

Guide to implementing an effective respiratory protective device programme

ICS 13.340.30

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PH/4, Respiratory protection, upon which the following bodies were represented:

- Association of Consulting Engineers
- British Compressed Air Society
- British Fluid Power Association
- British Occupational Hygiene Society
- British Safety Industry Federation
- Chemical Industries Association
- Chief and Assistant Chief Fire Officers Association
- Fire Brigades Union
- Health and Safety Executive
- Home Office
- Institution of Fire Engineers
- Institution of Mechanical Engineers
- Ministry of Defence
- Safety Equipment Association
- TES (Bretby Limited)
- Thermal Insulation Contractors Association
- UK Steel Association

The following bodies were also represented in the drafting of the standard, through sub-committees and panels:

- AEA Technology
- Construction Plant-Hire Association
- Imperial College of Science and Technology
- International Marine Contractors Association

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Foreword

This British Standard has been prepared under the direction of Technical Committee PH/4. It supersedes BS 4275:1974 which is withdrawn. At the time of publication of this British Standard, no equivalent international standard exists. However, relevant information is contained in CEN/CR 529:1993.

The general recommendations given in this standard have been developed in the light of present knowledge concerning the levels of respiratory protection which can realistically be achieved in workplaces by wearers given reasonable training and supervision. The levels of respiratory protection assigned to the different classes of device in this standard therefore differ substantially from the nominal protection factors in the previous edition of this standard, in CEN/CR 529, or in guidance such as that previously published by the Health and Safety Executive.

A respiratory protective device cannot simply be issued to a wearer on the assumption that it will automatically provide the level of protection assessed in this standard. It should be presented as part of a respiratory protective programme which covers hazard identification, risk assessment, risk control, respiratory protective device selection, fit, training, maintenance, storage and medical surveillance.

The purpose of this standard is to offer guidance for setting up, operating and administering an effective respiratory protective programme involving respiratory protective devices. The attitude of employers and employees is vital in promoting the effective use of respiratory protective devices in the workplace.

Devices purchased after 30 June 1995 will carry the CE Mark. All devices that have been approved by the Health and Safety Executive (HSE) or are claimed by the manufacturer to conform to a standard approved by HSE, which have been in the possession of the user before 30 June 1995 can be used at work beyond that date for as long as they provide adequate protection in the light of the performance levels recommended in this standard, and are maintained in good condition.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 59 and a back cover.

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1 Scope

This British Standard gives guidance on implementing effective respiratory protective device programmes intended to protect against either non respirable atmospheres or atmospheres containing airborne materials at concentrations which could constitute a threat to health, safety or welfare.

This British Standard is applicable to some respiratory protective devices which are intended solely for escape. It does not give complete guidance on such devices, but the principles of selection, use and maintenance described are generally applicable.

This British Standard is applicable to some highly specialized respiratory protective devices, such as closed-circuit oxygen equipment and air line suits for protection against chemical or radiological risks. Protection against biological risks is covered briefly. This British Standard is not applicable to equipment for underwater use.

The guidance given in this British Standard extends to other items of personal protective equipment worn with respiratory protective devices where interactions might either reduce the protection afforded, or interact to create heat strain. Examples of equipment which could interact with respiratory protective devices are ear, eye or head protection; interaction to create heat strain could occur with protective clothing.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 57. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on page 58, but reference should be made to the latest editions.

3 Definitions and nomenclature

For the purposes of this British Standard the definitions and illustrated nomenclature given in BS EN 132 and BS EN 134 respectively apply, together with the following.

NOTE 1 The term “fume” excludes gases or vapours.

NOTE 2 The term “facepiece” includes full, half and quarter masks, mouthpiece assemblies, filtering facepieces, semi-hoods, hoods, semi-blouses, blouses and suits.

3.1

assigned protection factor (APF)

level of respiratory protection that can realistically be expected to be achieved in the workplace by 95 % of adequately trained and supervised wearers using a properly functioning and correctly fitted respiratory protective device

3.2

workplace protection factor

measure of the protection provided in the workplace by a properly selected, fit tested, correctly maintained and functioning respiratory protective device when correctly worn and used

3.3

nominal protection factor

maximum percentage inward leakage permitted for a given standard class of respiratory protective device, expressed as the ratio:

$$\frac{100}{\% \text{ allowable inward leakage}}$$

3.4

atmosphere immediately dangerous to life and health (IDLH)

for the purposes of respiratory protective device selection only, the maximum concentration to which an unprotected person could be exposed in the event of device failure, without affecting their ability to escape or causing irreversible health effects

NOTE 1 If the advisory limit were exceeded, unprotected people would probably not escape unscathed from the exposure.

NOTE 2 The figure can be estimated from toxicity data or from USA DHSS NIOSH Publication No. 90-117 [1] in conjunction with The Control of Substances Hazardous to Health Regulations 1994 (COSHH) [2] assessment of the work.

3.5

emergency breathing facility (EBF)

means of providing the wearer with an adequate level of protection for a sufficient period to enable the wearer to exit the work area, unassisted, to a place of safety, without unacceptable risk

the emergency breathing facility may either be fitted with P3, Gas or GasXP3 filters or supply breathable gas as required for the given environment

NOTE 1 The letter "X" in "GasXP3" symbolizes the classification of the gas filter.

NOTE 2 Each of these alternatives are used in special situations following risk assessment.

