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How to implement and manage an effective respirator fit testing program.

Introduction

Do you know if your workers are wearing tight-fitting respirators that actually fit them?

Tight-fitting respirators must seal to the wearer's face in order to provide the expected protection. If there is a leak in the face seal, they may be exposed to harmful airborne contaminants. Fit testing is required by law and standards in many different countries around the world and is being increasingly adopted by companies as best practice even where there is not a mandatory requirement to fit test.

What is fit testing?

A respirator fit test can be defined[1] as:

"...a method for checking that a tight-fitting facepiece matches the person's facial features and seals adequately to the wearer's face. It will also help to identify unsuitable facepieces which should not be used."

Why fit testing?

A good fit means the tight-fitting respiratory protective device (RPD) will seal to your skin. A respirator can only provide adequate respiratory protection to the wearer when air passes through the filter and does not enter the wearer's breathing zone via any other route. Air will take the path of least resistance, so if there isn't a good face seal, some of the contaminated air will go through this path rather than through the respirator filter, and therefore reduce the protection.

Every wearer's face is different in shape, size and features. Tight-fitting respirators are also available in a wide range of shapes, styles, materials and sizes. Unfortunately, there is no single tight-fitting respirator that can be expected to fit every possible wearer. Therefore, the fit of a respirator is personal, individual and unique to each wearer. The only way to know if a respirator can provide an adequate seal to a wearer is to fit test each respirator-wearer combination.

Fit testing as part of your respiratory protection program

Implementing an effective respiratory protection program should be a methodical and documented process.

All programs should start with an exposure and risk assessment per AS/NZS 1715[17] to determine the level of adequate respiratory protection required. After this, the focus is the selection and fit testing of an RPD that is suitable for the workplace, the task and the wearer. A suitable tight-fitting RPD also needs to be compatible with other items of Personal Protective Equipment (PPE) such that the protection provided by the PPE is not compromised, be comfortable to wear and importantly fit the wearer. A medical evaluation is required to assess psychological and physical suitability prior to fit testing and wearing on the job. Finally, the entire program should be documented, particularly wearer training in the limitations, fitting, use and maintenance of the respirator.

Fit testing is a key part of a workplace respiratory protection program. A fit test gives an assessment of how well the respirator fits the wearer. A fit test also helps with the assessment of the respirator's comfort, compatibility with other PPE and overall suitability for the wearer, along with being an ideal training opportunity for the wearer on the correct fitting and use of the product.

What type of RPD should be fit tested?

Any tight-fitting facepiece should be fit tested. These include disposable facepiece respirators (disposable respirators, commonly referred to as 'dust masks'), half-masks with filters and full-face masks with filters. Any tight-fitting facepiece that is connected to a powered or supplied air system should also be fit tested; this includes tight-fitting face masks used with PAPR, powered masks, breathable compressed air or self contained breathing apparatus.

Only respirators that rely upon positive air flow through a loose-fitting headtop do not require face fit testing. Such products may be selected for a variety of reasons, which may include the need for higher protection levels available from some classes and types, wearer facial hair that may affect the seal of a tight-fitting respirator, long wear durations, wearer comfort and the need for a single item of PPE that offers combined protection from other hazards.

Disposable facepieces

Half-mask respirators

Full-facepiece respirators

Tight-fitting powered or supplied air respirators (including SCBA)

Fit test methods and protocols

Most respirator fit test methods rely upon the wearer wearing the respirator in an atmosphere containing a harmless aerosol, with the amount of the aerosol entering inside of the respirator due to face seal leakage being assessed either qualitatively or quantitatively.

All the fit test methods have significant commonality, and in most cases, are derived from the methods and regulations first implemented in the USA.

Fit test methods

Fit test methods can be defined as being either qualitative (QLFT) or quantitative (QNFT):

Qualitative (QLFT)

Qualitative fit testing is subjective, requiring the wearer to provide input to the fit test. The predominant methods use either a Saccharine or Bitrex® test solution, sprayed into an over hood, which the respirator wearer decides if they can taste whilst conducting a number of fit test exercises. If the test solution is not tasted during the fit test, then the test is deemed a pass (with an assumed fit factor of 100 for the respirator). Other methods are available and used in some countries, for example isoamyl acetate (banana oil) or stannic acid (irritant fumes).

Qualitative methods can be used to fit test disposable facepieces and half-masks (with particulate or combination filters) only. It is not suitable for full face masks.

Quantitative (QNFT)

A quantitative fit test is an objective method that can be used to fit-test most tight-fitting respirators. It involves using an instrument to measure leakage around the face seal and produces a numerical result called a "Fit Factor."

Note: the fit factor should not be confused with respirator protection factors such as minimum required protection factor (MRPF) or assigned protection factor (APF) that may be used to predict reduction of inhalation exposure.

