



Respiratory Protective Equipment (RPE) Standard – Disposable Filtering Half Mask on N95, FFP2 and KN95

Baderin Osman¹, A.M Leman^{2*}, K.A Rahman³, Nik Normunira Mat Hasan², Ng Goot Seong², M.Syafiq Muzarpar², Salwa Mohamad² Halah Mohamad¹

¹National Institute of Occupational Safety and Health (NIOSH), Lot 1, Jalan 15/1, Seksyen 15, 43650 Bandar Baru Bangi, Selangor, MALAYSIA

²Oil and Gas Research Group (OGRG), Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, KM 1 Jalan Panchor 84600, Muar, Johor, MALAYSIA

³Department of Petrochemical, Politeknik Tun Syed Nasir Syed Ismail (PTSN), KM 1 Jalan Panchor 84600, Muar, Johor, MALAYSIA

*Corresponding Author

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Abstract: Workplace and work activities issued many harmful substances that contaminating the air. Therefore, the employer needs to select a standard disposable filtering half mask for the workers in order to prevent them from harmful substance. This study presents current literature search of RPE standard in certain countries such as United States (US), United Kingdom (UK) and China. The selection of the standard disposable filtering half masks has to guide by Assigned Protection Factor (APF) according to working condition activity. The APF includes the suitability factor such as effectiveness towards particle and gas/vapour, continuous wear time and APF types (4, 10, 20, 40, 200, and 2000).

Keywords: Occupational Safety and Health (OSH), Respiratory Protective Equipment (RPE), Disposable Filtering Half Mask, N95, FFP2, KN95

1. Introduction

Many workers wear respirators or breathing apparatus to protect their health at the workplace. These devices are collectively known as respiratory protective equipment (RPE). Respirators filter the air to remove harmful substances and breathing apparatus (BA) provides clean air for the worker to breathe^[1]. The RPE is strictly need in workplace and work activities due to issues of some harmful substance from solid, liquid, vapour or gas that contaminating the air in form of mist, vapour, dust, gas or fume. Table 1 show the types of substances that formed in the workplace (Chen, H., Yang, C., & Lin, M., 2012). Example of workplace that may issue mentioned harmful substances are when workers handling dust powder, cutting a material such as stone and wood, welding process, workplace that containing the volatile solvent (Alghamri, A. A., 2012, Damalas, C. A., & Abdollahzadeh, G., 2016 and Zou, Z., & Yao, M., 2015)

Wi, A., Krzemie, A., & Sánchez, F.(2018) was mentioned; generally RPE is divided into three types which suit a variety of work situations, protect the wearers from various hazards and match the specific requirements of the wearers.

Table 1 - Types of substance that formed in the workplace (Health and Safety Executive, 2013)

Form	Properties	Sample of substance
Solid particle	Particle in solid material, including aerosol, dust, smoke, fibre and fume	Smoke, welding fume, wood dust, engine exhaust, asbestos dust and flour
Liquid particle	Mist, fine spray and aerosol that made a small droplet of liquid	Pesticide, paints, liquid jetting and powder coating mix
Vapour	Gaseous forms from solid and liquid	Mercury and solvent vapour
Gas	-	Engine exhaust gases, carbon monoxide, chlorine and sewer gas.

There are two types of RPE that are commonly used in the workplace, either filtering devices or breathing apparatus device as shown in Figure 1.

1.1 Filtering Device Types (Negative Respirators)

A range of different types exist such as disposable filtering half mask, half mask respirators, full face mask respirators and powered (fan assisted) respirators. These use filters to remove the contaminants in the workplace air. In a negative pressure device, one or more air purifying filters are attached via an inhalation valve to a tight-fitting face piece.

The negative pressure relative to the ambient air outside the respirator is created by inhalation of air, drawing the contaminated air through the purifying filter (Health and Safety Authority, 2010).

1.2 Breathing Apparatus (BA) Types (Positive Respirators)

A range of different types exist which are fresh air hose, airline, and demand valve; use an independent supply of breathing quality air, for example, an air cylinder or compressor. Powered air purifying respirators, supplied air and self-containing breathing apparatus are all positive pressure devices. The pressure on the inside of the respiratory inlet exceeds the ambient air pressure outside the respirator. As a general rule, positive pressure devices are used for more hazardous exposures (Health and Safety Authority, 2010).

