

# DON'T USE QUALITATIVE FIT TESTING FOR FULL-FACE RESPIRATORS

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APPLICATION NOTE ITI-032

Some U.S. standards and regulations have historically permitted the use of either qualitative fit testing (QLFT) or quantitative fit testing (QNFT) for both half-face and full-face respirators. However, if you examine the research that has been done, you will discover that QLFT is not adequate for determining whether or not a person is achieving the high level of fit required for full-face respirators.

OSHA finally recognized this fact in the OSHA Respiratory Protection Standard 29CFR1910.134 that was released on January 8, 1998.<sup>1</sup> QLFT is only permitted for fit testing tight-fitting respirator facepieces that are allowed to pass with a minimum fit factor of 100. Since OSHA requires a fit factor of 500 for full-face masks, and since there is currently no approved QLFT protocol capable of determining a fit factor higher than 100, employers using tight-fitting full-face respirators must either install engineering controls to eliminate the need for full-face masks or adopt QNFT.

OSHA's position on this issue makes sense. A fit factor below 500 for a full-face mask indicates an extremely poor fit. It is actually very easy (and common) to achieve much higher fit factors with the full-face respirators now on the market. OSHA has provided a detailed explanation of the rationale used for the new standard in the Preamble to 29CFR1910.134. For your convenience, TSI has provided [Application Note ITI-056: Respirator Fit Testing Highlights for OSHA Respiratory Protection Standard 29CFR1910.134](#) listing the major fit test related issues contained in the standard along with associated page references. You can [OSHA Respiratory Protection Standard 29 CFR 1910.134 released 1/8/98, Correction to OSHA 29 CFR 1910.134 released 4/23/98](#) or visit [www.osha.gov](http://www.osha.gov). from here if you don't already have a copy.

OSHA and the various other organizations that publish fit testing regulations and standards invariably use 100 as the minimum acceptable fit factor for half-face masks. Full-face respirators require a minimum fit factor of 500 and in some standards, a fit factor of at least 1000 is required. [Application Note ITI-046: Standards and Regulations Pertaining to Respirator Fit Testing](#) contains a table listing the fit testing requirements for various standards.

There are four types of QLFT currently accepted by OSHA: Isoamyl Acetate, Sodium Saccharin, Bitrex, and Irritant Smoke. Let's examine each of them separately.

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<sup>1</sup> OSHA Respiratory Protection Standard 29CFR1910.134, Federal Register, vol 63, no 5, Thursday, January 8, 1998.



## **Isoamyl Acetate (banana oil) QLFT Protocol**

The Isoamyl Acetate Protocol uses isoamyl acetate, more commonly known as banana oil or IAA, as a test agent. It is a qualitative fit test that relies on a person's sense of smell. If a banana odor is detected during the fit test, the fit is not acceptable.

The first part of the test involves testing the employee's sense of smell. Two jars of water are prepared, one with a low concentration of isoamyl acetate, the other with plain water. The employee must correctly identify the jar with the banana odor in order to qualify for this fit test method. Those who cannot identify the correct jar must wait until their sense of smell recovers, (they could be suffering from a cold or olfactory fatigue) or be fit tested using another technique.

During the test, a repeatable concentration of IAA around the test subject's head is established by using a plastic 55-gallon drum liner for a test booth. IAA is introduced into the booth by applying 0.75 cc of IAA on a paper towel of exactly 5 by 6 inches (folded in half), hanging it above the person's head, and then waiting two minutes. Each employee must use a newly prepared paper towel.

The Isoamyl Acetate Fit Test Protocol was developed and tested in the laboratory by comparing it to quantitative fit testing. This process is called validation. The Isoamyl Acetate Protocol has been validated for a fit factor of 100 only. In other words, a person who successfully passes a properly conducted isoamyl acetate fit test can claim a fit factor of 100 but no more.

## **Saccharin Solution Aerosol QLFT Protocol**

Another type of QLFT is the Saccharin Solution Fit Test. Sodium saccharin is the true chemical name of the test agent used. This technique is most commonly used for disposable filtering-facepiece type respirators but can be used for other masks as well. The saccharin test relies on a person's sense of taste. If the sweet taste of the saccharin is detected, the mask does not fit well enough.

A threshold test is conducted prior to the actual fit test to determine what concentration of saccharin is required to reach the test subject's taste threshold. A repeatable concentration of saccharin solution is maintained by putting a hood over the test subject's head and spraying solution into it using a hand operated atomizer. The number of squeezes that must be sprayed into the hood ranges between 10 and 30 depending on the results of the threshold test. The person being fit tested must be instructed to breathe through his or her mouth with tongue extended during the test.

The saccharin protocol has been validated in the lab by it's developer with the same limitation as the IAA test. A person who successfully passes a properly conducted saccharin solution fit test can claim a fit factor of 100 but no more.

Sodium saccharin is considered to be a potential occupational carcinogen. NIOSH has stated that "Because sodium saccharin is a potential occupational carcinogen, we recommend that it not be used for respirator fit-testing.<sup>2</sup>" Technically speaking, however, the amount of saccharin that a person is exposed to during a fit test is very low and is below the level used in many consumer products. OSHA is indifferent to the NIOSH position and continues to allow saccharin fit testing. See the 29CFR1910.134 Preamble for an explanation.

