Don’t Forget About Fit – What You Need to Know About Respirator Fit-testing

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[Disclaimer: This paper is based on current United States federal OSHA requirements 29 CFR 1910.134 in place as of March 2015. U.S. state or other country requirements may be different. Requirements can change in the future. No warrantees are made. This paper contains general information as of the date of this presentation and should not be relied upon to make specific decisions.]

Introduction

Appropriate respirator selection is a critical step in respirator program management. However, with particulate respirators, some environmental health and safety (EHS) professionals may focus on filter efficiency, while not paying proper attention to ensuring proper fit. The greatest source of leakage for a particulate respirator may not be through the filter, but through the face-to-seal fit. While compliance with regulatory requirements is an important reason for fit testing particulate respirators, a solid fit testing program provides several additional opportunities to advance the effectiveness of the employer’s respiratory program. Through effective fit testing as part of the employee training, the respirator program manager can help ensure appropriate respirator selection. The result is a worker who is knowledgeable, well protected, and comfortable.

The following points covered in this paper may help the EHS professional in their practice:

- Information regarding how to identify which respirators need fit testing, and when fit testing should be performed
- The key advantages and limitations of the various qualitative and quantitative fit test methods, and issues to consider when selecting the method most appropriate to a particular work environment
• A better understanding of how the fit and comfort of a respirator work in conjunction to help provide appropriate protection
• Answers to frequently asked questions from both EHS professionals and workers regarding fit testing of particulate respirators

**Fit Testing Basics**

How important is the fit of a tight-fitting respirator? Fit is very important. If a tight-fitting respirator does not seal tightly to the face, airborne hazards can enter underneath the facepiece seal and into the breathing zone. It is very important to always follow the donning instructions and do a user seal-check or fit-check before entering the contaminated environment.

**Facial Hair**
A good fit can only be obtained if the face is clean-shaven in the area where the respirator seals against the face. Beards, long mustaches, and stubble may cause leaks into the respirator. This is why OSHA states there should be “no facial hair that comes between the sealing surface of the facepiece and the face or that interferes with valve function.” Hoods, helmets, and loose-fitting facepieces can be a good option for respirator wearers with facial hair.

**Types of Respirators Needing Fit testing**
29 CFR 1910.134 requires fit testing all tight-fitting respirators, including tight-fitting respirators used in positive pressure mode. These respirators should be fit tested in negative pressure mode. The purpose for fit testing the facepiece of a positive pressure respirator is to eliminate “gross” face seal leakage that might degrade protection or shorten service life for self-contained breathing apparatus (SCBA). Loose-fitting facepieces, hoods and helmets, which are used on powered air purifying and/or supplied air respirators, are not fit tested.

**When to Fit Test**
In U.S. workplaces, the Occupational Safety and Health Administration (OSHA) requirements for respiratory protection (29 CFR 1910.134) must be followed including medical evaluation, training, and fit testing for employees required to use respirators in the workplace. The fit test should be performed at the following times:

• After medical evaluation is completed and prior to use in the workplace
• Whenever a different make, model or size respirator is used
• If there is a change in employee’s physical condition affecting fit
• Annually if not done sooner

**Why Fit Test?**
Many organizations conduct respirator fit testing for two main reasons:

• Fit testing helps ensure the respirator provides an adequate face to facepiece seal
• Fit testing is a regulatory requirement under the Occupational Safety and Health Act
However, there are additional benefits fit testing demonstrates to the wearer, such as:

- They can achieve an acceptable fit on their specific respirator
- That the respirator can be effective
- Whether their other PPE is compatible with their respirator
- How a proper respirator fit feels – so they can repeat it in the workplace

**Comparison of Fit Test Methods**

**Qualitative Fit Testing**
Qualitative fit testing uses the sense of smell or taste, or the reaction to an irritant to detect respirator leakage. These are pass/fail methods where the level of leakage is unknown. If the test agent is detected inside the respirator facepiece during any of a series of exercises, the user has failed the fit test. If the test agent is not detected inside the facepiece during any of a series of exercises, the user has passed the fit test. OSHA accepts the following types of qualitative fit test methods:

- Saccharin
- Bitrex™
- Isoamyl acetate (i.e. banana oil)
- Irritant smoke (Stannic Chloride)

Qualitative fit testing has its own set of advantages and disadvantages. The pros include: no calibration and minimum maintenance of the test kit, multiple respirator wearers can be tested simultaneously, kits are relatively inexpensive, and the wearer can verify the test results by breaking the seal at the end of the test to smell, taste, or experience the reaction to irritant smoke. The cons of qualitative fit testing include: room for error due to human administration, pass/fail test gives no numerical result and the test requires the respirator wearer to alert the test administrator to detection of the test agent.