> **Most respirator fit test methods rely upon the wearer wearing the respirator in an atmosphere containing a harmless aerosol**

Figure 1 - 3M FT-30 Bitrex® Fit Test kit being used to conduct a Qualitative Fit Test (QLFT) upon a subject wearing a disposable facepiece respirator

Figure 2 - Ambient Particle Counting - TSI® PortaCount® Model 8038 being used to conduct a Quantitative Fit Test (QNFT) upon a subject wearing a disposable facepiece respirator

Controlled Negative Pressure - OHD® Qantifit® CNP using the REDON method being used to conduct a Quantitative Fit Test (QNFT) upon a subject wearing a half face facepiece respirator. Image: courtesy of OHD®

There are two main QNFT methods in use:

Ambient Particle Counting

The most commonly used quantitative method is condensation nuclei counter (CNC) using a TSI® PortaCount®. This machine uses the principle of 'ambient particle counting' – it measures the concentration of both the ambient aerosol and the particles inside of the respirator being tested, the ratio of which is the Fit Factor. For more information on the use and operations of the TSI PortaCount, please see the manufacturer's website[2]

Ambient Particle Counting:

$$\text{Fit Factor (FF)} = \frac{\text{Conc. of particles outside the mask}}{\text{Conc. of particles inside the mask}}$$

Controlled Negative Pressure

An alternative quantitative method is controlled negative pressure (CNP) method using a OHD® Quantifit® machine. This machine and method uses the principle of 'controlled negative pressure' – it creates a slight negative pressure inside of the respirator being tested (while the wearer holds their breath and remains still), and monitors the pressure in order to measure any face seal leakage. A variant of the CNP fit testing protocol developed by OHD for the Quantifit is the REDON protocol. With the REDON protocol, the fit factor is measured after three different exercises, with the additional doffing and re-donning undertaken twice, with fit factor measurement after each re-donning. The REDON protocol is permitted in OSHA 1910.134[3] only. For more information on the use and operations of the OHD Quantifit, please see the manufacturer's website[4]

Controlled Negative Pressure:

$$\text{Fit Factor (FF)} = \frac{\text{Modelled breathing rate}}{\text{Leak rate}}$$

Fit test protocols

Across Australia and New Zealand, there is growing interest in fit testing and the implementation of fit testing as detailed in AS/NZS 1715[17] which specifies that fit testing is required for all tight fitting masks (positive and negative pressure). It details different fit test methodologies but is lacking in more specific detail around the process of conducting a fit test. For this reason the OSHA 1910.134 protocol is the most commonly used in protocol in Australia. AS/NZS 1715[17] also does not specify the minimum fit factor pass levels for the different classifications of respirators. Generally Australia and New Zealand follows the guidance set by OSHA 1910.134[3] and ANSI Z88.2[18] that the fit factor level is at least 10x the assigned protection factor specified in AS/NZS 1715[17] for Qualitative and Quantitative Ambient Particle Counting methods. Quantitative Controlled Negative Pressure guidance from OSHA 1910.134[3] and ISO 16975-3[5] recommend a minimum fit factor pass of 100 for half face masks and 500 for full face masks.

In 2017, ISO 16975-3[5] was published as part of a larger body of work to standardise international performance and test standards for respiratory protective devices. It is recommended that ISO 16975-3(5) be referred to for guidance in addition to AS/NZS 1715[17].

The most commonly used method [of quantitative fit testing] is condensation nuclei counter (CNC) using a TSI® PortaCount®

This ISO standard may be used voluntarily by workplaces or countries in lieu of any other national requirements. ISO 16975-3[5] has many similarities with other national protocols, particularly OSHA 1910.134[3] and HSE INDG 479[1]. It is very likely that if adopted as national standards, then the implementing nation may add a national foreword or annex that provides additional performance requirements, detail or instruction that shall be complied with.

Table 1 - Suitability of fit test method by product type and recommended minimum fit factor requirements

	Qualitative (Saccharine / Bitrex taste)	Quantitative – Ambient Particle Counting (TSI PortaCount)		Quantitative – Controlled Negative Pressure (OHD Quantifit)	
	Suitability	Suitability	Minimum Fit Factor Pass Level	Suitability	Minimum Fit Factor Pass Level
Disposable facepiece	Yes	Yes	100*	No	n/a
Half face mask	Yes	Yes	100*	Yes	100
Full face mask	No	Yes	1000	Yes	500

* Disposable respirators should ideally be fit tested using the TSI PortaCount Pro+ or if the N95 Companion for when P1 or P2 mask or filters are used for the fit test.

Respirator stability and fit test exercises

A key part of a fit test is to determine the respirator's ability to retain its seal when the wearer is in motion. That's why wearers are instructed to perform several standardised exercises that are meant to put the seal of the tight-fitting respirator under stress, as part of testing. The most common exercises used in protocols are as follows:

a. Normal breathing

b. Deep breathing

c. Turning head from side to side (inhaling at the extremes)

d. Moving head up and down (inhaling when looking up)

e. Reading/talking aloud

f. Grimace*

g. Bending over at the waist**

h. Normal breathing

*Grimace features in OSHA 1910.134, quantitative fit testing methods only – duration is 15 seconds, sampling within the mask is discarded for final fit factor calculation

**May be substituted for jogging on the spot in OSHA 1910.134 if the fit test method setup does not permit bending over at the waist

In 2019, OSHA added two new quantitative CNC modified protocols (one for full face and half face masks and one for disposable masks) which have 4 exercises taking less time to complete the fit test.

When to conduct a fit test?

A fit test must be conducted whenever there is a new wearer and tight-fitting facepiece combination, for example a new wearer or a change to a new type, brand or model of tight-fitting respirator. A fit test must also be conducted should some characteristic of the wearer or the product change that may affect the seal upon the face, for example when any facial changes occur that could affect fit, such as significant weight change, skin scarring or dental work.

