

BRITISH STANDARD

Respiratory protective devices for use against chemical, biological, radiological and nuclear (CBRN) agents –

Part 2: Negative pressure, air purifying devices with full face mask – Specification

ICS 13.340.30

BSi
British Standards

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 44, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard was published by BSI and comes into effect on 29 December 2006. It was prepared by Technical Committee PH/4, Respiratory protection. A list of organizations represented on this committee can be obtained on request to its secretary.

The start and finish of text introduced or altered by Amendment No. 1 is indicated by the tags **[A1]** **[A1]**.

Relationship with other publications

When finished, BS 8468 will be issued in seven parts:

- *Part 1: Positive pressure, self-contained breathing apparatus – Specification;*
- *Part 2: Negative pressure air purifying devices with full face mask – Specification;*
- *Part 3: Escape hoods – Specification;*
- *Part 4: Powered air-purifying respirators – Specification;*
- *Part 5: Dual-mode apparatus – Specification;*
- *Part 6: Positive-pressure compressed airline equipment – Specification;*
- *Part 7: Closed-circuit breathing apparatus – Specification.*

NOTE This standard may be used in conjunction with BS 8467, which gives categorization, requirements and test methods for personal protective ensembles against CBRN agents.

Information about this document

Recent changes in international politics have given rise to a threat from weapons previously expected to be confined to military operations. In the event that they are used against civilian targets, emergency and support agencies will need suitable PPE.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This standard applies to negative pressure air purifying devices with full face mask intended to be used during, rescue, evacuation, escape, hazard containment and decontamination, and similar activities by emergency responders (fire, ambulance, police, and associated civilian agencies and workers) in areas contaminated by chemical, biological, radiological and nuclear (CBRN) agents. It contains the requirements for designation, classification, testing and marking of the device.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 132, *Respiratory protective devices – Definitions of terms and pictograms*

BS EN 134, *Respiratory protective devices – Nomenclature of components*

BS EN 136:1998, *Respiratory protective devices – Full face masks – Requirements, testing, marking*

BS EN 148 (all parts), *Respiratory protective devices: threads for facepieces*

BS EN 13274-1, *Respiratory protective devices – Methods of test – Part 1: Determination of inward leakage and total inward leakage*

BS EN 13274-2:2001, *Respiratory protective devices – Methods of test – Part 2: Practical performance tests*

BS EN 13274-3:2001, *Respiratory protective devices – Methods of test – Part 3: Determination of breathing resistance*

BS EN 13274-5, *Respiratory protective devices – Methods of test – Part 5: Climatic conditions*

3 Terms and definitions

For the purpose of this British Standard the terms and definitions defined in BS EN 132 and BS EN 134 and the following apply.

3.1 negative pressure, air purifying device APD

negative pressure device comprising a full face mask and a filter(s) (which can be directly or remotely mounted)

4 Description

A negative pressure, air purifying device (APD) with full face mask is designed and constructed to enable the wearer to breathe ambient air via a filter(s). The filters shall be combined gas/vapour filters and particle filters. The particle filter shall be integral to the gas/vapour filter. The exhaled air passes without recirculation from the full face mask via the exhalation valve(s) to the ambient atmosphere.

5 Designation

5.1 Type

Two types of APD are described in this standard:

- type A: for personnel that do not need to use optical systems; and
- type B: for personnel that might need to use optical systems, e.g. microscopes, weapons sights.

5.2 Classification

APDs are classified in this standard in terms of filter breakthrough time as follows:

- Class 15 – with filter breakthrough time greater than or equal to 15 min and less than 30 min;
- Class 30 – with filter breakthrough time greater than or equal to 30 min and less than 45 min;
- Class 45 – with filter breakthrough time greater than or equal to 45 min and less than 60 min;
- Class 60 – with filter breakthrough time greater than or equal to 60 min and less than 90 min;
- Class 90 – with filter breakthrough time greater than or equal to 90 min and less than 120 min; and
- Class 120 – with filter breakthrough time greater than or equal to 120 min.

Classification for filter breakthrough times greater than 120 min is in 30 min intervals.

