In developing the 29 CFR Part 1910.134 standard, OSHA has included a number of very specific guidelines to follow, particularly involving the fit-testing process. What follows are excerpts from the actual standard, condensed by MSA into the most pertinent language regarding fit-testing procedures.

By carefully reading this protocol and following the procedures outlined within, you can be assured of compliance with the fit-testing portion of the new OSHA standard.
The Bitrex™ (Denatonium benzoate) solution aerosol QLFT protocol uses the published saccharin test protocol if the taste of saccharin is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator If the test subject passes the test, the efficiency of the test procedure shall be demonstrated by having the subject break the respirator face seal and take a breath before exiting the chamber. When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test, so that there is no significant IAA concentration buildup in the chamber during subsequent tests. The used towels shall be kept in a self-sealing plastic bag to keep the test area from being contaminated.

3. Saccarin Solution Aerosol Protocol
The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

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

(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) Only stannic chloride smoke tubes shall be used for this protocol.

(3) The test operator shall direct the stream of irritant smoke from the smoke tube toward the faceseal area of the test respirator. The test operator shall cover the other end of the smoke tube with a short piece of tubing to prevent potential injury to the test subject. The test operator shall start the test subject on the “smoke” produced by a stannic chloride ventilation smoke tube to detect leakage into the respirator.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the test subject through the slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a sweet taste.

(5) The test subject shall breathe through his/her slightly open mouth with tongue extended. He/she is instructed to report when he/she detects the weak saccharin solution.

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

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

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

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

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

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

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

(13) If the test subject does not report tasting saccarin, he/she may be asked to take notes to assist in evaluating the test.

(14) If the test subject does not report tasting saccarin, he/she may be asked to take notes to assist in evaluating the test.

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

(a) General Requirements and Precautions
(1) The test operator shall be equipped with high efficiency particulate air (HEPA) or P100 series filter(s).

(2) Only stannic chloride smoke tubes shall be used for this protocol.

(3) No form of test enclosure or hood for the test subject shall be used.

(4) Smoke can be irritating to the eyes, lungs, and nasal passages. The test conductor shall start the test subject on the irritant smoke to use only the minimum amount of smoke necessary to elicit a response from the test subject.

(5) The test shall be performed in an area with adequate ventilation to prevent exposure of the person conducting the test or the build-up of irritant smoke in the general atmosphere.

(b) Sensitivity Screening Check
The person to be tested must demonstrate his or her ability to detect a weak concentration of the irritant smoke.

(1) The test operator shall break both ends of a ventilation smoke tube containing stannic chloride, and attach one end of the smoke tube to a low flow fan pump set to deliver 200 milliliters per minute, or an aspirator smoke bulb. The test operator shall cover the other end of the smoke tube with a piece of tubing to prevent potential injury from the jagged end of the smoke tube.

(2) The test operator shall advise the test subject that the smoke can be irritating to the eyes, lungs, and nasal passages and instruct the subject to keep his/her eyes closed while the test is performed.

(3) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its irritating properties and to determine if he/she can detect the irritating properties of the smoke. The test operator shall carefully direct a small amount of the irritant smoke in the test subject's direction to determine that he/she can detect it.

(c) Sensitivity Smoke Fit Test Procedure
(1) The person being fit tested shall don the respirator without assistance, and perform the required user seal checks.

(2) The test subject shall be instructed to keep his/her eyes closed.

(3) The test operator shall direct the stream of irritant smoke from the smoke tube toward the faceseal area of the test subject, using the low flow pump or the smoke bulb. The test operator shall begin at least 12 inches from the faceseal and move the smoke stream around the entire perimeter of the mask. The operator shall gradually move the test apparatus around the perimeter of the mask, moving to within six inches of the respirator.

(4) If the person being tested has not had an involuntary response and/or detected the irritant smoke, proceed with the test exercises.

(5) The exercises identified in section I.A. 14. of this appendix shall be performed by the test subject while the respirator seal is being continually challenged by the smoke, directed around the perimeter of the respirator at a distance of six inches.