## **Bitrex Solution Aerosol QLFT Protocol**

This protocol uses a bitter-tasting test agent called Bitrex<sup>®</sup>. Bitrex is an FDA-approved flavoring originally developed as an aversion agent in toxic household chemicals to deter children from swallowing them. The technical name for the chemical is Denatonium Benzoate. The Bitrex test uses the same hood, atomizer, threshold test and general procedure as the saccharin test. Bitrex is said to produce a strong reaction from test subjects when leaks do occur. As with saccharin, the person being fit tested must be instructed to breathe through his or her mouth with tongue extended during the test.

The Bitrex protocol has been validated in the lab by it's developer with the same limitation as the IAA and saccharin protocols. A person who successfully passes a properly conducted Bitrex solution fit test can claim a fit factor of 100 but no more.

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<sup>2</sup> Letter from J. Donald Millar, M.D., Director of NIOSH to Mr. Darell A. Bevis, Industrial Hygienist, January 31, 1992.

## Irritant Smoke QLFT Protocol

The fourth method that OSHA permits for QLFT is the Irritant Smoke Protocol. This test utilizes a chemical called stannic chloride ( $\text{SnCl}_4$ ), which is sprayed out of a ventilation tube around the test subject's head with the use of a squeeze bulb. As ambient air is forced through the tube,  $\text{SnCl}_4$  reacts with moisture in the air producing stannic chloride ( $\text{SnOCl}_2$ ) and hydrogen chloride (HCl). As the HCl emerges from the tube, it combines with additional water vapor in the air forming a visible smoke. If enough of the irritant smoke leaks into the mask it will result in a reaction such as coughing or watery eyes (OSHA requires that the person being fit tested close his or her eyes when using this protocol).

A study of the irritant smoke test done at Los Alamos National Laboratory in 1983<sup>3</sup> indicated a 92 percent confidence level for a fit factor of 100 (industry experts generally consider a 95 percent confidence level to be required). The Irritant Smoke Protocol cannot be truly validated because of the lack of a true threshold test. A 100 percent concentration of irritant smoke is directed at the test subject's face prior to the test just to show him/her what it feels like. Since the concentration of irritant smoke is high and uncontrolled, this is by no means a threshold test. Also, the concentration of irritant smoke around the test subject's head during the fit test is not controlled or repeatable. There is no enclosure as with the saccharin and IAA test. Technically speaking, a claim of a specific fit factor cannot be made after passing this test. Studies cited by OSHA suggest that it is effective for determining a fit factor of 100. Like the other QLFT protocols, OSHA allows a person who successfully passes a properly conducted irritant smoke fit test to claim a fit factor of 100 but no more.

Another problem with irritant smoke has been identified by NIOSH in a NIOSH Health Hazard Evaluation Report.<sup>4</sup> In this report, NIOSH asserts that unhealthy concentrations of hydrogen chloride resulting from the reaction of irritant smoke (stannic chloride) with ambient humidity can occur during a qualitative fit test with irritant smoke. Hydrogen chloride concentrations of 100 ppm to 14,400 ppm during fit testing were encountered. The permissible exposure limit (PEL) for hydrogen chloride is 5 ppm and the concentration that is considered immediately dangerous to life and health (IDLH) has been determined by NIOSH to be 100 ppm. Additional, less publicized, occurrences of respiratory fatigue related to irritant smoke QLFT have also been reported. These problems, combined with the fact that the [MSDS for stannic chloride](#) warns not to breathe the smoke or allow it to touch your clothing or skin, has caused some ventilation tube suppliers to discontinue promotion of the product for respirator fit testing purposes due to liability concerns.

On May 4, 1999 NIOSH issued a [Respirator Use Policy Statement](#) explaining that NIOSH believes it is unsafe to use irritant smoke for fit testing. None the less, OSHA has included the irritant smoke protocol in 29CFR1910.134. OSHA addresses the exposure concerns by prohibiting the use of a chamber or hood and requiring the eyes to be closed. A detailed explanation of OSHA's reasoning for retaining the irritant smoke protocol can be found in the [Preamble to 29CFR1910.134](#).

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<sup>3</sup>James L. Marsh, Evaluation of Irritant Smoke Qualitative Fitting Test for Respirators, Los Alamos National Laboratory document LA-9778-MS, 1983

<sup>4</sup>HETA 93-040-2315 Anchorage Fire Department Anchorage, Alaska, U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health, May 1993 (for a free copy FAX a request to the NIOSH Publications Office at (513) 533-8573.)

## Conclusion

Existing QLFT protocols are technically unsuitable for the fit testing of respirators where a fit factor greater than 100 is required. OSHA's Respiratory Protection Standard 29CFR1910.134 released on January 8, 1998 recognizes this fact. The new standard replaces the various fit testing provisions contained in the many substance-specific regulations so that respirator fit testing will now be done the same way by all employers.



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