6 Requirements

6.1 General

The complete APD shall conform to all relevant requirements of this standard. The APD shall comprise a full face mask and (a) filter(s) (which may be directly or remotely mounted). In all tests, all test samples shall meet the requirements.

If a full face mask is to be used with non-direct mounted filters it shall be provided with an inhalation valve if there is no valve in the filter or the breathing hose.

If a full face mask is to be used with direct mounted filters it shall be provided with an inhalation valve if there is no valve in the filter.

A device of type A shall conform to the chemical agent penetration and permeation resistance specified in **6.2**, have a full face mask that conforms to BS EN 136:1998 class 2 or class 3, and have filter(s) that conform to the requirements of **6.5**, **6.6** and **6.7**.

A device of type B shall conform to the chemical agent penetration and permeation resistance specified in **6.2**, have a full face mask that conforms to BS EN 136:1998 class 2 or class 3, and have filter(s) that conform to the requirements of **6.5**, **6.6** and **6.7**, but with the field of vision requirement specified in BS EN 136:1998 **7.21** for full face masks with two eyepieces and conform to the requirements of Annex C (use with optical systems).

6.2 Chemical agent permeation and penetration

A device of type A or type B shall be resistant to chemical agents: the maximum permissible permeation levels are given in Table 1 when tested in accordance with Annex B. Six APD systems will be tested, two systems (one for each agent) comprising a full face mask plus filter(s) and breathing hoses/harness/belts where applicable, in as-received condition and four systems (two for each agent) comprising a full face mask, breathing hose and harness/belt where applicable, conditioned in accordance with BS EN 136:1998 **8.2** plus a filter(s) conditioned in its packaging in accordance with **A.8** of this standard.

Table 1 Maximum acceptable levels of permeation and penetration

Agent	Maximum acceptable peak excursion ^{A)} mg/m ³	Maximum acceptable breakthrough (concentration integrated over time) ^{B)} mg·min/m ³
Distilled sulfur mustard (HD) (vapour) [sequential test with liquid HD]	0.30	3.0
Distilled sulfur mustard (HD) (liquid) [sequential test after HD vapour]	0.30	3.0
Sarin (GB) (vapour)	0.044	1.05

A) Three sequential test data points, with sample times of two minutes, at or above the maximum peak excursion level constitute a failure.

B) The maximum acceptable breakthrough is calculated over the six-hour duration of the test.

6.3 Ergonomics

The APD shall take account of the interaction between the wearer, the respiratory protective device, and where possible the working environment in which the respiratory protective device is likely to be used, by meeting the requirements of this standard. See Annex D.

6.4 Breathing resistance

The breathing resistance imposed by the APD to the flow of air shall be as low as possible and in no case exceed the values shown in Table 2.

Table 2 Breathing resistance

	Inhalation resistance			Exhalation resistance
	mbar			mbar
	30 l/min continuous flow	95 l/min continuous flow	160 l/min continuous flow or 50 l/min sinusoidal (25 cycles/min, 2.0 l/stroke)	160 l/min continuous flow or 50 l/min sinusoidal (25 cycles/min, 2.0 l/stroke)
Full face mask	0.5	1.5	2.5	3.0
Filter	1.9	6.0	NA	NA
APD	2.4	7.5	12.6	3.0

Testing shall be in accordance with BS EN 13274-3:2001 and **A.4**.

Three full face masks shall be tested in accordance with **A.4**, all in the as-received condition.

Four filters shall be tested, two after the test for mechanical strength in accordance with **A.7** and two after the test for mechanical strength in accordance with **A.7**, followed by the temperature conditioning test in accordance with **A.8**. Testing shall be done in accordance with **A.4**.

Three APDs shall be tested in accordance with **A.4**, all in the as-received condition.

6.5 Flammability

The complete APD (including filters, hoses, and harnesses/belts that attach to the full face mask) shall not continue to burn for more than five seconds.

Testing shall be in accordance with **A.6**.

6.6 Filters

6.6.1 Design

The filter(s) shall be sufficiently robust to withstand the rough usage it is likely to receive in service.

No part of the filter(s) likely to be in contact with the wearer shall have sharp edges or burrs.

