Guidance on managing the choosing, fitting and using of respirators
by Dr Mark Piney (Version 1) 12ᵗʰ February 2020

1.0 Introduction: respirator facts-of-life

1. No one wears a respirator /mask for fun (unless perhaps they're going to a fancy-dress party!)
2. All respirators are more-or-less uncomfortable
3. If someone wears a respirator, they do so because they believe that airborne contaminants pose a potential health risk, **and** that the respirator provides some protection
4. Choosing to routinely wear a respirator, when the airborne risk is high, is a personal decision, made for personal reasons.

Photo 1. The respirator maybe technical capable (and approved), but it's not tight on her face, and will not be providing much protection

Managing a respirator programme at work is very different from facilitating, and encouraging, use of respirators voluntarily by members of the public.

At work a whole set of procedures can be developed and implemented, and checks agreed and put in place. The process can be formally managed, including the selection and fitting of devices, and active supervision of wearers. Outside work, the whole process relies on encouraging and facilitating voluntary behaviour. Inevitably the proportion of people following good practice outside of work will be less than an equivalent programme at work.

If staff wish to adopt good respirator practice it will have to do so via facilitation and encouragement, and communication of practical procedures and facts, in a variety of ways. To achieve widespread take-up of respirator use outside work, will require a sustained campaign.

2.0 Getting effective, reliable protection using respirators

To get effective, reliable protection from respirators they must:
1. Filter the air well, (i.e. trapping the air contaminants of concern)
2. Fit the wearer's face i.e. the respirator achieves a good seal against the wearer's face. When the device is selected, and then **every time** the device is worn,

3. Be comfortable enough so that they can be worn routinely.

In practice getting effective protection, using respirators, is as much about human motivation, behaviour, training and device selection, as it is about technical specification. Having said this, choosing from a range of devices that could potentially provide protection is important.

2.1 Technical specification   In Europe, the United States, and other countries, respirator standards for testing and approval exist[1]. There are also devices, for instance, worn by cyclists, which are not approved, but have undergone some testing,

Photo 2. This device claims to meet European standard EN 149 and US standard N95. It's not at all clear that it meets either standard

Photo 3 This device, whilst it looks good, claims to meet filter 97.5% of fine particles. It uses a replaceable filter. Most of the air breathed in will not pass through the filter. It cannot work effectively

and may provide some protection. And then there are devices that are blatantly counterfeit, and although packaged and labelled to suggest they are tested and approved, in fact provide little if any protection (see Photos 2 & 3). The company could usefully provide guidance to staff on how to identify and select respirators that may provide protection.

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[1] And similar standards may exist in China

2.2 Motivation For people to take and wear their respirator, adequately fitted against their face, with the straps correctly positioned (see Photo 1), people need to be motivated and trained. They need to believe that there is a **need** to make the effort, and that correctly wearing the respirator will protect their health i.e. that there's meaningful risk, which the respirator will protect against. Staff need to understand that air pollution represents a long-term threat to their health. And, to reduce their exposure long-term, they need to be diligent in the use of their respirators, every day the pollution value is high.

2.3 Behaviour and training When a person is motivated, with the right practical training they can get into a routine of correctly putting on the respirator. It will then provide effective protection.

2.4 Respirator fit, and face size and shape Probably the single factor that stops a respirator providing effective protection is that it doesn't fit the person's face. Anthropometry is the study and measurement of the variation of people's bodily dimensions. Clothing and shoe manufacturers use this information to provide clothes and shoes that fit for a wide variety of sizes and shapes of people. The same logic should apply to selecting a respirator. As with clothing and shoes - one size cannot, and does not, fit all. Surprisingly some respirator manufacturers still only produce one size of device. Others give somewhat greater choice and supply small, medium and large devices. Even so, the sizes and shapes in one range of devices are usually limited.

It's tempting to go for one make of device, perhaps of three different sizes, because these makes supply easier, and if you buy in bulk, a supplier will offer a larger discount. In practice to get good facial fit on a population of people, studies have shown that a variety of different devices, from different manufacturers, or different models by the same manufacturer, will be needed. There's no getting away from this anthropmometric fact of life. People's faces vary in shape and size; a lot.

2.5 Fit-testing of respirators during selection, and daily use To check that a respirator fits your face you will need to use some type of fit-test. There is one common qualitative, subjective, test, and two quantitative tests. There is also the manufacturers daily pre-use check.

