required to solicit a taste response.
 - (11) If the subject does not taste the Bitrex after 30 squeezes (step 10), the test subject cannot taste Bitrex and may not do the Bitrex fit test.
 - (12) If they taste the Bitrex, ask the test subject to remember the taste for reference in the fit test.
 - (13) Correct use of the nebulizer is approximately 1 ml of liquid at a time in the nebulizer body.
 - (14) Thoroughly rinse the nebulizer in water, shake to dry, and refill at least each morning and afternoon or at least every 4 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 in 4.(a) above.
- (3) The test subject must put on the enclosure while wearing the respirator selected according to section I.A. They must properly adjust the respirator and it must have any type particulate filter(s).
- (4) Use a second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent to spray the fit test solution into the enclosure. Clearly mark this nebulizer to distinguish it from the screening test solution nebulizer.
- (5) Make the fit test solution by adding 337.5 mg of Bitrex to 200 ml of a 5 percent salt (NaCl) solution in warm water.
- (6) As before, the test subject must breathe through his or her slightly open mouth with tongue extended, and report if they taste the bitter taste of Bitrex.
- (7) Insert the nebulizer into the hole in the front of the enclosure and spray an initial concentration of the fit test solution 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, tell the test subject to do the exercises in section I.A.13.
- (9) Replenish the aerosol concentration every 30 seconds using one half the number of squeezes used initially (e.g., 5, 10 or 15).
- (10) The test subject must indicate to the test conductor if they taste the Bitrex during the test. If the test subject does not taste the Bitrex, the test passes.
- (11) If they taste the Bitrex, the fit is unsatisfactory and the test fails. They must try a different respirator and repeat the entire test procedure (taste threshold screening and fit testing).

(5) Irritant Smoke (Stannic Chloride) Procedure

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 test respirator must have high efficiency particulate air (HEPA) or P100 series filter(s).
- (2) Use only stannic chloride smoke tubes for this procedure.

- (3) Do not use any form of test enclosure or hood for the test subject.
 - (4) The smoke can be irritating to the eyes, lungs, and nasal passages. The test conductor must 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. Use only the smallest amount of smoke necessary to get a response when doing the sensitivity screening checks that determine if the test subject can detect irritant.
 - (5) Do the fit test in an area with adequate ventilation to prevent exposure of the person doing the fit test or the build-up of irritant smoke in the general area.
- (b) Sensitivity Screening Check. The person taking the test must demonstrate their ability to detect a weak concentration of the irritant smoke.
 - (1) The test operator must 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 must 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 must advise the test subject that the smoke can be irritating to the eyes, lungs, and nasal passages and instruct the subject to keep their eyes closed during the test.
 - (3) Allow the test subject to smell a weak concentration of the irritant smoke before putting the respirator on to become familiar with its irritating properties and to determine if they can detect the irritating properties of the smoke. Carefully direct a small amount of the irritant smoke in the test subject's direction to determine that they can detect it.
- (c) Irritant Smoke Fit Test Procedure
 - (1) The person fit tested must put on the respirator without assistance, and do the required user seal check(s).
 - (2) Tell the test subject to keep their eyes closed.

- (3) The test operator must 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 must begin at least 12 inches from the face piece and move the smoke stream around the whole perimeter of the mask. The operator must gradually make two more passes around the perimeter of the mask, moving to within 6 inches of the respirator.
- (4) If the test subject has no involuntary response and/or does not detect the irritant smoke, proceed with the test exercises.
- (5) The test subject must do the exercises in section I.A.13. while the respirator seal is continually challenged by the smoke, directed around the perimeter of the respirator at a distance of 6 inches.
- (6) If the person detects the irritant smoke, the test fails. The person re-testing must repeat the entire sensitivity check and fit test procedure.
- (7) Give a second sensitivity screening check to each test subject passing the irritant smoke test without evidence of a response (involuntary cough, irritation), with the smoke from the same smoke tube used during the fit test, with the respirator off, to determine if they still reacts to the smoke. Failure to evoke a response voids the fit test.
- (8) If there is a response during this second sensitivity check, then the fit test passes.