The filter(s) shall be designed to ensure its full function in any orientation.

Testing shall be done in accordance with **A.3**.

6.6.2 Materials

The filter shall be made of suitable material to withstand normal usage and exposures to those temperatures, humidity and corrosive environments that are likely to be encountered. Internally it shall withstand corrosion by the filtering media.

Any material of the filter media or any gaseous products that may be released by the airflow through the filter shall not be known to constitute a hazard or nuisance for the wearer.

Testing shall be done in accordance with **A.3**.

6.6.3 Mass

The maximum mass of filter(s) designated to be used directly connected to a full face mask is 500 g.

Where the filter(s) is not directly connected to the full face mask, the mass shall not be supported by the full face mask filter connection. The effective mass supported by a full face mask shall not exceed 500 g.

Testing shall be done in accordance with **A.1**.

6.6.4 Connection

6.6.4.1 Direct filters

The connection between filter(s) and full face mask or other device(s) with which it is intended to be used shall be robust and leaktight.

The connection between filter(s) and full face mask shall be achieved by a permanent or special connector or a screw thread including a thread conforming to BS EN 148-1.

Threads conforming to BS EN 148-2 or BS EN 148-3 shall not be used.

If the filter is designated to be used on a multiple filter full face mask or has any other thread, it shall not be possible to connect it to a thread conforming to BS EN 148-1, BS EN 148-2 or BS EN 148-3.

The filter(s) shall be readily replaceable without use of special tools and shall be designed or marked to prevent incorrect assembly.

The particle filter of combined filters shall be on the influent side of the gas filter.

The filter/full face mask connection shall withstand an axial force of 150 N at the connection.

Testing shall be done in accordance with **A.1**, **A.3** and **A.5**.

6.6.4.2 Non-direct filters

6.6.4.2.1 General

Where filters are not directly mounted to the full face mask, the breathing hose(s) shall permit free head movement and shall not restrict or close off the airflow under chin or arm pressure. The hose(s) shall be flexible so that the full face mask fit is maintained during head movements.

The harness or belt shall ensure comfortable and safe wearing of the non-mask-mounted filter. The harness or belt shall be adjustable and permit donning and doffing.

Practical performance testing shall be done accordance with BS EN 13274-2:2001 using only Activity 2 (walking on the level with full headroom), Activity 3 (walking on the level with reduced headroom), Activity 10 (crawling on the level), and Activity 14 (filling a basket with “chippings”).

6.6.4.2.2 Strength of connections

The breathing hose(s) and couplings intended to connect to full face masks shall withstand an axial force of 150 N at the filter connection and at the connection to the full face mask. After testing, breathing hose(s) and couplings shall not become disconnected or physically damaged.

Testing shall be in accordance with **A.5**.

6.6.5 Multiple filters

Where respirators are designed to use more than one filter (i.e. multiple filter device), through which the flow is proportioned, all requirements given in this standard are to be met by the complete set of filters (e.g. the total mass of a filter set designated to be used directly connected to a full face mask shall not exceed 500 g).

If, however, it is possible that a single filter of a multiple filter device can be used alone, then the requirements of the full flow rate for the tests, as stated in this standard, shall be met.

In the information supplied by the manufacturer all necessary information on how to use multiple filters shall be given.

Testing shall be done in accordance with **A.1**.

6.6.6 Combined filters

Gas/vapour filters shall incorporate a particle filter.

The particle filter shall be on the influent side of the gas/vapour filter.

Testing shall be in accordance with **A.3**.

6.6.7 Packaging

Filters shall be offered for sale packaged in such a way that they are protected against mechanical damage or visible contamination before use.

Filters shall be factory sealed to protect the filter media against environmental influences in such a way that the breaking of the factory sealing can be identified.

Testing shall be done in accordance with **A.3**.

6.6.8 Mechanical strength (MS)

Filters shall be subjected to the mechanical strength test when required by the relevant clauses of this standard.

Testing shall be done in accordance with **A.7**.

After this treatment the filters shall show no mechanical defect and shall meet the requirements of the relevant clauses.

Testing shall be done in accordance with **A.3**.

