Both qualitative and quantitative methods have advantages, and both are effective.

Fit testing is an important requirement in the process of determining whether a given respirator is the “correct” respirator for a particular worker. Fit testing was first mandated in the United States in the early 1970’s when OSHA adopted its general industry respiratory protection standard, 29 CFR 1910.134. Since then, standard protocols have been published for qualitative fit testing, and suggested methodology began to be published for quantitative fit testing. In January 1998, OSHA revised 29 CFR 1910.134. It now contains four qualitative fit test protocols and three quantitative fit test protocols.

The OSHA standard requires that a respiratory protection program be established by an employer when effective engineering controls are not feasible. The primary objective is to prevent excessive exposure to hazardous occupational airborne contaminants. Employers are responsible for determining which work applications require respiratory protection and providing proper respiratory protection to meet the needs of those applications.

Fit testing helps determine that a particular model and size of respirator fits a worker so there is minimal faceseal leakage.

Employees required to wear a tight-fitting respirator must be fitted properly and tested for faceseal leakage before using the respirator in a contaminated area. Fit testing is required by OSHA regulations and recommended by the American National Standards Institute for Respiratory Protection (ANSI Z88.2-1992) for all quarter, half and full facepiece respirators. Workers using any type respirator using these facepieces must be fit tested.

Qualitative or Quantitative Testing?

There are two fit testing methods: qualitative fit testing and quantitative fit testing. Generally, qualitative fit testing is acceptable for most airborne hazards, although quantitative fit testing is required when negative pressure full facepiece respirators are used for airborne contaminant concentrations greater than 10 times but not more than 50 times the PEL. OSHA considers both methods to be equally effective when properly conducted for negative pressure respirators in concentrations up to 10 times the PEL and all positive pressure respirators.

Some people wrongly believe that quantitative fit testing is more
What is a User Seal (Fit) Check?

Respirator program supervisors often are confused about the difference between fit test and fit check. In fact, to reduce some of the confusion, OSHA changed the name of fit check to user seal check. A fit test establishes that a particular model and size of respirator provides an adequate face seal for the individual worker and is conducted before the worker uses it in a contaminated area. Fit tests are conducted by the respirator program supervisor or trainer.

A user seal check, on the other hand, is conducted by the wearer to determine whether the respirator is properly seated to the face. OSHA requires that user seal checks be conducted each time a tight-fitting respirator is donned or adjusted.

User seal checks are easy to conduct and can be performed by the wearer. Usually, special equipment is not required. Negative (-) and positive (+) pressure checks have been used for many years and are described in 29 CFR 1910.134. The user of maintenance-free respirators, where the filter is the face piece (filtering face piece), can check the respirator seal according to instructions provided by the manufacturer. Respirators with elastomeric face pieces can also be checked according to instructions provided by the manufacturer.

User seal checks add no significant cost to a respiratory protection program and produce excellent results for the value. Workers should be trained to perform user seal checks on both elastomeric and maintenance-free respirators. User seal checks on elastomeric and disposable respirators are not sensitive enough to replace fit testing and must not be considered a substitute for fit tests.

Every tight-fitting respirator can be fit tested with at least one of the qualitative fit test agents, but not all people are sensitive to each of the test aerosols. The OSHA protocols require use of only one fit test method for a given respirator. A respirator must be rejected as fitting improperly when a fit test is performed correctly and the test agent is detected. Therefore, it is important that the test subject be able to sense the test agent. The QLFT protocols included in the OSHA standard each contain a test to determine if the test subject is able to sense low levels of the test agent. Qualitative fit tests can be used for all tight-fitting respirators. This includes both negative and positive pressure respirators. However, the use of negative pressure full face piece respirators are restricted to concentrations not exceeding 10X the PEL if qualitative fit testing is performed.

Quantitative fit testing (QNFT), on the other hand, uses an instrument to measure face seal leakage. During the test, the concentration of an aerosol is measured both inside and outside the respirator or the air leak rate is measured.

These methods require the respirator to be equipped with adapters or probes that allow air to be sampled from inside the respirator. For the aerosol tests the respirator must also be equipped with 100 level filters. Use of these filters ensures the test agent enters the respirator only through the face seal. If the respirator does not already have 100 level filters or cannot be equipped with them, quantitative fit testing methods cannot be used.

A qualitative fit test (QLFT) is a pass/fail test that relies on the ability of the wearer to sense a test agent. OSHA has accepted four QLFT protocols, each of which uses a different test agent. These test agents are isoamyl acetate (banana oil), saccharin, Bitrex® and irritant smoke (stannic chloride). The isoamyl acetate test is an odor-detection test, the saccharin and Bitrex test are taste-detection tests, and the irritant smoke test relies on an involuntary irritation response by the wearer.