C. Quantitative Fit Test (QNFT) Procedures. The following quantitative fit testing procedures are 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 using 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 face piece to quantify the respirator fit.

(1) General

- (a) The employer must 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 must ensure that QNFT equipment is clean, and maintained and calibrated according to the manufacturer's instructions so as to operate at its design parameters.
- (2) Generated Aerosol Quantitative Fit Testing Procedure
 - (a) Apparatus.
 - (1) Instrumentation. Use 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.
 - (2) Test chamber. The test chamber must 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 must effectively isolate the test agent from the outside air, yet allow its concentration to be uniform throughout the chamber.
 - (3) When testing air-purifying respirators, replace the normal filter or cartridge element with a high efficiency particulate air (HEPA) or P100 series filter supplied by the same manufacturer.
 - (4) The sampling instrument must make a computer record or strip chart record of the test showing the rise and fall of the test agent concentration with each inhale and exhale 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 are Ok if they make a record of the readings.
 - (5) The combination of substitute air-purifying elements, test agent and test agent concentration must not expose the test subject in excess of an established exposure limit for the test agent at any time during the testing process.
 - (6) The sampling port on the test specimen must not allow leaks around the port (e.g., where the respirator is probed). It must always allow a free airflow into the sampling line, and there must be no interference with the fit or performance of the respirator. The in-mask sampling device (probe) must draw the air sample from the breathing zone of the test subject, midway between the nose and mouth and with the probe extending into the face piece cavity at least 1/4-inch.
 - (7) The test setup must permit the person administering the test to observe the test subject inside the chamber during the test.

- (8) The equipment generating the test atmosphere must keep 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) must be minimal. There must be a clear association between the occurrence of an event and its recording.
 - (10) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port must be of equal diameter and of the same material. The length of the two lines must be equal.
 - (11) The exhaust flow from the test chamber must pass through an appropriate filter (i.e., high efficiency particulate filter) before release.
 - (12) When using sodium chloride aerosol, the relative humidity inside the test chamber must not exceed 50 percent.
 - (13) Take into account the limitations of instrument when determining the fit factor.
 - (14) Test respirators must work right. Inspect them 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, crimp the sampling line closed 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 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) You must measure a reasonably stable test agent concentration in the test chamber prior to testing. For canopy or shower curtain types of test units, you may determine the test agent's stability after the test subject enters the test environment.
 - (4) Immediately after the subject enters the test chamber, measure the test agent concentration inside the respirator to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full-face piece respirator.

- (5) You must have a stable test agent concentration before starting the test.
- (6) Do not tighten the respirator restraining straps too much for testing. The wearer must adjust the straps without assistance to give a reasonably comfortable fit typical of normal use. Do not adjust the after the fit test exercises begin.
- (7) Stop the test when any single peak penetration exceeds 5 percent for half masks and 1 percent for full-face piece respirators. The test subject must refit and retest.
- (8) Calculation of fit factors.
 - (i) Determine the fit factor 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) Calculate the average test chamber concentration 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) Use one of these methods to figure the concentration of the challenge agent inside the respirator:
 - (A) Average peak penetration method means the method of determining test agent penetration into the respirator using a strip chart recorder, integrator, or computer. The agent penetration is the 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 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 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 equation represents the procedure:

$$\text{Overall Fit Factor} = \frac{\text{Number of exercises}}{1/ff_1 + 1/ff_2 + 1/ff_3 + 1/ff_4 + 1/ff_5 + 1/ff_6 + 1/ff_7 + 1/ff_8}$$

Where ff_1 , ff_2 , ff_3 , etc. are the fit factors for exercises 1, 2, 3, etc.

- (9) Do not allow the test subject to wear a half mask or quarter face piece respirator unless they have a minimum fit factor of 100, or a full face piece respirator unless they have a minimum fit factor of 500.
- (10) Replace filters used for quantitative fit testing when they cause increased breathing resistance, or when the test agent has altered the integrity of the filter media.
- (3) Quantitative fit testing (QNFT) procedure for the ambient aerosol condensation nuclei counter (CNC).