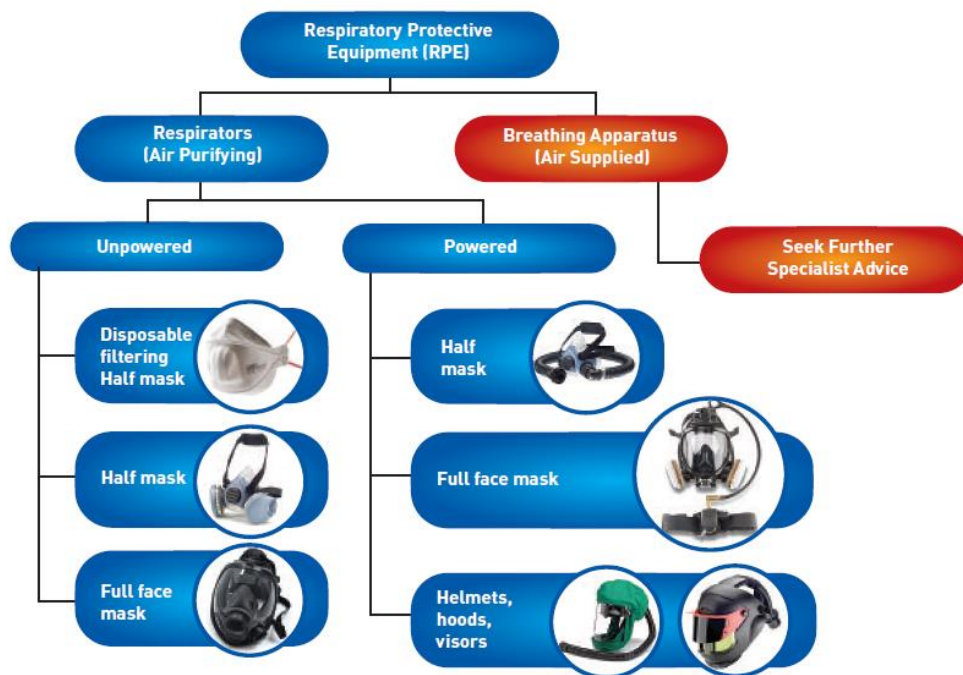


Fig. 1 - Respirator and Breathing Apparatus Types (Health and Safety Authority, 2010).

2. Disposable Filtering Half Mask

Disposable filtering half masks are designed to reduce inhalation exposure to particulate contaminants including dust, mist and fume. Generally, these masks are applied to decrease exposure to particulates such as wood dust, animal dander and pollen produced by the industry. Also, there were healthcare facilities that have been using these devices as part of infection control program. In this context, healthcare workers wear them as protection when dealing with aerosolized droplets released from sick patients (UC Santa Cruz., 2019).

2.1 Disposable Filtering Half Mask Standard in the US, UK and China

According to Occupational Safety and Health Administration, N95, FFP2 and are equivalent to each other (UC Santa Cruz., 2019). Centers for Disease Control and Prevention (CDC) stated KN95 masks which are commonly made in China are similar to N95 masks that frequently used in the United States (CDC.,2021). This in lines with Health and Safety Executive (HSE), where the performance rating under Chinese and European standard facemasks are broadly the same although there is no independent certification or assurance of their quality and products manufactured to KN95 rating are declared as compliant by the manufacturer (Health and Safety Executive.,2020). CDC also reminds public to not wear counterfeit (fake) KN95 masks as about 60% KN95 masks in the US are counterfeit and do not meet NIOSH requirements (CDC., 2021). Meanwhile, in the UK, personal protective equipment (PPE) without CE marked cannot be sold or supplied. Thus, KN95 must not be worn as PPE at work unless their supply has been agreed by HSE as the Market Surveillance Authority (Health and Safety Executive.,2020).