3.6

loose fitting facepiece

facepiece designed to form a partial seal with the face, e.g. visors, helmets, hoods, semi-blouses, blouses and full suits

loose fitting facepieces rely on the flow of breathable gas to prevent the ingress of contamination into the facepiece

3.7

tight fitting facepiece

facepiece designed to form a complete seal with the breathing zone or face

includes mouthpieces and quarter, half and full face masks

3.8

semi-hood

loose fitting facepiece, to which air is supplied, that encloses the whole face and is fitted to the face and crown of the head by means of flexible seals

semi-hoods include air fed or ventilated visors

3.9

semi-blouse

garment which resembles a blouse except that it covers the head and upper parts of the body but does not extend as far down the body as a blouse, and which ties or seals at the waist and/or lower arms

semi-blouses include hoods with capes and sleeveless blouses

3.10

competent person

individual who has such practical and theoretical knowledge and actual experience of the type of work, plant or equipment which has to be examined or maintained as will enable him or her to detect defects or weaknesses

NOTE In certain situations practical and theoretical knowledge requires ratification and support by formal validation.

4 Overall protective programme

Where an inhalation hazard exists in a workplace, it is important to assess whether a risk from such a hazard can be controlled other than by the provision of respiratory protective devices. Elements which should be considered in this risk assessment are shown in Figure 1. Where unacceptable inhalation risks in the workplace are identified, the following approaches should be used to prevent or reduce exposure other than by the use of respiratory protective devices. These approaches are shown in order of preferred priority; preventions are listed a) to c) and controls listed d) to k).

NOTE This approach is in line with The Control of Substances Hazardous to Health Regulations 1994 [2].

- a) The use of alternative substances which are less hazardous.
- b) The substitution of a given substance in a form that is less hazardous, e.g. replacing a fine powder by a coarser powder, pellets, or by a solution.
- c) The substitution of a process by an alternative process likely to generate lower airborne concentrations of substances.
- d) Total or partially enclosed process and handling systems.
- e) Partial enclosure with local exhaust ventilation.
- f) Local exhaust ventilation.
- g) General ventilation.
- h) Reducing period of exposure.
- i) The introduction of appropriate working practices and systems of work, e.g. to close and store containers securely when not in use.
- j) Use of monitors and warning devices to give a clear indication when unsafe airborne concentrations are present.
- k) Good housekeeping.
- l) Provision of a respiratory protective device programme (see 8.2).

All the steps given in a) to l) for preventing or reducing inhalation risks should be thoroughly evaluated, because in many work situations no single step provides adequate reduction of risk. However, the combination of two or more steps may achieve the required reduction of risk.

The provisions of this standard apply both during and after the implementation of all reasonably practicable steps to eliminate or adequately control the foreseeable inhalation risk by means other than by the use of respiratory protective devices.

It should be appreciated that a higher level of respiratory protection may be required while control measures are being implemented. Consequently, it is essential that, where respiratory protective devices are used, the importance of correct training and supervision of the wearers is stressed. This should ensure that the higher levels of respiratory protection required are reliably obtained.

If elimination or control of risks cannot achieve a safe and healthy workplace, assessment is required of the residual inhalation or skin uptake risks. This allows the determination of which respiratory protective devices are required and the extent of the respiratory protective programme. This assessment should cover both on-going routine process, any potential exposures which could occur during routine or emergency maintenance operations and the potential consequences of plant or process failure.