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

The ambient aerosol condensation nuclei counter (CNC) quantitative fit testing (PortaCount®) procedure quantitatively fit tests respirators with the use of a probe. The probed respirator is only for use with 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 is available from the respirator manufacturer or distributor. The primary CNC instrument manufacturer, TSI Incorporated, also provides probe attachments (TSI mask 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 (elastomeric or filtering facepiece), and a minimum fit factor pass level of at least 500 is required for a full-facepiece elastomeric respirator. Explain the entire screening and testing procedure to the test subject before doing 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 face piece and that the respirator has 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 test employee to put on the respirator for 5 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 person must have training 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 it leaks, determine the cause. If the leak is from a poorly fitting face piece, try another size of the same model respirator, or another model of respirator.
 - (5) Follow the manufacturer's instructions for operating the PortaCount® and proceed with the test.
 - (6) Instruct the test subject to perform the exercises in section I.A.13.
 - (7) After the test exercises, question the test subject about the comfort of the respirator. If it has become unacceptable, try another model respirator.
- (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 must ensure that the pass or fail criterion meet the requirements for minimum respirator performance in this Appendix.
 - (3) Keep a record of the test, assuming the fit test was successful. The record must have the test subject's name; overall fit factor; make, model, style, and size of respirator; and date of the test.
 - (4) Modified ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol for full-facepiece and half-mask elastomeric respirators.

- (a) When administering this protocol to test subjects, employers shall comply with the requirements specified in Part I.C.3 of this Appendix (ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol), except they shall use the test exercises described below in paragraph (b) of this protocol instead of the test exercises specified in section I.C.3(a)(6) of this Appendix.
- (b) Employers shall ensure that each test subject being fit tested using this protocol follows the exercise and duration procedures, including the order of administration, described in Table A-1 of this Appendix.

Table A-1 - Modified Ambient Aerosol CNC Quantitative Fit Testing Protocol for Full Facepiece and Half-Mask Elastomeric Respirators

Exercises ¹	Exercise procedure	Measurement procedure
Bending Over	The test subject shall bend at the waist, as if going to touch his/her toes for 50 seconds and inhale 2 times at the bottom ² .	A 20 second ambient sample, followed by a 30 second mask sample.
Jogging-in-Place	The test subject shall jog in place comfortably for 30 seconds	A 30 second mask sample.
Head Side-to-Side	The test subject shall stand in place, slowly turning his/her head from side to side for 30 seconds and inhale 2 times at each extreme ² .	A 30 second mask sample.
Head Up-and-Down	The test subject shall stand in place, slowly moving his/her head up and down for 39 seconds and inhale 2 times at each extreme ² .	A 30 second mask sample followed by a 9 second ambient sample.

¹Exercises are listed in the order in which they are to be administered.

²It is optional for test subjects to take additional breaths at other times during this exercise.

- (5) Modified ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol for filtering facepiece respirators.
 - (a) When administering this protocol to test subjects, employers shall comply with the requirements specified in Part I.C.3 of this Appendix (ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol), except they shall use the test exercises described below in paragraph (b) of this protocol instead of the test exercises specified in section I.C.3(a)(6) of this Appendix.

- (b) Employers shall ensure that each test subject being fit tested using this protocol follows the exercise and duration procedures, including the order of administration, described in Table A-2 of this Appendix.

Table A-2 - Modified Ambient Aerosol CNC Quantitative Fit Testing Protocol for Filtering Facepiece Respirators

Exercises ¹	Exercise procedure	Measurement procedure
Bending Over	The test subject shall bend at the waist, as if going to touch his/her toes for 50 seconds and inhale 2 times at the bottom ² .	A 20 second ambient sample, followed by a 30 second mask sample.
Talking	The test subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor for 30 seconds. He/she will either read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.	A 30 second mask sample.
Head Side-to-Side	The test subject shall stand in place, slowly turning his/her head from side to side for 30 seconds and inhale 2 times at each extreme ² .	A 30 second mask sample.
Head Up-and-Down	The test subject shall stand in place, slowly moving his/her head up and down for 39 seconds and inhale 2 times at each extreme ² .	A 30 second mask sample followed by a 9 second ambient sample.