- AS/NZS 1715[17], ISO 16975-3[4] and OHSA 1910[13] specifiy that fit testing should be conducted annually

In 2016, NIOSH completed a 3 year study (19) showing that after 1 year an estimated 10 percent of workers' respirators did not fit properly. Two and three years later, that figure rose to 20 percent and 26 percent, respectively. Additionally, nearly one-quarter of subjects who lost more than 9kg were unable to maintain an acceptable fit, according to the study. These finding support the recommendation in these protocols for annual fit testing.

Importance of fit

Incorrectly fitted respirators may not achieve a reliable seal to the wearer's face and may be uncomfortable, possibly leading to wearers not wearing the respirator during all periods of exposure.

There are many factors that affect the fit of tight-fitting respirators:

- Donning procedure: everything from putting the respirator on the right way up through to the correct position and tension adjustment of the headbands or proper formation of the noseclip (if fitted).
- Facial hair: look out for hair under the faceseal, beard growth/stubble, forward hairlines (full face masks) and big sideburns. Beards, moustaches, or even stubble interfere with the seal of a tight-fitting respirator. Wearers must be clean-shaven in any area of the face and neck where the respirator comes into contact with the face. This rule applies not only for the day of fit testing, but for any day when a tight-fitting respirator is worn in the workplace.
- Other contaminants: anything that can interfere with the seal to the face, includes hair, cosmetics, sweat, facial jewellery, foreign bodies within the mask and facial hair.
- Face shape and size: extremes of face size (length and width of face) and well as very angular or very round faces can cause issue with fit.
- Facial features: prominent facial features can also cause some issues such as cleft chins, scars on the facesealing area, depressions around the temple/ cheekbones, unusual chin profiles (chiselled features), unusual nose shapes (very large or very flat).

User (wearer) seal check: An essential everyday test

Workers wearing tight-fitting respiratory protection should perform a wearer seal check each time they put on their respirator (including before a fit test). A fit test ensures that the respirator is able to fit and provide a secure seal, but a wearer seal check ensures that it's being worn right each time – a quick way of identifying errors in fitting and certain faults with the respirator. Wearers can either perform a positive-pressure or negative-pressure seal check, as detailed in the manufacturer's user instructions:

- A positive-pressure check means blocking the exhalation valve on a half or full facepiece respirator or covering the respirator surface on a disposable facepiece, usually by using your hands, and trying to breathe out. If slight pressure builds up, that means the seal is adequate. Note that exhalation valves on disposable facepieces are not designed to be blocked, so this method is not viable for valved disposable facepieces.
- A negative-pressure check involves blocking the intake valves or filters on a half or full facepiece respirator or covering the respirator surface on a disposable facepiece, typically using your hands and trying to breathe in. If no air enters, the seal is adequate. See the product user instructions for more details.

> **Incorrectly fitted respirators may not achieve a reliable seal to the wearer's face and may be uncomfortable, possibly leading to wearers not wearing the respirator during all periods of exposure.**

Compatibility with other PPE

Prescription and safety spectacles, goggles, face shields, hearing protection, hard hats and coveralls can all compete with a respirator for space upon a wearer's face, head or body. For instance, if a half mask respirator doesn't fit well (especially if it's too large), it can overlap with spectacles. The more that happens, the more fogging can potentially occur on the spectacles.

Adjusting the position of a respirator upon the face to better accommodate spectacles and goggles, or a hard hat or coverall hood affecting the correct positioning of respirator headbands can all interfere with the respirator's seal.

To catch these problems before they happen on the job, any item of PPE that could potentially interfere with the respirator's seal should also be worn during the fit test.

Interpreting fit test passes and fit factor values

A respirator fit test pass means that on that day, in those circumstances, the respirator was shown to be able to provide an adequate seal to the wearer's face. A fit test pass is not a guarantee of adequate respirator fit when the next respirator is worn. Therefore, a tight-fitting respirator should be fitted correctly and in accordance with the manufacturer's instructions, and the wearer must always perform a wearer seal check (fit check) each time the respirator is fitted.

With quantitative fit tests, there may be a temptation to interpret the fit factor values from a fit test, particularly if comparing two or more different models of respirator. With all fit tests, there are a number of product, wearer, fit testing device, environmental and fit tester variables that can affect the fit test and the resulting fit factor measured. Therefore, unless the effect of these variables is reduced or eliminated, and the results have been shown to be both scientifically reproducible and repeatable, then caution is advised when comparing fit factor values.

Furthermore, little to no correlation has been shown between quantitative fit factors and workplace performance.

It is important to note that provided that the overall fit factor(s) exceed the minimum fit factor requirement, then the fit test has been passed. Then a record of the fit test must be made and stored, and the respirator can be worn by the wearer in the workplace.

According to ISO 16975-3[17], a fit test record should contain the following:

a) date of the test;

b) identification of the fit-test operator and fit-test operator's employer/company name;

c) name of the person fit tested;

d) details which will uniquely identify the respirator tested such as make, model, size and material;

e) details which will uniquely identify all other potentially interfering PPE worn during the fit test such as spectacles, jewellery, make, model and size;

f) fit-test method used;

g) pass/fail criteria;

h) results: pass/fail, fit factors or other information generated may be documented;

i) corrective actions in case of a failed fit test;

j) overall fit factor achieved;

k) pass level used in the test;

l) serial number or other means of identifying test equipment used in the test;

m) any additional information the RPD program administrator deems relevant.