(6) If the person being fit tested reports detecting the irritant smoke at any time, the test is failed. The person being retested must repeat the entire sensitivity check and fit test procedure.

(7) Each test subject passing the irritant smoke test without evidence of a response (involuntary cough, irritation) shall be given a second sensitivity screening check, with the smoke from the same smoke tube used during the fit test, once the respirator has been removed, to determine whether he/she still reacts to the smoke. Failure to evoke a response shall void the fit test.

(8) If a response is produced during this second sensitivity check, then the fit test is passed.
C. Quantitative Fit Test (QNFT) Protocols

The following quantitative fit testing procedures have been demonstrated to be acceptable: Quantitative fit testing using a non-hazardous test aerosol (such as corn oil, polyethylene glycol 400 [PEG 400], d-2-ethyl-hexyl sebacate (DEHS), or sodium chloride) generated in the test chamber, and employing instrumentation to quantify the fit of the respirator; Quantitative fit testing using ambient aerosol as the test agent and appropriate instrumentation (condensation nuclei counter) to quantify the respirator fit; Quantitative fit testing using controlled negative pressure and appropriate instrumentation to measure the volumetric leak rate of a facemask to quantify the respirator fit.

1. Overview

(a) The employer shall ensure that persons administering QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly and ensure that test equipment is in proper working order.

(b) The employer shall ensure that QNFT equipment is kept clean, and is maintained and calibrated according to the manufacturer’s instructions so as to operate at the parameters for which it was designed.

2. Generated Aerosol Quantitative Fit Testing Protocol

(i) Apparatus.

(a) Instrumentation. Aerosol generation, dilution, and measurement systems using particulates (corn oil, polyethylene glycol 400 [PEG 400], d-2-ethyl-hexyl sebacate (DEHS) or sodium chloride) as test aerosols shall be used for quantitative fit testing.

(b) Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without disturbing the test agent concentration and expiration inside the test chamber. The facepiece respirator shall be equipped and constructed so that the test agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(c) The sampling system shall include a filter or cartridge element that shall be replaced with a high efficiency particulate air (HEPA) or P100 series filter supplied by the same manufacturer.

(d) The sampling instrument shall be selected so that a computer record or strip chart record may be made of the test showing the rise and fall of the test agent concentration in conjunction with inspiration and expiration at factors of at least 2,000. Integrators or computers that integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.

(e) The substitution of air-purifying elements, test agent and test concentration shall be such that the test subject is not exposed in excess of an established exposure limit for the test agent at any time during the testing process, based upon the length of the exposure and the exposure limit duration.

(f) The sample port on the test agent concentration device shall be placed and constructed so that the leakage occurs around the port (e.g., where the respirator is probed), a free air flow is allowed into the sampling line at all times, and there is no interference with the fit or performance of the respirator. The in-mask sampling device (probe) shall be the same brand and model used in the controlled negative pressure fit testing in an employee’s own respirator. A respirator shall not be adjusted once the fit test exercises begin.

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

(h) The test subject shall be seated at a table or standing in a comfortable position.

(i) The time (lag time) interval between the test subject and the test chamber shall not exceed 20 seconds.

(j) The time of the test exercise shall be kept to a minimum. There shall be a clear association between the occurrence of an event and its breathing pattern.

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

(l) The test chamber shall be maintained in proper working order and be inspected regularly for deficiencies such as cracks or missing valves and gaskets.

(m) Procedural Requirements.

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

(2) The use of an unabated screening QNFT test is optional. Such a test shall be utilized in order to quickly identify poor-fitting respirators that passed the positive and/or negative pressure test and reduce the amount of QNFT time.

(3) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 95 percent.

(4) The test subject shall be kept informed of the test sequence and test procedure.

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

(6) The test subject shall be kept informed of the test sequence and test procedure.

(7) The test subject shall be kept informed of the test sequence and test procedure.

(8) The test subject shall be kept informed of the test sequence and test procedure.

(i) Calculations of fit factors.