Table 2 - N95, FFP2 and KN95

Disposable filtering half mask	N95 (US)	FFP2 (UK)	KN95 (China)
Standard	NIOSH-42CFR84	BSEN149:2001+A1:2009	GB2626:2006

In the US, National Institute for Occupational Safety and Health (NIOSH) approves respirator and classifies particulate respirators into one of three main classes, which are N (not resistant to oil), R (somewhat resistant to oil) and P (oil proof). NIOSH ratings are applied with particulate filtration efficiencies of 95%, 99% and 99.97%. N95 masks are commonly used to help reduce exposure from non-oily particulates, such as air pollution particulates (3M Personal Safety Division. , 2014).

The European standard classifies filtering into three classes: FFP1, FFP2 and FFP3 with corresponding minimum filtration efficiencies of 80%, 94% and 99%, respectively (Lee, S. A. et al., 2016). In spite of the fact that N95s are not tested and approved for use in oil-based applications, but FFP2 were used (Health and Safety Executive.,2021).








In the Chinese standard, there are two classes of particulate respirators: KN and KP classes. KN class respirators only filter non-oily particles, such as dust, mist and microorganisms. KP class filter respirators can be used for oily and non-oily particulates. Both KN and KP classes available with several filtration efficiencies: 90%, 95% and 99.97% efficiency (3M Personal Safety Division.,2014).

As for APF, N95 and FFP2 have comparable APF of 10 (Health and Safety Executive.,2021). APF is the minimum expected workplace level of respiratory protection that would be provided by a properly functioning respirator, to a stated percentage of properly fitted and trained users. To define the overall protection that a certain type of respirator could afforded is by determining the ratio of the concentration of contaminant outside a face mask or hood to that inside the mask while in a contaminated atmosphere. For example, if a half-mask respirator has a protection factor of 10, it may provide adequate protection in atmosphere where the contaminant concentration is up to 10 times the permissible exposure limit (PEL) for that specific contaminant ^[8].

3. Effectiveness of RPE

The hazardous substance has been identified and also the types of RPE to protect the worker from that substances. There are several assigned protection factor (APF) that support the selection process of RPE, which provide the workers with an adequate protection. Table 2 shows the listing of RPE suitability in order to select the device for an appropriate work place and working environment.

Table 2 - Suitability of RPE devices ^[1]

Suitability		RPE						
								
		Disposable half mask – particle filter*	Reusable half mask – particle filter	Reusable half mask – gas/vapour filter	Full face mask – particle filter	Full face mask – gas/vapour filter	Powered mask	Powered hoods/helmet
Effective for Particle		√	√	x	√	x	√	√
Effective for gas/vapour		x	x	√	x	√	√	√
Continuous wear time		< 1 hr	< 1 hr	< 1 hr	< 1 hr	< 1 hr	> 1 hr	> 1 hr
APF4 types		√	√	x	√	x	x	x
APF10 types		√	√	√	√	x	√	√
APF20 types		√	√	x	x	√	√	√
APF40 types		x	x	x	√	x	√	√
APF200 types		x	x	x	x	x	x	x
APF2000 types		x	x	x	x	x	x	x

4. Discussion

Based on the result in Table 2, it show that not all type of RPE is suitable for all substances. For example Reusable half mask – gas/ vapour filter and Full face mask – gas/vapour filter is not suitable for particle. Other than that, the Disposable half mask – particle filter*, Reusable half mask – particle filter and Full face mask – particle filter is not suitable for gas or vapour. The application of the RPE must take into consideration of substances and also the wear time should be monitored by referring to their continuous wear time. In this study, it show that only 2 of the RPEis suitable for continuous waer time more than 1 hour (Powered mask and Powered hoods/helmet). On the other only a certain RPE is suitable of APF 4 types and APF 40 types. Meanwhile there has no RPE is suitable for APF 200 and APF 2000.

The employer and their respective safety and health personnel including the Safety and health officer (SHO) should realize what are the types of substance in their workplace and also the emerging air pollution comes from the work station of from outdoor. This is important to select the suitable and proper attention to the workers protection and moreover to the health condition of the employees.

5. Conclusion

There are two types of RPE, which are filtering device types and breathing apparatus (BA) types. Disposable filtering half masks fall under filtering device types, where respirators filter the air to remove harmful substances. Although different countries comply to different standards, but most of the respirators serve the same purposes and functions. Other than that, the selection of the RPE should be guided by APF in order for the employers decide an appropriate RPE with adequate protection.

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