> **A respirator fit test pass means that on that day, in those circumstances, the respirator was shown to be able to provide an adequate seal to the wearer's face.**

Facial hair and clean-shaven policies

Wearer facial hair is perhaps the most commonly cited issue regarding both respirator selection, use and fit testing. It can be a highly contentious issue, touching on wearer's rights, employment law, religious beliefs and employer/PCBU responsibilities. The rights of the wearer need to be balanced against the needs to protect the health and safety of the wearer – a balance that can be tricky to achieve in many circumstances.

Ultimately though, tight-fitting respirators rely upon a good seal to the face to protect the wearer. Anything that can interfere with this seal and create gaps, including the full range of facial hair from stubble to beards, can and will compromise protection as shown by the images below.

Numerous studies (20&21) have evaluated the effects of facial hair upon the performance of tight-fitting respirators. These indicated that in the presence of facial hair, face seal leakage increases from 20 time to 1000 times. Another study showed a three hundred and thirty (330) fold drop in protection was experienced be bearded employees. None of the studies showed that facial hair improves the seal of the respirator to the face, with the conclusion being that the effects of facial hair are variable by length and person but generally facial hair reduces the protection to the wearer.

HSE RR1052

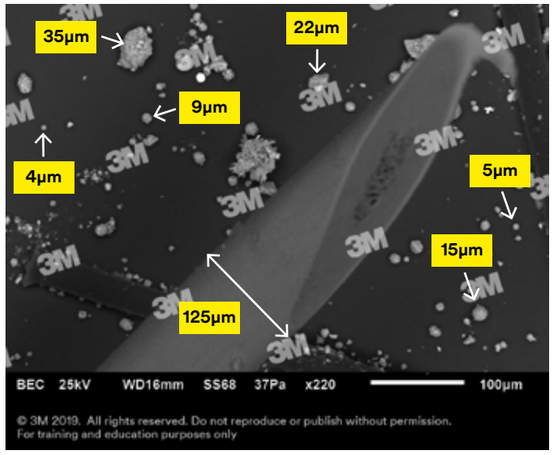
The effect of wearer stubble on the protection given by disposable masks and Half Masks, 2015[9]

This study evaluated the effect of facial hair growth on the inward leakage (fit) of seven different makes and models of disposable respirators and two different makes and model of half masks. Fifteen male subjects were tested with the respirators over the course of one week, starting with clean-shaven through to 7 days of facial hair growth. Each subject, respirator combination was tested for leakage (fit) daily throughout the study.

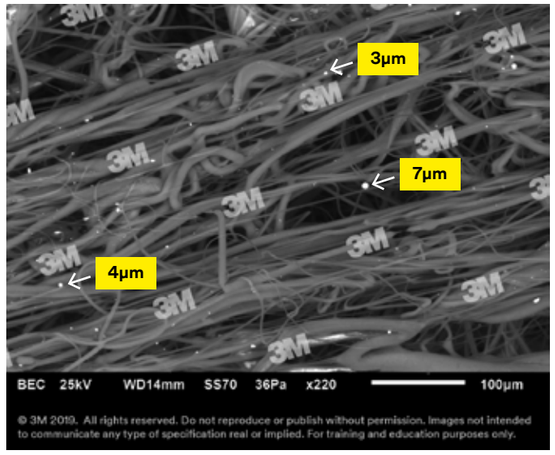
The effects of facial hair varied by subject and respirator worn:

- By day 7, all subjects with all respirators had unacceptable degradation in protection due to facial hair growth
- For some subject respirator combinations, protection degraded significantly by the end of day 4
- For other respirators and some subjects, protection degraded with facial hair growth, yet for a minority little/no degradation occurred.

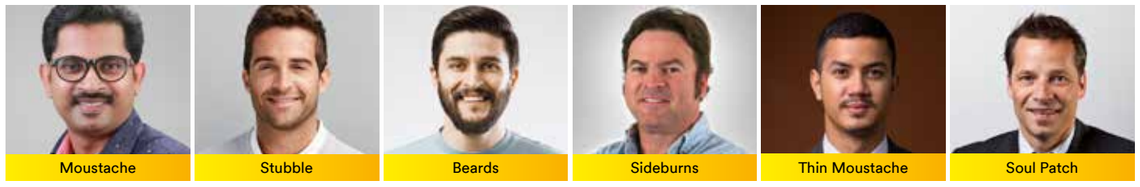
The effect of stubble upon protection is unpredictable as each person has different facial and facial hair characteristics (coarseness, hair density, growth rate, etc.) and each respirator can respond differently to facial hair. However, the research clearly supported guidance that workers should be clean-shaven - in the area of the faceseal when wearing tight fitting respirators.