In order for any fit test to be meaningful, care must be taken to ensure that if the test agent enters the respirator it is primarily through a face seal leak. This means the respirator must be capable of filtering out substantially all of the test agent. For example, isoamyl acetate produces an organic vapor, so the respirator being tested must be equipped with an organic vapor chemical cartridge. If the wearer can smell isoamyl acetate, the respirator does not fit well.
Fit Factor
The term “fit factor” is used to express the results of a quantitative fit test. A fit factor is the ratio of the test agent concentration outside the respirator to the test agent concentration inside the respirator. It may also be the ratio of total airflow through the respirator (modeled by the fit test instrument) to the airflow through face seal leaks.

Respirator fit is rejected if the overall fit factor does not meet the pass criteria, which is generally 10 times the assigned protection factor for the negative pressure respirator tested. When performing a QNFT on a full facepiece that will be used on a positive pressure respirator, the fit factor must be greater than or equal to 500. A variety of things have been used as QNFT challenge agents, including oil mists, salt particles, ambient dust particles, sulfur hexafluoride gas and air flow.

QNFT requires a highly trained operator who understands how to use the equipment, perform preventive equipment maintenance, check for system leaks and conduct system calibrations.

The most difficult part of most quantitative fit testing is collecting a representative sample from inside the respirator. Studies evaluating this problem in both half and full-facepiece respirators have determined that errors in measuring test aerosol inside the respirator can be caused by a variety of factors. These include the location and depth of the sampling probe, whether the wearer breathes through the mouth or nose; the design of the facepiece (e.g., the location of the inhalation valves with respect to the location of the sampling probe, which affects the airflow pattern in the facepiece), and other variables.

Because there are no standards for probing respirators, probe design, location, and depth into the facepiece cavity vary when testing respirators from different manufacturers. These studies concluded such variables make it impossible to use QNFT to select a “best fitting” facepiece within a group of facepieces unless the leak rates are grossly different.

Limitations of quantitative fit testing equipment and fit factor measurement must be understood as well. While a fit factor of 5,000 sounds greatly different from a fit factor of 10,000, the difference in respirator leakage is actually very small. The difference in respirator leakage corresponding to fit factors of 5,000 and 10,000 is only 0.01 percent.

OSHA’s Requirements for a Respiratory Protection Program*
In any workplace where respirators are necessary to help protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures. The program shall be updated as necessary to reflect those changes in workplace conditions that affect respirator use. The employer shall include in the program the following provisions of 1910.134, as applicable:

1. Procedures for selecting respirators for use in the workplace;
2. Medical evaluations of employees required to use respirators;
3. Fit testing procedures for tight-fitting respirators;
4. Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;
5. Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;
6. Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;
7. Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;
8. Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and
9. Procedures for regularly evaluating the effectiveness of the program.

The employer shall designate a program administrator who is qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness.

In addition, the accuracy of the instrumentation and the level of the challenge atmosphere must be considered, because the instrument may not be able to measure this slight difference reliably.

Advantages and Disadvantages

Workplace protection factor studies assess respirator performance in the workplace. These studies have also provided information about the effectiveness of fit test methods in the field. Several studies have examined the relationship between quantitative fit factors and workplace protection factors. To date, no correlation has been found.

In other words, a higher fit factor does not necessarily translate into greater protection in the workplace. However, these studies do show that workers who achieved a minimum fit factor of ten times (10X) the assigned protection factor of negative-pressure respirators were protected adequately.

Workplace studies using qualitative fit testing for selection of the respirator facepiece have also been performed. These studies have shown excellent protection when validated qualitative fit testing methods are used. This is not surprising since the QLFT methods were validated for fit factors of 100 (10X the APF of 10) using quantitative fit testing.

Finally, workplace protection factors can be used to determine whether one fit test method more effectively predicts workplace protection than the other. Although studies using QLFT generated a higher average numerical workplace protection factor, the difference between the two means was not statistically significant. Therefore, both fit test methods were equally effective for respirator selection.

Each method has advantages and disadvantages. QNFT is expensive, requiring costly instrumentation, (approximately $7,000-10,000), as well as expenditures for additional adapters or probed respirators. In addition, quantitative fit tests must be conducted by highly trained personnel.

In contrast, qualitative fit tests are convenient and easy to perform. The equipment used is also much less expensive, only about $200. Not surprisingly, QLFT is more widely used.

Selecting the best fit test method can only be done after considering several criteria, including:

- ease of use
- training and skill of the person conducting the fit test
- suitability of the test method for the respirator in use
- workers’ level of understanding—both the test and its purpose
- workers’ abilities to detect the challenge agent
- cost and benefits of the fit test method
- determining if airborne concentrations exceed 10 times the PEL.

Training materials, including fitting posters, videos, selection guides, face fit products, and written administrative respiratory protection programs, can help ensure OSHA compliance and worker safety.