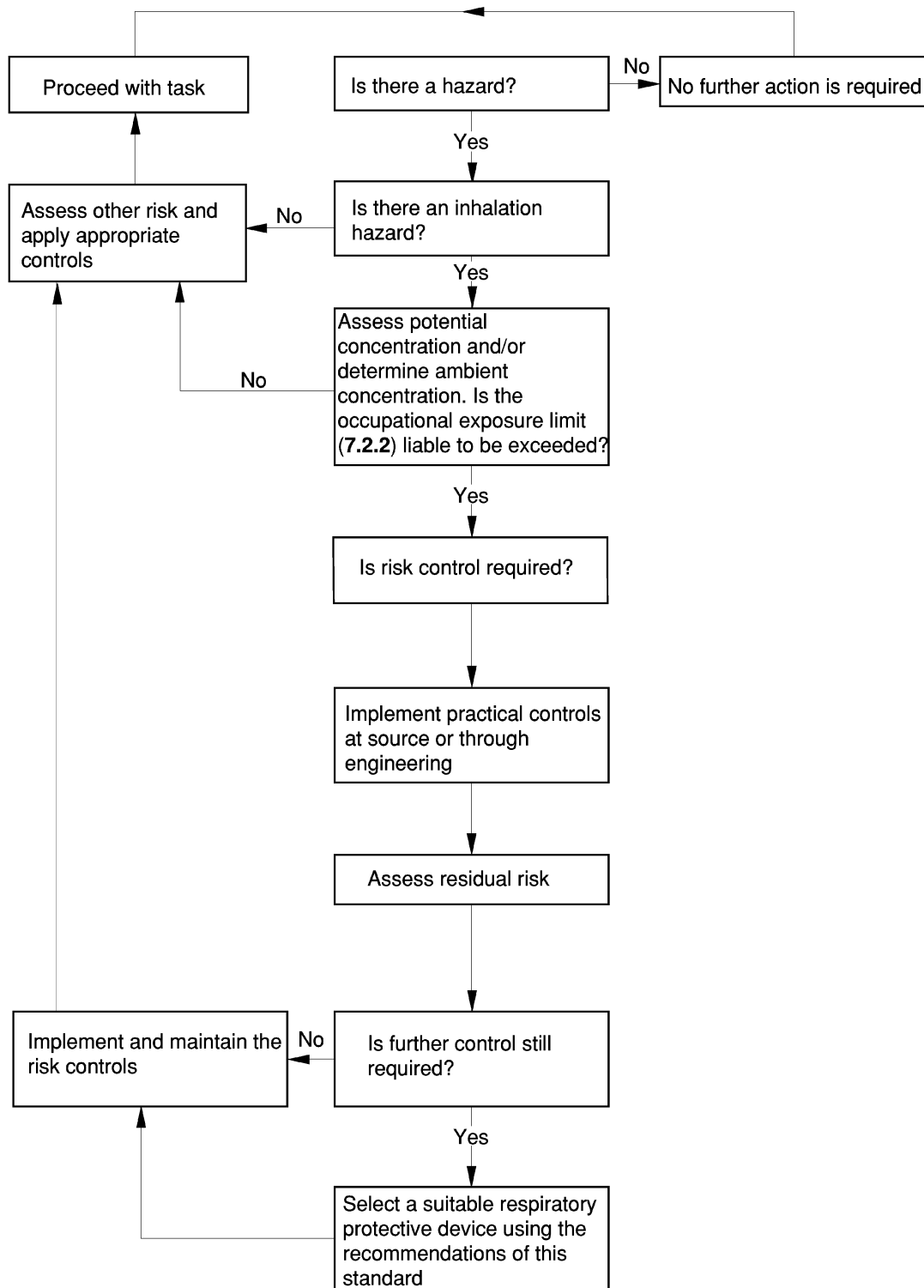


Figure 1 — Elements to be considered in a risk assessment

5 Types of respiratory protective devices

5.1 General

An environment may be contaminated by any combination of particles, droplets, gases or vapours. There may also be insufficient oxygen to support life.

There are two distinctly different methods of providing personal respiratory protection against contaminated atmospheres:

- a) by purifying the air breathed, using filters which remove harmful substances by filtering or cleaning the air. Devices that achieve this are known as filtering devices (commonly called “respirators” in the UK); or
- b) by supplying the wearer with air or oxygen from an uncontaminated source. Devices that achieve this are known as breathing apparatus.

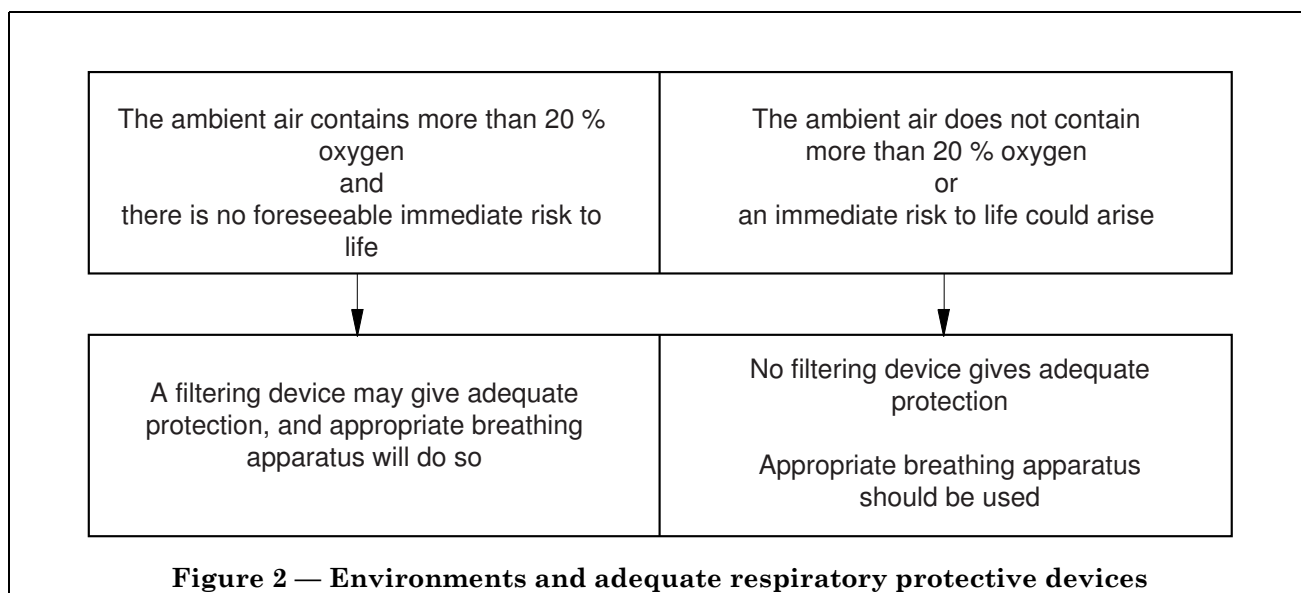
The type and class of respiratory protective devices which have the potential to provide adequate protection in any given environment depends on the nature of the hazard and the degree of risk.

The environments in which the two major types of respiratory protective devices are appropriate are given in Figure 2.

Filtering devices do not supply oxygen. They should not be used unless it is known that the ambient air contains at least 20 % oxygen, and should not be used in IDLH environments.

Both filtering devices and breathing apparatus consist of two main components: a means of providing breathing gas and a facepiece which directs the breathing gas to the wearers breathing zone. In some devices, the facepiece can seal to the wearer’s face to prevent contaminated air from entering the breathing zone.