Particulates, gases and vapours can bypass facial hair that is preventing an adequate seal and still expose the wearer



Example layer from a 3M reusable respirator particulate filter



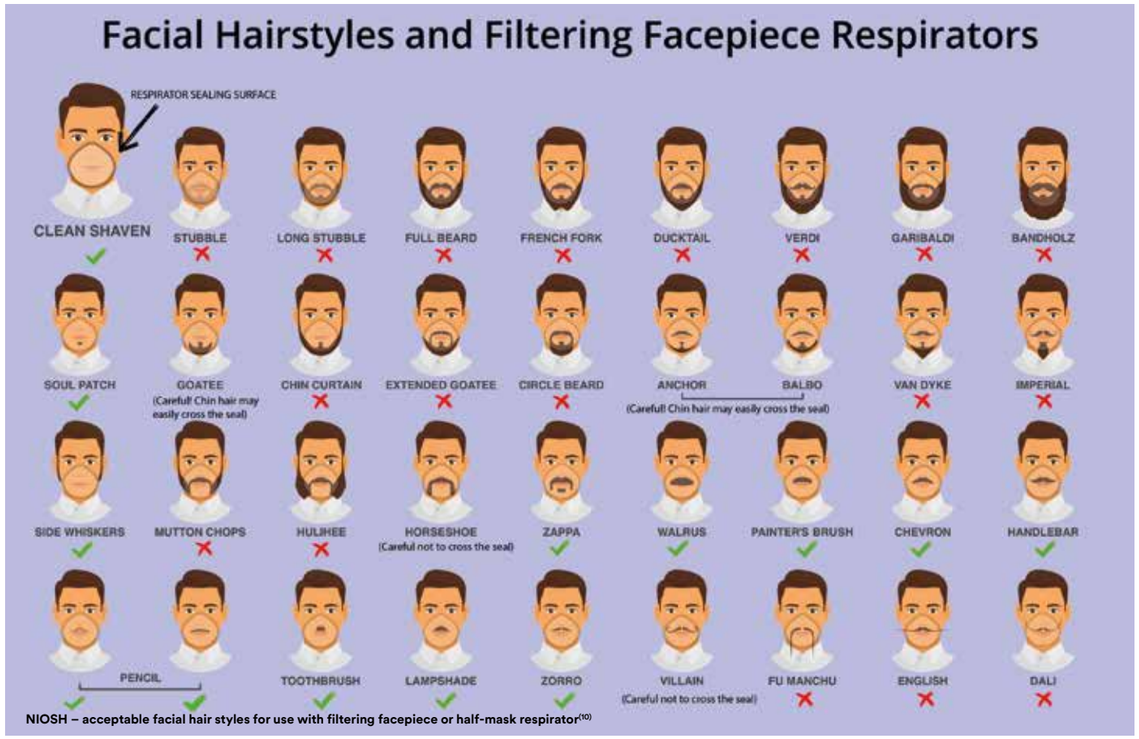
Facial hair

Any facial hair that interferes with the seal of the respirator onto the face can compromise protection.

Even long hair can interfere with the seal of the respirator to the face, particularly on full-face masks. However, some facial hair can be worn provided that it does not interfere with the respirator seal to the face – two examples of facial hair that may be acceptable are provided below. As facial hair varies, evaluate facial hair on a case by case basis and if a fit test pass is achieved, record the condition and length of any acceptable facial hair; this will then have to be managed in the workplace.

In the US, the National Institute for Occupational Safety and Health (NIOSH) has created guidance for wearers around facial hair that may or may not be acceptable under a tight-fitting half-mask or disposable facepiece*[10]. The intended purpose was to give guidance and support to men's health awareness charity events in the month of November (for example 'Movember').

*May be suitable – case by case assessment of potential to interfere with face seal needs to be required



NIOSH – acceptable facial hair styles for use with filtering facepiece or half-mask respirator[10]

Not only are our faces unique (shape, size, skin textures/firmness, etc.), but men's facial hair is also unique.
Variables that may affect the interaction with a tight-fitting respirator include[11][12]:

- Density (hairs/cm^3)
- Distribution on face (density variations on different parts of the face)
- Curliness of the hair
- Hair stiffness (how stiff is the hair itself)
- Hair cross-sectional size/diameter and shape
- Number of days of growth and facial hair length (note: men have different facial hair growth rates)

Clean-shaven policies

Implementing a mandatory clean-shaven policy for wearers who wear tight-fitting respirators is the obvious solution and yet can be challenging to implement effectively. Wearers can be reluctant or refuse to be clean-shaven, with common reasons being linked to behavior, religious or medical grounds:

- Lack of understanding of the need to protect themselves or be clean-shaven
- Misunderstanding about how respirators work, for example tight-fitting respirators require a good seal to the face, whilst loose-fitting do not
- Bravado around respiratory hazards: "it won't happen to me" – a natural optimism
- Defiance of the rules - the need to be clean-shaven: "why should I" or "I don't want to and don't care"
- Laziness/absentmindedness – apathy to the need to shave
- Personal religious and customs are protected by law and employers must make reasonable allowances, for example non-enforcement of clean-shaven policies, for example devout followers of Sikhism, Islam, and some sects of Judaism; selection of loose-fitting RPD
- A wide variety of medical conditions can also exempt wearers from needing to shave, for example dermatological conditions aggravated by shaving.

Addressing behavioural issues can be difficult. The best approach is to engage with the employees and seek to change their behaviour by making them fully aware of the hazards and risks to their health, explanation of the need to be clean-shaven, training on the correct use and fitting of respirators in order to address the issues head on.

Policies around fit testing and being clean-shaven must be transparent, well documented, and available and applied to all. Policies need to be continuously monitored and enforced, not just a passing fad or a one-off activity. The ideal would be to incorporate clean-shaven policy into the terms of employment.