**Quantitative Fit Testing**
During quantitative fit testing a machine is used to measure the level of leakage inside the facepiece. The result of this measurement is a numerical fit factor (FF). As defined by OSHA, a fit factor is a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn. The person undergoing the fit test is not relied upon to detect the challenge agent, as in a qualitative fit test. Instead, the machine measures leakage and the result is the FF. The following types of quantitative fit testing are accepted by OSHA:

- Condensation nuclei counter (CNC, e.g. TSI Portacount™)
- Controlled negative pressure (CNP, e.g. OHD Quantifit™)

Some advantages of quantitative fit testing can include the automatic computer control, generation of the numerical fit factor, the objective response independent of the respirator wearer, a higher assigned protection factor (APF) for a full facepiece respirator, and automatic record
keeping software. Possible disadvantages of quantitative methods include: required calibration and maintenance, ability to test only one person at a time, the expense of the fit testing apparatus.

Figure 1 shows the pros and cons qualitative and quantitative fit testing.

<table>
<thead>
<tr>
<th>Quantitative Fit Testing</th>
<th>Qualitative Fit Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer controlled</td>
<td>Human administration</td>
</tr>
<tr>
<td>Numerical result</td>
<td>Pass / Fail only</td>
</tr>
<tr>
<td>Objective response independent of wearer</td>
<td>Subjective response dependent on wearer</td>
</tr>
<tr>
<td>Half face APF = 10</td>
<td>Half face APF = 10</td>
</tr>
<tr>
<td>Full face APF = 50</td>
<td>Full face APF = 10</td>
</tr>
<tr>
<td>Record keeping software</td>
<td>No automated record keeping</td>
</tr>
<tr>
<td>Calibration and maintenance</td>
<td>No calibration, minimal maintenance</td>
</tr>
<tr>
<td>One person at a time</td>
<td>Multiple tests can be conducted simultaneously</td>
</tr>
<tr>
<td>Expensive (~$8000+)</td>
<td>Inexpensive (~$300 kit)</td>
</tr>
<tr>
<td>Wearer must trust the machine</td>
<td>Wearer can verify test result</td>
</tr>
</tbody>
</table>

Figure 1. Comparison of quantitative and qualitative fit test methods.

Acceptable Fit Test Methods
For the most part, either qualitative or quantitative fit test methods can be used. 29 CFR 1910.134 requires the use of quantitative fit testing for only a few specific situations, including:

- The assigned protection factor of 50 is needed while using a full facepiece in negative-pressure air-purifying mode
- A supplied-air respirator (SAR) or self-contained breathing apparatus (SCBA) is used in demand mode (currently very uncommon and distinct from pressure-demand mode)
- Facepieces used in SCBAs for structural firefighting must be quantitatively fit tested, per the National Fire Protection Association^2

Figure 2, taken from the OSHA Instruction CPL 02-00.120, shows acceptable fit test methods by respirator type.3

<table>
<thead>
<tr>
<th>Acceptable Fit Test Methods</th>
<th>QLFT</th>
<th>QNFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-Face, Negative Pressure, APR (&lt;100 fit factor)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Full-Face, Negative Pressure, APR (&lt;100 fit factor) used in atmospheres up to 10 times the PEL</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Full-Face, Negative Pressure, APR (&gt;100 fit factor)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>PAPR</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Supplied-Air Respirators (SAR), or SCBA used in Negative Pressure (Demand Mode) (&gt;100 fit factor)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Supplied-Air Respirators (SAR), or SCBA used in Positive Pressure (Pressure Demand Mode)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SCBA - Structural Fire Fighting, Positive Pressure</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Effective Protection vs. Assigned Protection Factor (APF)

OSHA defines the assigned protection factor, or APF, as the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program as specified by 29 CFR 1910.134. The assumption is made that to achieve the APF for a particular respirator, the respirator is worn 100% of the time a contaminant is present. If the respirator is not worn at all times when the contaminant is present, the protection provided by the respirator will be reduced. This reduced protection provided by the respirator is known as the effective protection factor, or EPF.5 We will use an example to illustrate this concept further. We will assume:

- Contaminant Level = 10 X PEL (permissible exposure limit)
- Exposure time = 6 hr. = 360 min.
- Half facepiece = APF 10
- Leak Rate1 = 1/10 = .1
- Wear Time = 90% (360 X .90) = 324 min.
- Non-Wear Time = 10% (360 X .10) = 36 min.