Types of facepiece (loose and tight fitting) are defined in clause 3. Not all combinations of device and facepiece are satisfactory. A range of combinations is available from manufacturers, whose instructions on the acceptability of combinations should be strictly followed.



5.2 Filtering devices

5.2.1 *General*

Filtering devices include two major components: a filter which removes airborne contaminants and a facepiece which conveys filtered air to the wearer's breathing zone and which prevents contaminants from the environment getting into the breathing zone.

Filters can be for removing particles only, (particle filters); for removing gases and vapours only (gas filters); or for removing both particles and gases or vapours (combined filters).

For a description of specific filtering devices, see Annex A.

5.2.2 *Facepieces*

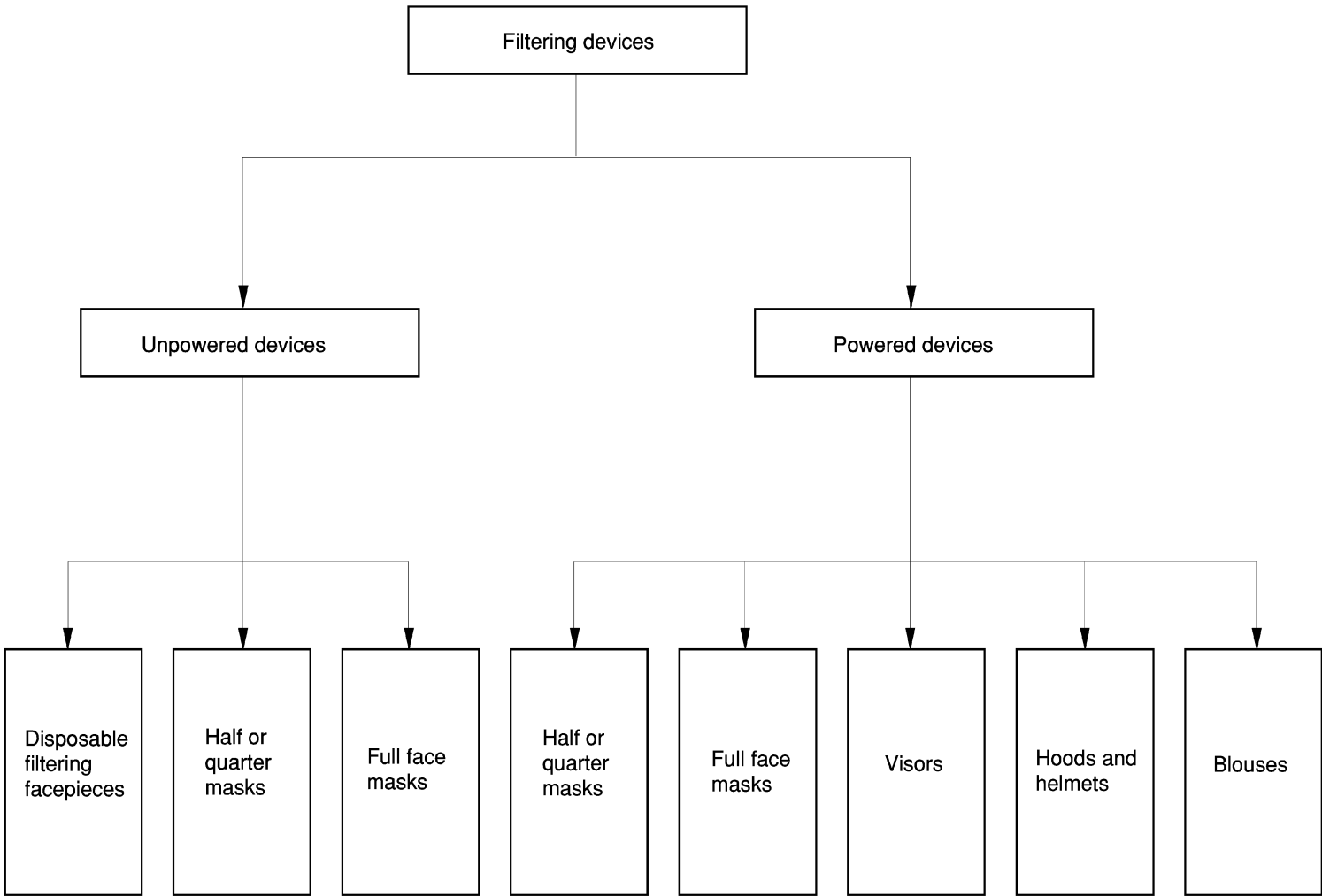
Unpowered filtering devices (see Figure 3) can only function properly if a tight fitting facepiece is used.

Powered filtering devices (see Figure 3) are divided into two categories which are power assisted devices and powered devices.

Power assisted devices should have tight fitting facepieces. Thus in the case of a high airflow demand by the user, the pressure inside the facepiece can, in principle, become negative.

NOTE The common description "positive pressure powered respirator" is therefore somewhat misleading.

Powered devices have loose fitting facepieces and rely for their effectiveness on the constant flow of air, which should be above a minimum stated by the manufacturer, and on the degree of restriction to ingress of contamination offered by the loose closures such as ties, cuffs and wrist seals.



NOTE 1 Each type of filtering device is available in three performance classifications, see Table 1.

NOTE 2 For each type of filtering device, the following types of filter may be available:

a) for particulate materials only; b) for certain gases and vapours only; c) combination types for particulates and some gases and vapours.