(a) The fit factor is determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration measured inside the respirator for each test exercise except the grimace exercise.

(b) The average chamber concentration shall be calculated as the arithmetic average of the concentration measured and after each test (i.e., 1 exercises) or the arithmetic average of the concentration measured before and after each exercise or the true average measured continuously during the respirator sample.

(c) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(A) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integers, or computers that calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of this protocol.

(B) Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by the equivalent peak height on the strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be the maximum peak penetration for the 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 is using individual exercise fit factors involves first converting the exercise fit factors to penetration values, determining the average, and then converting that result back to a fit factor. This procedure is described in the following equation:

Overall Fit Factor = \[ \frac{1}{1+f_1} + \frac{1}{1+f_2} + \frac{1}{1+f_3} + \frac{1}{1+f_4} + \frac{1}{1+f_5} + \frac{1}{1+f_6} + \frac{1}{1+f_7} + \frac{1}{1+f_8} \]

Where ff, ff_1, ff_2, etc., are the fit factors for exercises 1, 2, 3, etc.
Part II. New Fit Test Protocols

A. Any person may submit to OSHA an application for approval of a new fit test protocol. If the application meets the following criteria, OSHA will initiate a rulemaking proceeding under section 6(b)(7) of the OSH Act to determine whether to list the new protocol as an approved protocol in this Appendix A.

B. The application must include a detailed description of the proposed new fit test protocol. This application must be supported by either:

1. A test report prepared by an independent government research laboratory (e.g., Lawrence Livermore National Laboratory, Los Alamos National Laboratory, the National Institute for Standards and Technology) stating that the laboratory has tested the protocol and had found it to be accurate and reliable; or

2. An article that has been published in a peer-reviewed industrial hygiene journal describing the protocol and explaining how test data support the protocol’s accuracy and reliability.

C. If OSHA determines that additional information is required before the Agency commences a rulemaking proceeding under this section, OSHA will notify the applicant and afford the applicant the opportunity to submit the supplemental information. Initiation of a rulemaking proceeding will be deferred until OSHA has received and evaluated the supplemental information.

Appendix B-1 to Sec. 1910.134: User Seal Check Procedures (Mandatory)

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

I. Facepiece Positive and/or Negative Pressure Checks

A. Positive pressure check. Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

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

II. Manufacturer’s Recommended User Seal Check Procedures

The respirator manufacturer’s recommended procedures for performing a user seal check may be used instead of the positive and/or negative pressure check procedures provided that the employer demonstrates that the manufacturer’s procedures are equally effective.

### Table A.1. – CNP REDON Quantitative Fit Testing Protocol

<table>
<thead>
<tr>
<th>Exercises</th>
<th>Exercise procedure</th>
<th>Measurement procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facing forward</td>
<td>Stand and breathe normally, without talking, for 30 seconds</td>
<td>Face forward, while holding breath for 10 seconds</td>
</tr>
<tr>
<td>Bending over</td>
<td>Bend at the waist, as if going to touch his or her toes, for 30 seconds</td>
<td>Face parallel to the floor, while holding breath for 10 seconds</td>
</tr>
<tr>
<td>Head shaking</td>
<td>For about three seconds, shake head back and forth vigorously several times while shouting</td>
<td>Face forward, while holding breath for 10 seconds</td>
</tr>
<tr>
<td>REDON 1</td>
<td>Remove the respirator mask, loosen all facepiece straps, and then redon the respirator mask</td>
<td>Face forward, while holding breath for 10 seconds</td>
</tr>
<tr>
<td>REDON 2</td>
<td>Remove the respirator mask, loosen all facepiece straps, and then redon the respirator mask again</td>
<td>Face forward, while holding breath for 10 seconds</td>
</tr>
</tbody>
</table>

1. Exercises 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) Employees must determine the overall fit factor for each test subject by calculating the harmonic mean of the fit testing exercises as follows:

\[
\text{Overall Fit Factor} = \frac{1}{\frac{1}{FF_1} + \frac{1}{FF_2} + \ldots + \frac{1}{FF_n}}
\]

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.