However, including this in employment contracts for new hires or retrospectively for existing employees may be problematic or even illegal in some countries.

For employees who have legitimate reasons for having facial hair or when enforcement of a clean-shaven policy is impractical or has failed, other options such as alternative respiratory protective devices or alternative work tasks that do not require respiratory protection should be considered.

What is clean-shaven?

Not only are men's facial hair characteristics different, but people shave differently and at varying frequencies.

Unfortunately, there is little guidance or technical definition on what actually 'clean-shaven' actually is or how to measure growth. Therefore, it is a personal interpretation for the respirator wearer, employer and if conducting a respirator fit test, the fit tester.

A general rule of thumb is that if stubble is seen to clearly protrude above the skin, then the subject is not clean-shaven. But this is not scientific and is open to interpretation. Clean-shaven (or a close shave) can mean different things to different people. A sharp razor blade will shave closer and more consistently than a blunt blade. Shaving with the grain can produce a 'close shave', but shaving against the grain of the hair can result in a 'very close shave', but at the risk of razor bumps and skin irritation.

Different models and makes of electric razor, sharpness of the cutting elements, pressure and shaving duration will equally produce different results.

ISO 16975-3[17] provides us with at least a time-based definition: *"sealing surfaces shall be shaved within 24 h of testing, preferably within 12 h"*

Alternative RPD

If wearers will not or are unable to comply with a clean-shaven policy, there are alternative products that may be considered. Loose-fitting facepieces or headtops have a close fit to the head and/or face, but do not rely on a tight seal to the wearer's face. These types of product are connected to a continuous flow of filtered or uncontaminated air. Examples of loose-fitting facepieces and headtops include:

Hood

Headtop/helmet

Powered or supplied air respirators require a relatively significant initial investment compared to many tight-fitting respirators. This upfront cost is a potential barrier to implementation, however these systems can actually prove to be more cost-effective, in the long term, than some tight-fitting respirators, in addition to having numerous other practical, comfort and wearer protection benefits.

Managing a fit testing program

Tips and good practises

Managing wearer time/minimise man hours lost

Fit testing takes time. The actual fit test itself may take 7-8 minutes (or 2.5 minutes using the OSHA modified protocol), but additional time is required for the following:

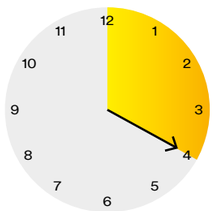
- Sensitivity test (if applicable)
- Preparation of facepiece for the test
- Instruction of the wearer in the fit test exercises
- Donning and performing the wearer seal check of the facepiece fit
- Comfort assessment period
- The actual fit test
- Removal of facepiece
- Explanation of the results of the fit test
- Training on selection, use, donning, maintenance of the respirator or any other questions from the subject.

As a rule of thumb, allow 10-20 (depending on the selected protocol) minutes per wearer – respirator fit test; 'experienced' wearers who are familiar with the process may require closer to 10 minutes, whilst new wearers and/or respirators may require closer to 20 minutes. Additional fit tests – repeats due to initial failure or for more than one respirator – will need to be accommodated or rescheduled.

Preparing for fit testing

As discussed above, fit testing takes time – time when the wearer is not being productive. It is therefore advisable to seek the cooperation of the production colleagues when fit testing is being conducted, so that cover is in place for wearers being fit tested. Scheduling fit testing appointments will also help minimise time lost due to waiting around, yet a level of flexibility is required as you will have some failures and a need to conduct additional repeat fit tests.

Fit testing should not be conducted in a hazardous environment, but should be conducted in a safe and private room, for example in an office. Some wearers can be self-conscious, so the use of a private office or meeting room is advisable. Qualitative fit test methods are best conducted in larger rooms with good ventilation. Conversely, quantitative ambient particle counting methods (TSI® PortaCount®) are best conducted in smaller rooms, where air conditioning can be turned off and the ambient particle concentration can be more easily controlled and maintained.



A successful fit test will take approximately 10-20 minutes depending on the selected protocol. However it may take longer if additional fit tests are required or more than one mask is being tested.

Wearer responsibilities

- Turn up for the fit test when scheduled
- Be clean-shaven
- Should not eat, drink (except water), chew gum or smoke or vape in the 30 minutes (or 60 minutes in the case of ambient particle counting method) prior to conducting a fit test. The results of fit testing are affected by anything that changes the sense of smell/taste (qualitative methods) or results in wearer generated particles (quantitative particle counting methods)
- Bring their respirator (as required) and any other item of PPE that they wear that may affect the fit of the respirator
- Don the respirator as trained and as per the manufacturer's user instructions
- Be able to conduct the required fit test exercises.

Employer responsibilities

- Select suitable and adequate RPD, and make this readily available to those wearers who require it
- Ensure all employees wearing tight fitting RPD have been successfully fit tested and are wearing the correct facepiece
- Ensure that the RPD is used in accordance with the manufacturer's instructions
- Ensure that the RPD is maintained properly and is in good condition
- Comply with all relevant fit testing, health and safety regulations and legislation, company policies, etc.