Figure 3 — Types of filtering devices

5.2.3 Particle filters

Particle filters are divided into filters for use against solid aerosols and filters for use against solid and liquid aerosols. Both types are classified according to their minimum filter efficiency. For disposable-type filtering facepieces, the filter is integral to the facepiece and therefore the complete device is given a single efficiency classification. See Table 1.

Table 1 — Classification of particle filters

Type of device and relevant standard	Efficiency ¹	Marking	
Unpowered BS EN 143	Low efficiency Medium efficiency High efficiency	P1 P2 P3	S ²
Disposable filtering facepiece BS EN 149	Low efficiency Medium efficiency High efficiency	FFP1 FFP2 FFP3	S or SL ³
Powered prEN 12941 or prEN 12942	Low efficiency Medium efficiency High efficiency	TH1P or TM1P TH2P or TM2P TH3P or TM3P	S or SL ³
Valveless filtering half masks prEN 1827	Low efficiency Medium efficiency High efficiency	FMP1 FMP2 FMP3	S or SL ³
¹ Efficiency is a qualitative term and filters for different types of devices will not have an equivalent performance. Filters have been classified by performance according to the reference standards. ² Filters not suitable for liquid aerosols are marked "For use against solid aerosols only" or "S". ³ "S" denotes use against solid aerosols only. "SL" denotes use against solid and liquid aerosols.			

5.2.4 Gas filters

Gas filters are specific to the substance or class of substance for which the filters are intended by the manufacturer, and are classified accordingly, e.g. "A" for use against organic compounds with boiling points >65 °C.

The substances against which gas filters and combined filters are intended to provide protection in air filtering devices, and the standards which specify their performance and characteristics are shown in Table 2.

For filtering half-masks, the gas filter code is prefixed with "FF" in the case of devices conforming to BS EN 405 and "FM" for devices conforming to prEN 1827.

Gas filters are coloured in accordance with the classes of substance against which they are intended to provide protection.

The breathing resistance of a given type of gas filter generally increases with capacity, and the breathing resistance of a combined filter is generally higher than that of either the equivalent gas only, or particulate only, filters.

The capacity of a gas filter can vary with both the concentration and nature of the airborne contaminant, and can be lower in high ambient temperatures and/or high relative humidities. The safe duration of use of a gas filter is therefore also affected by these factors. Since the total volume of air drawn through the filter in an unpowered device increases with increasing work rate, the safe duration of use of a gas filter in such devices therefore decreases with increasing workrate.

In addition, if a gas filter which has collected a certain contaminant and is subsequently exposed to a different contaminant which has a greater affinity for the filter medium, the previous contaminant can be released from the filter. Release of contaminant may be of particular importance where the filter is used against several different contaminants. A similar effect can also occur for certain contaminants if the relative humidity increases substantially over the period of use, the filter medium having a greater affinity for water vapour than some contaminants. However, a class 3 filter will last longer than a class 2 filter, and a class 2 filter will last longer than a class 1 filter of the same type in any given environment. If a user finds that they are not obtaining an acceptable lifetime from the filter they should consider using a filter of the same type but of a higher class.

It is therefore not possible to give accurate general guidance regarding the safe duration of gas filters. Users of such filters should obtain the maximum possible information regarding the nature and concentrations of likely gaseous contaminants in their workplace and seek guidance from the filter manufacturer or supplier.

5.2.5 Combined filters

Combined filters combine a gas filter with a particle filter. The gas filter can be combined with a P1, P2 or P3 particle filter, except for gas filters Hg and NO (see Table 2) which are always combined with P3.

Table 2 — Gas and vapour filters and combined filters and relevant standards

Substance	Filter type	Colour	Relevant standard
Organic vapours and gases with boiling points >65 °C	A	Brown	BS EN 141 prEN 12941 prEN 12942 BS EN 405 prEN 1827
Inorganic gases excluding carbon monoxide	B	Grey	BS EN 141 prEN 12941 prEN 12942 BS EN 405 prEN 1827
Sulfur dioxide and acidic gases	E	Yellow	BS EN 141 prEN 12941 prEN 12942 BS EN 405 prEN 1827
Ammonia and organic ammonia derivatives	K	Green	BS EN 141 prEN 12941 prEN 12942 BS EN 405 prEN 1827
Oxides of nitrogen	NO-P3		BS EN 141 prEN 12941 prEN 12942
Mercury	Hg-P3		BS EN 141 prEN 12941 prEN 12942
Organic vapours and gases with boiling points <65 °C	AX* FFAX FMAX	Brown	BS EN 371 BS EN 405 prEN 12941 prEN 12942 prEN 1827

Table 2 — Gas and vapour filters and combined filters and relevant standards (*concluded*)

Substance	Filter type	Colour	Relevant standard
Filter types against specific compounds	SX*		BS EN 372 BS EN 405 prEN 12941 prEN 12942 prEN 1827
NOTE 1 Gas filters and combined filters should be used only against the substances identified by the manufacturer.			
NOTE 2 Very specific use limitations apply to filters marked with a “*”, see clause 6.			
NOTE 3 Most gas filters are graded according to their capacity to absorb contaminants and are graded into low, medium and high capacity filters. Filter capacity is identified by a code having the second digit as a number which identifies capacity; “1” being low capacity and “3” high capacity. For example, a medium capacity filter for use against organic compounds with boiling points above 65 °C, as specified by the manufacturer, is coded A2, FFA2 or FMA2. FF and FM gas filtering facepieces are available only with low and medium capacity filters.			
NOTE 4 A combined gas and particulate filter is coded with an additional two digits after the gas filter code which show the efficiency of the particulate filter element. For example, a medium capacity combined gas and particulate filter for use against organic compounds with boiling points above 65 °C, as specified by the manufacturer, and with a high efficiency particulate filter element, is coded “A2P3”.			
NOTE 5 Where gases, vapours and dusts exist together, a combined filter should be used, even if the dust had not been assessed as a risk.			