1. Leak rate is 1/APF

The following formula shows how an EPF may be calculated by using leak rate, wear time, and non-wear time values. A higher EPF means the worker is better protected.

\[
\text{EPF} = \frac{\text{Work Shift time in Minutes}}{(\text{Leak Rate}) (\text{Wear time}) + \text{Non-Wear time})}
\]

Working through the calculations, we find that a Non-Wear Time of 10% results in an Effective Protection Factor (EPF) less than 10.

\[
\text{EPF} = \frac{360 \text{ min.}}{(0.1) (324 \text{ min.}) + 36 \text{ min.}}
\]
\[
\text{EPF} = 360 / 68.4 = 5.26
\]

With an EPF of less than 10 and a contaminant level of 10 X PEL, the worker in this situation is possibly being overexposed.

Using the same values as above, but increasing the Wear Time to 95%, will yield an Effective Protection Factor of 6.9 as shown below.

\[
\text{EPF} = \frac{360 \text{ min.}}{(0.1) (342 \text{ min.}) + 18 \text{ min.}}
\]
\[
\text{EPF} = 360 / 52.2 = 6.9
\]
The requirement for these two examples was an Effective Protection Factor of at least 10. Both workers were using respirators that would help provide protection, but both workers had EPFs less than 10, and could possibly be over exposed.

The following table shows EPFs for respirators with various fit factors at increasing wear times. Notice that an increase in the fit factor (i.e. respirator type) does not have a significant effect on the effective protection factor until the respirator is worn at least 95% of the required time.

<table>
<thead>
<tr>
<th>Respirator Type</th>
<th>APF</th>
<th>Percent of Time Respirator Worn &amp; Associated EPF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>80%</td>
</tr>
<tr>
<td>Half Facepiece APR</td>
<td>10</td>
<td>3.6</td>
</tr>
<tr>
<td>Loose fitting Facepiece</td>
<td>25</td>
<td>4.3</td>
</tr>
<tr>
<td>Full Facepiece APR</td>
<td>50</td>
<td>4.6</td>
</tr>
<tr>
<td>Hood or Helmet</td>
<td>1000</td>
<td>4.98</td>
</tr>
<tr>
<td>SCBA</td>
<td>10,000</td>
<td>4.99</td>
</tr>
</tbody>
</table>

How can worker’s wear time be increased? One method is to inform workers of the potential exposure resulting from respirator removal in contaminated environments, even for short periods of time. There should also be increased emphasis for workers to wear their respirators during as much of the work shift as possible, when exposed to hazardous levels of contaminants.

In addition to a program of worker education, employers may be able to make considerable progress toward increased wear time by using respirators with proven performance that are well accepted by the wearer because of lightweight comfort, ease of breathing, and ease of communication. Improved worker comfort can lead to increased wear time, and increased wear time leads to increased worker protection.

Answers to Frequently Asked Fit Testing Questions

We have covered many of the most commonly asked questions regarding respirator fit testing already. However, there are several additional questions that are commonly asked regarding fit testing.

- Do I have to be certified to conduct fit testing?
- Does the fit test subject need to be clean-shaven?
- How should I document my fit testing?
- Are there any respirators that don’t require fit testing?

OSHA does not require any specific certification for fit testers. In 29 CFR 1910.134 Appendix A, OSHA says, “The employer shall 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 is in proper working order.” No specific certification is required.

Per OSHA, employees wearing respirators must be clean-shaven where the respirator seal comes into contact with the face, including during the fit test. In other words, no facial hair can be present that interferes with the respirator seal. Many companies and fit testers create policies regarding shaving for fit tests. For example in order to hold a position where respirator use is required, an employee must come to work clean-shaven. Or if the work is predictable, the employee must be clean-shaven any day when a respirator will need to be worn – including fit testing.

OSHA requires employers to keep records that include the name or employee number; the type of fit test performed; the make, model, and size of the respirator; the date of the test; and pass/fail results for QLFT or numerical results for QNFT. This information needs to be retained until the date of the next fit test administered to that individual. Of course, employers may also want to maintain reports longer for other purposes as well.

Loose-fitting face pieces, hoods and helmets, which are all used in positive-pressure configurations, do not depend on a tight seal with the face to provide protection and therefore do not need to be fit tested. Furthermore, per OSHA, disposable filtering facepiece respirators that are used in voluntary use situations do not need to be fit tested.

**Conclusion**

Fit testing is an important part of respiratory protection programs. There are a number of fit testing options available today. To determine the best option for your program, benefits and limitations of each method must be considered. A fit test need not be complicated or expensive to be effective, but it must have a documented protocol, and that protocol must be followed closely.

Fit testing should be seen as an additional touch point with the respirator wearer. During this time the EHS professional can help the worker understand the importance of wearing the respirator the entire time it is required. This will further ensure the success of the respiratory protection program, and help ensure the appropriate protection of respirator wearers.

**References**


OSHA Instruction, CPL 02-00.120, Inspection Procedures for the Respiratory Protection Standard, September 25, 1998.