Importance of training

The short time each RPD wearer is taken away from the production environment for a fit test is not just an opportunity to conduct the actual fit test, it is also a unique opportunity for training and assessing behavioural safety:

- Fit the product correctly
- Check on maintenance, storage, end of service life
- Feedback on all aspects of the respirator and the RPD program
- Raise awareness of the hazards and risks in the workplace
- Reinforce the message of the importance of correct fitting.

Respirator selection, realistic expectations and managing fit test failures

Although modern tight-fitting respirators can have excellent fitting characteristics, no single tight-fitting respirator will likely fit all workers in a large population. Management of both wearer and employer expectations is important in implementing and managing a fit testing program. A failed fit test should not affect the employment status of the wearer.

So, be prepared for some level of fit test failure – whether that be a repeat fit test to correct poor fit or an alternative respirator size, model or even type.

If you do have a fit test failure, then the following is recommended:

1. At the end of a failed fit test, and without the wearer removing the respirator – inspect for any obvious signs or poor fit. It may be useful to ask the wearer to repeat the exercise when the fit test failed as this may help show any poor fitting.
   - If poor fitting has been identified – attempt to correct the fit, conduct a wearer seal check and if this passes, then repeat the fit test
   - If poor fitting cannot be identified – ask the wearer to remove the respirator, and then refit. Inspect for signs of poor fitting – correct as required. If using a quantitative fit test method, check the function of the test equipment and the probing of the respirator. Conduct a wearer seal check and if this passes, then repeat the fit test.
2. If a second fit test failure has occurred after attempting to correct poor fitting, then an alternative respirator size, model or type should be selected. Repeat the fit testing procedure (as required) with the new respirator.

Note: if conducting qualitative fit testing, the wearer must repeat the sensitivity test for each fit test having allowed sufficient time for the taste from the previous test to have dissipated.

"The short time each RPD wearer is taken away from the production environment for a fit test is not just an opportunity to conduct the actual fit test, it is also a unique opportunity for training and assessing behavioural safety"

"Although modern tight-fitting respirators can have excellent fitting characteristics, no single tight-fitting respirator will likely fit all workers in a large population.

1st Choice:
flat-fold disposable respirator

fits large-medium face shapes

fits medium-small face shapes

2nd Choice:
cup-shaped disposable respirator

3rd Choice:
Half-mask (available in 3 sizes)
with P3 filters

Whenever you conduct fit testing, there must be prior agreement between the employer and the fit tester on what the first-choice respirator is and a range of alternatives. These respirators must be available for fit testing and for use in the workplace. This may mean that more products will need to be purchased and managed as a result of fit testing.

In the example above, if a failure is experienced on the first-choice disposable respirator, then the next choice might be a different shape of disposable respirator. If failures occur on this respirator, then it might be appropriate to use a half-mask and filters – particularly as these are typically available in range of sizes.

It is important to note that a fit test is respirator-wearer specific. A change in the respirator, e.g. from one model of disposable to another model of disposable, even though they may be of the same class, e.g. P2, does require another fit test.

Method selection

Page 4 details what types of respirator can be fit tested by what method. For products where either method can be used, the selection process often comes down to perceptions of the method, personal experience and the ability/desire to conduct the fit testing in-house or use an external specialist (see below). A summary of the key points of each of the main methods are below:

	Qualitative Bitrex® / Saccharine taste	Quantitative Ambient Particle Counter	Qualitative Controlled Negative Pressure
Initial cost	Low	High	High
Fit tester	Typically in-house (H&S officer or company nurse)	Typically external specialist	Typically external specialist
Method	Subjective	Objective	Objective
Products	Disposable facepieces and half-masks	All types	Half face and full face
Perception	Basic/old-fashioned	Modern/scientific	Modern/scientific
Wearer seal check assistance	No	Yes (Real-Time Mode)	Yes
Validity	Valid method	Valid method	Valid method

In-house vs out-sourced fit testing

The choice as to whether to use an in-house fit tester (commonly a member of the company health and safety team or company nurse) or employ an external fit testing company is complex. Factors to consider include:

- Available resources and competencies: do you have personnel who are competent and have spare time to deliver in-house fit testing?
- Number of wearers to be fit tested
- Types of respirator to be fit tested
- Are you initiating a program (for example fit testing 500 wearers for the first time) or is there a continuous need (several new hires/contractors each week)?
- Is there funding available to invest in a QLFT kit, TSI® PortaCount® or OHD® Quantifit®, or pay for an external company to fit test your wearers?
- Is there a particular deadline that you must achieve?

Who can conduct a fit test?

In theory, anybody can conduct a fit test - provided they are competent to do so. Unfortunately, fit testing is often conducted by people with little or no training or practical experience. The result of a fit test can be greatly influenced by competency of the fit tester and if a fit test is not conducted correctly, the health of the respirator wearer may be put at risk.

AS/NZS 1715[17] does not provide any guidance on the knowledge or competence a fit test operator should have. Hence we reccomended referring to ISO 16975-3[4] which does describe in detail the knowledge requirements a fit test operator should have. Fit-test operators should have adequate knowledge, understanding and practical skills required to conduct a fit test. Fit-test operators should be familiar with AS/NZS 1715[17], ISO 16975-3[4] and other relevant protocols being used by the fit test operator. They should also be familiar with the appropriate sections of the RPD program concerning RPD fit testing, purpose and applicability, specific roles and responsibilities, interference concerns, inspection, cleaning, maintenance and storage in AS/NZS 1715[17].