5.2.6 Multi gas filters

Gas filters can be made to protect against contaminants of more than one gas filter type, e.g. A2B2, AXB2E1K1. These multi type gas filters can be made in any combination of type and class. They can also be used to form any combined filter (see 5.2.5).

5.2.7 Complete devices

The overall performance of filtering devices is limited by the sum of contaminant ingress through the filter and leakage between the facepiece and the wearer’s face, and leakage through valves, where they are fitted.

With devices fitted with particle or combined filters, the performance against particles is limited by the sum of particle penetration of the filter and leakage between the facepiece and the wearer’s face. With devices fitted with gas or combined filters, it is assumed that prior to overloading of the filter capacity, there is no penetration of a gas filter. Overall performance against a gas before overloading occurs is therefore limited only by leakage between the facepiece and the wearer’s face, and leakage through valves where fitted.

Loose fitting facepiece devices rely upon the flow of air into the facepiece to prevent inward leakage of contaminant.

The types of filtering devices available and the relevant standards are shown in Table 3.

Table 3 — Filtering device types and relevant standards

Unpowered devices						Powered devices	
	Half or quarter mask and filter	Filtering half masks without inhalation valves	Valved filtering half masks	Filtering half masks	Full face mask and filter	Power assisted filtering devices incorporating full, half or quarter masks	Powered filtering devices incorporating helmets or hoods
	BS 7356 (EN 140)	prEN 1827	BS EN 405	BS EN 149	BS 7355 (EN 136)	prEN 12942	prEN 12941
Particle filter	Facepiece BS 7356 and filter BS EN 143	✓	No device	✓	Facepiece BS 7355 and filter BS EN 143	✓	✓
Gas filter	Facepiece BS 7356 and filter BS EN 141 BS EN 371 BS EN 372	✓	✓	No device	Facepiece BS 7355 and filter BS EN 141 BS EN 371 BS EN 372	✓	✓
Combined filter	Facepiece BS 7356 and filter BS EN 141 BS EN 371 BS EN 372	✓	✓	No device	Facepiece BS 7355 and filter BS EN 141 BS EN 371 BS EN 372	✓	✓

5.3 Breathing apparatus

5.3.1 General

Breathing apparatus is a respiratory protective device to which breathable air or gas is supplied from an uncontaminated source. Breathing apparatus consists of a means of supplying breathing gas and a facepiece which conveys filtered air to the wearer's breathing zone.

This type of respiratory protective device is manufactured in a variety of product types to meet the application of use and may be conveniently subdivided as follows:

- fresh air hose equipment;
- compressed air line supplied equipment;
- compressed air and compressed oxygen self-contained breathing apparatus.

Types of breathing apparatus and relevant standards are given in Figure 4, Table 4 and Table 5. For a description of specific breathing apparatus, see Annex B.