¹Exercises are listed in the order in which they are to be administered.

²It is optional for test subjects to take additional breaths at other times during this exercise.

- (6) Controlled negative pressure (CNP) quantitative fit testing procedure.

The CNP procedure is an alternative to aerosol fit test methods. The CNP fit test method technology is based on exhausting air from a temporarily sealed respirator face piece to generate and then maintain a constant negative pressure inside the face piece. The rate of air exhaust is controlled so that there is a constant negative pressure in the respirator during the fit test. The level of pressure is selected to replicate the mean inhalation pressure that causes leakage into the respirator under normal use conditions. With pressure held constant, airflow out of the respirator is equal to air flow into the respirator. Therefore, measurement of the exhaust stream required to hold the pressure in the temporarily sealed respirator constant yields a direct measure of leakage airflow into the respirator. The CNP fit test method measures leak rates through the face piece as a method for determining the face piece fit for negative pressure respirators. The CNP instrument manufacturer Occupational Health Dynamics of Birmingham, Alabama 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 their breath, after which an air pump removes air from the respirator face piece at a pre-selected constant pressure. The face piece fit is expressed as the leak rate through the face piece, in milliliters per minute. The quality and validity of the CNP fit tests are determined by the degree to which the in-mask pressure tracks the test pressure during the system measurement time of approximately five seconds. Instantaneous feedback in the form of a real-time pressure trace of the in-mask pressure is provided and used to determine test validity and quality. A minimum fit factor pass level of 100 is necessary for a half-mask respirator and a minimum fit factor of at least 500 is required for a full-face piece respirator. Explain the entire screening and testing procedure to the test subject before doing the screening test.

(a) CNP Fit Test Requirements.

- (1) The instrument must have a nonadjustable test pressure of 15.0 mm water pressure.
- (2) The CNP system defaults selected for test pressure must be set at 15 mm of water (-0.58 inches of water) and the modeled inhalation flow rate must 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 must have adequate training to lead the test.
 - (4) Replace the respirator filter or cartridge with the CNP test manifold. Temporarily remove or prop open the inhalation valve downstream from the manifold.
 - (5) Train the test subject to hold his or her breath for at least 20 seconds.
 - (6) The test subject must put on the test respirator without any assistance. The respirator must not be adjusted once the fit-test exercises begin. Any adjustment voids the test, and the test subject must repeat the fit-test.
 - (7) Follow the QNFT procedure according to section I.C.1. with an exception for the CNP test exercises.
- (b) CNP Test Exercises.
- (1) Normal breathing. In a normal standing position, without talking, the subject must breathe normally for 1-minute. After the normal breathing exercise, the subject needs to hold their head straight ahead and hold their breath for 10 seconds during the test measurement.
 - (2) Deep breathing. In a normal standing position, the subject must breathe slowly and deeply for 1-minute, being careful not to hyperventilate. After the deep breathing exercise, the subject must hold their head straight ahead and hold their breath for 10 seconds during test measurement.
 - (3) Turning head side to side. Standing in place, the subject must slowly turn their head from side to side between the extreme positions on each side for 1 minute. The head must 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 their head full left and hold his or her breath for 10 seconds during test measurement. Next, the subject needs to hold their 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 must slowly move their head up and down for 1-minute. Instruct the subject to inhale in the up position (i.e., when looking toward the ceiling). After the moving head up and down exercise, the subject must hold their head full up and hold his or her breath for 10 seconds during test measurement. Next, the subject must hold their head full down and hold his or her breath for 10 seconds during test measurement.
 - (5) Talking. The subject must talk out loud slowly and loud enough to be heard clearly by the test conductor. The subject can read from a prepared text like the Rainbow Passage, count backward from 100, or recite a memorized poem or song for 1-minute. After the talking exercise, the subject must hold their head straight ahead and hold their breath for 10 seconds during the test measurement.
 - (6) Grimace. The test subject must grimace by smiling or frowning for 15 seconds.
 - (7) Bending Over. The test subject must bend at the waist as if they were to touch their toes for 1-minute. Substitute jogging in place 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 must hold their head straight ahead and hold their breath for 10 seconds during the test measurement.
 - (8) Normal Breathing. The test subject must remove and re-don the respirator within a 1-minute period. Then, in a normal standing position, without talking, the subject must breathe normally for 1-minute. After the normal breathing exercise, the subject must hold their head straight ahead and hold their breath for 10 seconds during the test measurement. After the test exercises, question the test about the comfort of the respirator after completion of the test. If it is unacceptable, try another model of respirator.
- (c) CNP Test Instrument.
- (1) The test instrument must have an effective audio warning device when the test subject fails to hold their breath during the test. Stop the test when the test subject fails to hold their breath. Refit and retest the test subject.
 - (2) Keep a record of the test, assuming the fit test was successful. The record must have the test subject's name; overall fit factor; make, model, style and size of respirator; and date of the test.