Fit test competency is gained from a mixture of training and practical experience. Fit testing under supervision and mentoring are invaluable in gaining competence.

ISO 16975-3[4]: To be competent the fit tester should have adequate knowledge, and have received adequate instruction and training in the following areas:

1. selection of adequate and suitable RPD;
2. examination of RPD and the ability to identify poorly maintained facepieces;
3. ability to correctly fit a facepiece and perform pre-use fit checks;
4. ability to recognise a poor fitting facepiece;
5. the purpose and applicability of fit testing; the differences between, and the appropriate use of, quantitative and qualitative fit testing methods;
6. the purpose of the fit test exercises;
7. preparation of facepieces for fit testing;
8. how to carry out diagnostic checks on the facepiece and the fit test equipment;
9. capabilities and limitations of the fit test equipment;
10. how to perform a correct fit test with the chosen method;
11. be aware of and know how to prevent and correct problems during fit testing;
12. interpretation of fit test results;
13. an understanding of the differences between fit factor, workplace protection factor, assigned protection factor and minimum required protection factors;

ISO 16975-3[4] also states that fit testers should be properly trained and demonstrate a proficiency in the fit-test method(s) being used. The standard goes on to list in some detail the required competencies of the fit tester around general RPD knowledge used for the fit test, knowledge of the fit test method, ability to set up and monitor the function of the equipment used, ability to conduct the fit test and the ability of the fit tester to identify the likely cause of a fit test failure.

Program management

Fit testing is more than just a one-off fit test of your wearers with their current respirators. Employees leave and are hired, respirator types, makes and models may change over time, wearers themselves age and their faces change. Furthermore, implementing a fit testing program will likely affect the type, model and number of respirator purchased, impacting both purchasing and stores within your organisation. The benefits of enhanced wearer protection may likely need to be explained to other stakeholders in the organisation. Fit testing should be an established part and a continuous consideration of your respiratory protection and general health and safety policies:

- Plan – determine your policy, plan for implementation, communicate roles and responsibilities for all involved
- Do – implement the fit testing plan
- Check – measure the performance of the program and impact on purchasing and production
- Act – review performance of the program (implementation and products used) and act upon improvement actions.

It is important to stress that following a successful fit test, the wearer should be instructed that they must wear the exact respirator model as they wore during the fit test and that they fit it as instructed on every occasion. Passing a fit test does not mean that the wearer will obtain a good fit every time unless they follow the donning and wearer seal checking procedures.

Benefits of fit testing

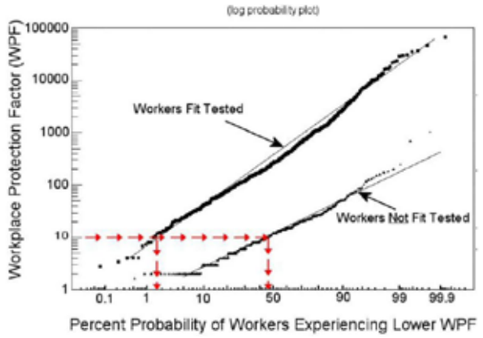
There are many benefits of implementing a fit testing program.

Fit testing provides a unique opportunity for one-to-one training for wearers covering topics as diverse as respirator use and limitations, workplace hazards, donning techniques and compatibility with other items of PPE (which should be part of the fit test).

Fit testing is recognised as best practice. Studies have demonstrated that when fit testing is performed the work place protection provided to the respirator wearer is increased. However, studies struggled to prove a direct correlation between Fit Factors (FF) (resulting from a fit test) and Workplace Protection Factors (WPFs).

- The best correlations between WPFs and FFs have been found where respirators are poor fitting. However, as it is unethical to expose wearers that knowingly have failed a respiratory fit test to concentrations exceeding Workplace exposure standards (WES), it is difficult to perform expansive studies
- There are many differences between WPF studies and fit tests which introduce variability that adversely affect correlation
- Aerosol size distribution in the workplace is different than in fit test protocols and this can introduce variability
- WPF studies use gravimetric measurements, whilst the most commonly used fit testing method used in such studies (TSI® PortaCount®) employs ambient particle counting
- Fit tests are short duration tests using representative exercises that do not significantly increase subject metabolic/breathing rates. In contrast, WPF studies are conducted in the workplace, whilst subjects conduct real work activities for extended durations – the stresses and strains upon the respirator seal to the face and the metabolic/breathing rates in the workplace will be significantly more varied.

Respirator Performance with and without fit testing



Colton, CE., Filtering facepieces: Study supports need for fit-testing, 3M Job Health Highlights, Vol 17, No 2, 1999[16]

The chart above shows a probability plot of aggregated Workplace Protection Factors for 16 different studies conducted between 1984 and 1996. The results are separated as to whether or not the subjects undertook a fit test prior to the WPF study.

- 12 studies conducted fit testing upon the subjects: subjects who failed the fit test were excluded from the WPF study
- The remaining 4 studies did not conduct a fit test on the subjects prior to the WPF study: therefore all subjects were included.

The above log probability plot shows that 98 percent of the fit tested workers exceeded the minimum expected protection factor of 10 for a half face respirator (which the studies collected data on) compared to only 55 percent of non-fit tested workers. This means that only 2% of fit tested workers failed to achieve the protection level of 10, compared to 45% of the non fit tested workers.

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