2.5.1 Pre-use check
The standard qualitative test, recommended by manufacturers, involves sucking and blowing air into the respirator whilst wearing it, and noting any escape of air. And then settling the device closely against the face, to eliminate leakage routes.

2.5.2.1 Qualitative test
1. A more sophisticated test of facial fit involves exposing the wearer to aerosols which can be tasted, such as saccharin or Bitrex (link).

2.5.2.2 Quantitative tests

1. A common quantitative test used on professional respirator users, that can be done in the field, involves a test machine that measures particle numbers inside and outside the respirator. The most commonly used is the TSI Portacount (link).
2. A common laboratory set of tests involves exposing people to a fine salt (sodium chloride) aerosol, while the wearer walks and runs on a treadmill, and does other exercises.

The simplest and quickest test is to follow the manufacturer's pre-use instructions. This is something all staff using respirators could do each day. It's the least exact test. The saccharin/Bitrex and quantitative tests are more exact but take far longer. Whether they are practical on a large scale needs to be discussed and considered. For instance, the saccharin/Bitrex test could be made available for staff who wished to check the fit of their chosen respirator?

Whichever method is chosen, the person carrying out the fit-testing will need training in its use, and interpretation of the results. Once a device is known to fit a person's face he or she will still need to know how to wear, and check the fit of, the device **every time** the respirator is worn. The fit-testing exercise is also useful as an aid to training and motivation.

2.6 Wear-time
People who rely upon RPE as the main means of controlling their exposure, need to wear them all the time they are exposed. This may seem an obvious statement but many people are not aware of the rapid fall off in actual protection provided if a device is taken off, even for a relatively short time.

2.7 'When' time
People also need to know when they are exposed to significant levels of airborne risk. Again, this may seem an obvious point, but airborne contaminants are often not visible, and do not smell.

2.8 Filter material
Filters vary in their ability to trap fine airborne particles. Filters and filter material are made to three standards based on their ability to remove 0.3 um particles. While the standards are important, to get effective protection day-to-day, fit and comfort are critical.

2.9 Filter, and device life
Apart from the filtering capabilities of filter material, another factor, which matters to the user is how long the filter will last i.e. how much capacity does it have to trap particles. Almost all airborne particles carry an electrostatic electric charge. Most, perhaps all, disposable (filtering facepiece – FFP) respirator filter material nowadays, uses the charge on the particles to trap them. The electrostatic material contains charged "electret" (link) groups that attract and trap airborne particles. Once the electret charges are nearly used-up, the filtration effectiveness of the material falls. What the user needs to know is when this will happen. Knowledgeable manufacturers should be able to estimate the approximate lifetime of a respirator or filter if they have reasonable information about the airborne particle challenge.

Some suppliers suggest that filtering facepiece (FFP) devices should only be used once, and then thrown away[2]. Whether this is necessary will depend on the filter challenge. For low air pollution FFP devices can be reused over several days. The question, to the manufacturer, is how many?

And there's two device lifetime issues to consider. How long will the respirator (mask) physically last, and how to keep it clean? Ideally the respirator is stored in a container that protects it. But it's possible that it is kept in a pocket or mixed with other things in a bag. This will limit the devices lifetime, before it gets damaged beyond use.

If a device is to be re-used it needs to be kept clean. Soft wet-wipe type tissues can be used to surface clean FFP devices, but there's a limit to how many times a respirator can be cleaned and re-used. In most instances the limit is probably set by the physical integrity and cleanliness of the respirator, and not its continuing capacity to trap airborne particles. Finally, for hygiene reasons masks (respirators) should only be used by one person.

3.0 Concluding remarks

There is a tendency when choosing and using respirators to focus on a device's technical specification, and believe that the higher the claimed filter effectiveness, the better. In reality while technical specification has its place, unless the device fits well, and is comfortable it will not provide good protection.

And there's three other very human issues that have to be faced:

1. The person wearing a respirator has to believe that there's a need to do so,
2. And, that the device will protect them if they wear it
3. And, others in their peer group or family also wear respirators when the potential airborne risk is high

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[2] In Europe disposable (FFP) type devices have been labelled R (reuseable) and NR (non-reusable) products. Non-reusable means dispose of after a day's use. The R rated products (reusable) have to undergo additional penetration testing after loading and storage, and users have to be given a method of cleaning the product.