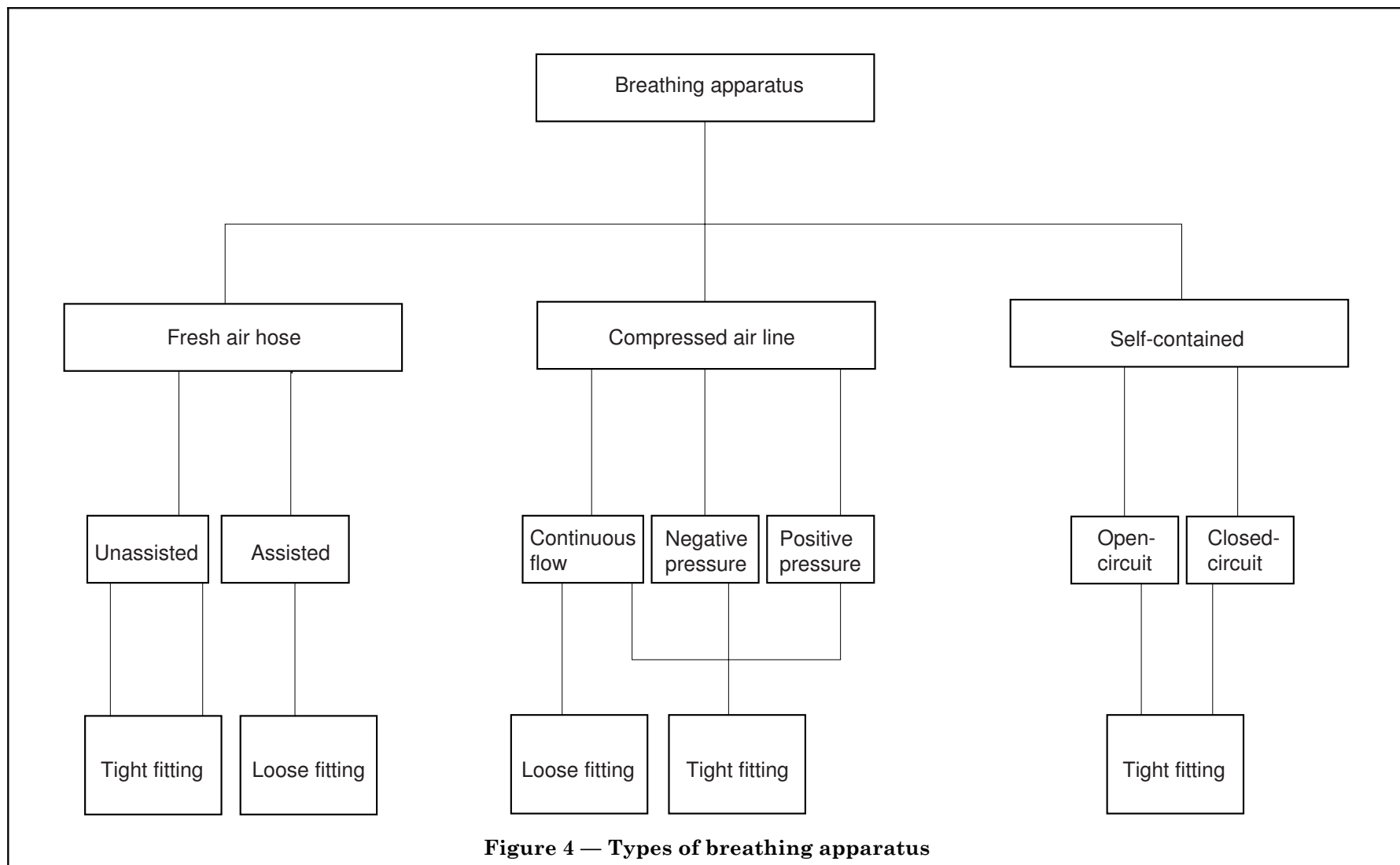


Table 4 — Fresh air hose and compressed air line breathing apparatus

Fresh air hose			Powered fresh air hose hood	Compressed air line hood	Power operated or compressed air line abrasive blasting hood	Compressed air line for use with full face mask, half mask or mouthpiece			Light duty construction compressed air line
BS EN 138			BS EN 269	BS EN 270	BS EN 271	BS EN 139			Helmet or hood prEN 1835 Mask prEN 12419
Unassisted	Manually assisted	Power operated	Power operated	Continuous flow	Power operated or compressed air line	Continuous flow	Negative pressure	Positive pressure	Continuous flow
Heavy duty construction only	Light or heavy duty construction	Light or heavy duty construction	Light or heavy duty construction						Class 1, 2 or 3
Full face mask or mouthpiece only	Half or full face mask or mouthpiece	Half or full face mask or mouthpiece	Hood	Hood	Abrasive blasting hood	Half or full face mask or mouthpiece			Helmet or hood or mask
NOTE 1 Certain devices may conform to more than one standard.									
NOTE 2 Standards exist for suits intended for radiological protection (prEN 1073) and chemical protection (prEN 943 and BS 7184) but the manufacturer's guidance should be sought for respiratory protective requirements.									

Table 5 — Self-contained breathing apparatus

Open-circuit		Closed-circuit	
Self-contained open-circuit compressed air breathing apparatus		Self-contained closed-circuit breathing apparatus Compressed oxygen or compressed oxygen-nitrogen type	Self-contained closed-circuit chemical oxygen breathing apparatus
BS EN 137		BS EN 145	No relevant standard
Negative pressure	Positive pressure	Negative pressure	Positive pressure
Full face mask or mouthpiece only		Full face mask or mouthpiece only	
		Full face mask or mouthpiece only	

5.3.2 Facepieces

Breathing apparatus can have air supplied at a constant flow above a specified minimum and in this mode can employ either loose or tight fitting facepieces. Alternatively, breathing apparatus (with tight fitting facepieces only) can be used with demand valves which allow air from a compressed air source to enter the facepiece when the wearer inhales.

5.3.3 Fresh air hose equipment

With this type of breathing apparatus, breathable air is drawn from an uncontaminated source along a short hose.

Using the wearer's lung power, it is likely that unacceptable inhalation resistance will be achieved with hose lengths in excess of 9 m. Longer lengths are used in conjunction with an air mover such as an electrically operated blower.

NOTE It should be noted that a requirement of the standard for power assisted fresh air hose equipment, BS EN 269, is to meet a breathing resistance performance with the power source turned off.

The manufacturer's instructions on the equipment, for example on hose length and bore, should be strictly observed. This equipment should only be used where the contaminant in the working environment has been fully assessed. See Table 4.

5.3.4 Compressed air line supplied equipment

Compressed air line supplied equipment generally falls into two categories, light duty equipment and the more robust heavy duty type of equipment normally used for external industrial applications.

Light duty equipment should be used only in applications where the suitability has been fully assessed. The equipment is chosen for its simplicity and comfort and is often worn for routine, everyday tasks. Manufacturers supply this type of equipment in various forms such as visors, masks, hoods and helmets (see Table 4). Some equipment is fitted with a warning device to alert the wearer that the flow rate is low.

Heavy duty compressed air line equipment incorporating a full face mask with either constant flow or demand valves, a mouthpiece, half mask, hood, helmet or suit is also available. Some of this equipment may be designed and used for confined space entry, tank cleaning, or other applications where an emergency escape may be necessary.

Breathable air can be supplied to the wearer by one of three methods which are as follows.