- (7) Controlled negative pressure (CNP) REDON quantitative fit testing protocol.
- (a) When administering this protocol to test subjects, employers must comply with the requirements specified in paragraphs (a) and (c) of Part I.C.6 of this Appendix ("Controlled negative pressure (CNP) quantitative fit testing protocol"), as well as use the test exercises described below in paragraph (b) of this protocol instead of the test exercises specified in paragraph (b) of Part I.C.6 of this Appendix.
- (b) Employers must ensure that each test subject being fit tested using this protocol follows the exercise and measurement procedures, including the order of administration, described below in Table A-3 of this Appendix.

Table A-3 - CNP REDON Quantitative Fit Testing Protocol

Exercises ¹	Exercise procedure	Measurement procedure
Facing Forward	Stand and breathe normally, without talking, for 30 seconds.	Face forward, while holding breath for 10 seconds.
Bending Over	Bend at the waist, as if going to touch his or her toes, for 30 seconds.	Face parallel to the floor, while holding breath for 10 seconds
Head Shaking	For about three seconds, shake head back and forth vigorously several times while shouting.	Face forward, while holding breath for 10 seconds.
Redon-1	Remove the respirator mask, loosen all facepiece straps, and then redon the respirator mask.	Face forward, while holding breath for 10 seconds.
Redon-2	Remove the respirator mask, loosen all facepiece straps, and then redon the respirator mask again.	Face forward, while holding breath for 10 seconds.

¹Exercises are listed in the order in which they are to be administered.

- (c) After completing the test exercises, the test administrator must question each test subject regarding the comfort of the respirator. When a test subject states that the respirator is unacceptable, the employer must ensure that the test administrator repeats the protocol using another respirator model.
- (d) Employers must determine the overall fit factor for each test subject by calculating the harmonic mean of the fit testing exercises as follows:

$$\text{Overall fit factor} = \frac{1}{[1/FF_1 + 1/FF_2 + \dots 1/FF_N]}$$

Where:

N = The number of exercises;

FF_1 = The fit factor for the first exercise;

FF_2 = The fit factor for the second exercise; and

FF_n = The fit factor for the nth exercise.

Part II. New Fit Test Procedures

Oregon OSHA will accept any new procedures that OSHA accepts. For more information of submitting new procedures for acceptance or other information about this subject, read the federal rules.

Statutory Authority: ORS 654.025(2) and 656.726(4).

Statutes Implemented: ORS 654.001 through 654.295.

History: OR-OSHA Administrative Order 3-2006, filed 6/7/06, effective 3/1/07.

OR-OSHA Administrative Order 3-2007, filed 8/13/07, effective 8/13/07.

OR-OSHA Administrative Order 4-2012, filed 9/19/12, effective 1/1/13.

OR-OSHA Administrative Order 1-2020, filed 2/13/20, effective 2/13/20.