- A continuous flow of air is supplied at a constant rate to the facepiece. In some systems the flow rate can be altered by means of a valve on the wearer's belt. This type of system can have either a tight fitting facepiece or a loose fitting facepiece.
- Negative pressure demand, in which the suction generated in the face mask during inhalation opens a demand valve and allows air into the mask from the compressed air supply. With this equipment, the pressure inside the mask is lower than atmospheric pressure during inhalation.
- Positive pressure demand device, designed to maintain a pressure slightly above atmospheric inside the mask, even when the wearer is inhaling. If facepiece leakage occurs, any leakage is outward, therefore contaminants would not be inhaled by the user. However, in the case of high air flow demand by the user, the pressure in the facepiece can, in principle, become negative.

On all three systems, the compressed air quality should conform to Annex C and the air flow rate should be at least sufficient to meet the foreseeable needs of the total number of wearers who will use the equipment at maximum work rate. It is not acceptable to connect an air line breathing apparatus to an air supply intended for general works use, unless the air is filtered to meet the quality standards described in Annex C.

5.3.5 Self-contained breathing apparatus, compressed air, compressed oxygen and chemical oxygen types

5.3.5.1 General

Some of these types of equipment are capable of providing the highest degree of protection of any type of respiratory protective device and are designed for use in the most hazardous circumstances, including those where the atmosphere may be immediately fatal to the unprotected person. Compressed gas breathing apparatus is divided into the types given in 5.3.5.2, 5.3.5.3 and 5.3.5.4.

5.3.5.2 Open-circuit self-contained breathing apparatus

Air is supplied from high pressure cylinders worn by the user. There are two different methods of supplying compressed air to the wearer, as follows.

- a) Negative pressure demand, in which the suction generated in the face mask during inhalation opens a demand valve and allows air into the mask from the compressed air supply. With this equipment, the pressure inside the mask is lower than atmospheric pressure during inhalation.
- b) Positive pressure demand, which is designed to maintain a pressure slightly above atmospheric inside the mask, even when the wearer is inhaling. However, the maximum flow through the demand valve may be less than the peak inhalation flow required by a wearer at high physical work rates, so positive pressure within the mask may not be maintained at all times.

Open-circuit self-contained breathing apparatus is extensively used in some industries, and always requires a very high standard of training and maintenance. These factors should be taken into consideration when selecting this equipment for use.

5.3.5.3 Closed-circuit self-contained breathing apparatus

In this equipment, oxygen or a breathable gas mixture is supplied from high pressure cylinders worn by the user. The exhaled breath is passed through a carbon dioxide absorber to be recirculated in a closed-circuit to the face mask or mouthpiece. Closed-circuit self-contained air-supplying devices using oxygen or a breathable gas mixture are not generally used in industrial situations and may require special consideration in view of the fire hazards associated with the use of pure oxygen, together with the specialized maintenance required to support this type of device.

5.3.5.4 Self-contained breathing apparatus for escape purposes

This equipment is available in compressed-air, compressed-oxygen and chemical oxygen types and is intended for short duration use for emergency escape from hazardous areas. Escape apparatus should be used for escape purposes only and should not be used for normal working, entry to hazardous areas, or rescue.

6 Limitations

6.1 General

The protective performance of a respiratory protective device is generally expressed in terms of its assigned protection factor.

NOTE In the previous edition of this standard, and in other guidance documents, it is assumed that if respiratory protective devices were correctly worn, the protection factor achieved in the workplace was adequately indicated by the performance achieved in the laboratory during the standard tests carried out to assess conformity with the requirements of the relevant standard.

However, extensive research has indicated that even when respiratory protective devices are correctly worn in the workplace, the workplace protection factor could be substantially different from that observed during standard laboratory tests. The levels of respiratory protection inferred in this standard to be achievable in the workplace are based on the results of workplace studies.

This standard sets assigned protection factors to each class of device on the basis of workplace studies. See Annex D.

Where it is necessary to determine the maximum use concentration for a specific respiratory protective device, the occupational exposure limit for the substance given in Health and Safety Executive Guidance Note EH 40/96 [3] (see **7.2.2**) should be multiplied by the assigned protection factor.

The assigned protection factors for filtering devices and breathing apparatus are shown in Table 6 and Table 7.

The assigned protection factors shown in Table 6 and Table 7 can only potentially be achieved if the devices are correctly matched to:

- a) the relevant airborne contaminant;
- b) the individual wearer and his/her duties;
- c) duration of wear;
- d) environmental factors such as cold, heat, humidity and work space; and
- e) if the devices are to be used on more than one occasion, whether they are maintained in an efficient and hygienic condition.

It is essential that wearers are adequately trained in the limitations of their device, how to fit the device correctly and be adequately supervised at all times when wearing their device. Wearers of tight fitting devices should not have facial hair or stubble under the seal, as this can adversely affect the fit of the facepiece. Other items of personal protective equipment should be selected such that they do not interfere with the fit or performance of the respiratory protective device and vice versa (for example, the device does not displace a helmet, and eye protection does not move or reduce the face seal of a device).

For information on the selection of respiratory protective devices, see clause 7.

Communication is important, and is easier in a hood or in certain full face masks than in certain helmets, half or quarter masks. Communication is almost impossible with a mouthpiece.

Assigned protection factors higher than shown in Table 6 and Table 7 should not be used unless objective workplace performance data are available for the specific workplace in which the device is to be used.

For limitations relating to specific devices, see Annex A and Annex B.