6.6.9 Temperature conditioning (TC)

Filters shall be subjected to the temperature conditioning test when required by the relevant clauses of this standard.

Testing shall be done in accordance with A.8.

After the treatment the filters shall show no signs of damage and shall meet the requirements of the relevant clauses.

Testing shall be done in accordance with A.3.

6.7 Filters – Gas/vapour element

6.7.1 General

Filters shall meet the appropriate requirements of Table 3.

Filters shall be tested after mechanical strength testing according to A.7 followed by temperature conditioning, according to A.8.

Testing shall be done in accordance with A.10.

6.7.2 CBRN requirements – Filter classification, test agents – Challenges and breakthrough concentrations

Three filters shall be tested against each test representative agent (TRA) and under the test conditions specified in A.10. Filters shall be classified according to the breakthrough times achieved in the laboratory tests, as given in Table 3.

Table 3 Breakthrough times

Classification	Breakthrough time
Class 15	≥ 15 min
Class 30	≥ 30 min
Class 45	≥ 45 min
Class 60	≥ 60 min
Class 90	≥ 90 min
Class 120	≥ 120 min
<i>NOTE Irrespective of classification, the useful service life of the filter will depend on the work rate of the wearer, the type and concentration of the contaminant and environmental conditions such as temperature and humidity.</i>	

The gas/vapour test challenges and breakthrough concentrations shown in Table 4 shall be used to establish the filter breakthrough time and thus classification. The TRAs have been chosen to represent families of potential CBRN threat agents.

Table 4 Filter test challenge and test breakthrough concentrations

Test representative agent	Test concentration ppm	Breakthrough concentration ppm
Ammonia	2 500	12.5
Cyanogen chloride	300	2
Cyclohexane	2 600	10
Formaldehyde	500	1
Hydrogen cyanide	940	4.7 ^{A)}
Hydrogen sulfide	1 000	5.0
Nitrogen dioxide	200	1 (NO ₂) or 25 (NO) ^{B)}
Phosgene	250	1.25
Phosphine	300	0.3
Sulfur dioxide	1 500	5

A) Sum of HCN and C₂N₂.

B) Nitrogen dioxide breakthrough is monitored for both NO₂ and NO. The breakthrough is determined by which quantity, NO₂ or NO reaches breakthrough first.

6.8 Filters – Particulate element

6.8.1 General

The particle filter shall be on the influent side of the gas/vapour filter. Testing shall be done in accordance with **A.3**.

6.8.2 Filter penetration

Filters shall meet the requirements for the maximum penetration of each test aerosol as specified in Table 5.

Table 5 Requirements for maximum penetration of test aerosols

Filter class	Maximum filter penetration of test aerosols (%)	
	Sodium chloride test at 95 l/min	Paraffin oil test at 95 l/min
P3	0.05	0.05

Four filters shall be tested for each test agent, two after the test for mechanical strength in accordance with **A.7** and two after the test for mechanical strength in accordance with **A.7** followed by the temperature conditioning test in accordance with **A.8**.

Testing shall be done in accordance with **A.9** and **A.11**.

7 Marking

7.1 General

Marking shall be as clearly visible and durable as practicable.

7.2 System

Each APD conforming to this standard shall be permanently marked with the designation and year of this standard, i.e. BS 8468-2:2006.

Sub-assemblies and components with considerable bearing on safety shall be marked so that they can be identified.

If sub-assemblies with considerable bearing on safety are too small to be marked, the information shall be given in the information supplied by the manufacturer.

7.3 Full face mask

Marking shall be in accordance with BS EN 136:1998.

In addition, each full face mask conforming to this standard shall be permanently marked with the designation and year of this standard, i.e. BS 8468-2:2006.

7.4 Filters

The filter(s) shall be marked at least with the following:

- a) filter class and colour code, that is, combined filters shall be colour coded orange/white, e.g. Class 15 P3, colour coded orange/white;

NOTE If the marking is not directly on the filter body or if the filter body is not of the appropriate colour, then the marking shall be on a label of the appropriate colour code affixed to the filter body. In this case, the colour of the body shall not be considered to be the colour code.

Silver or light metal colour shall not be regarded as white.

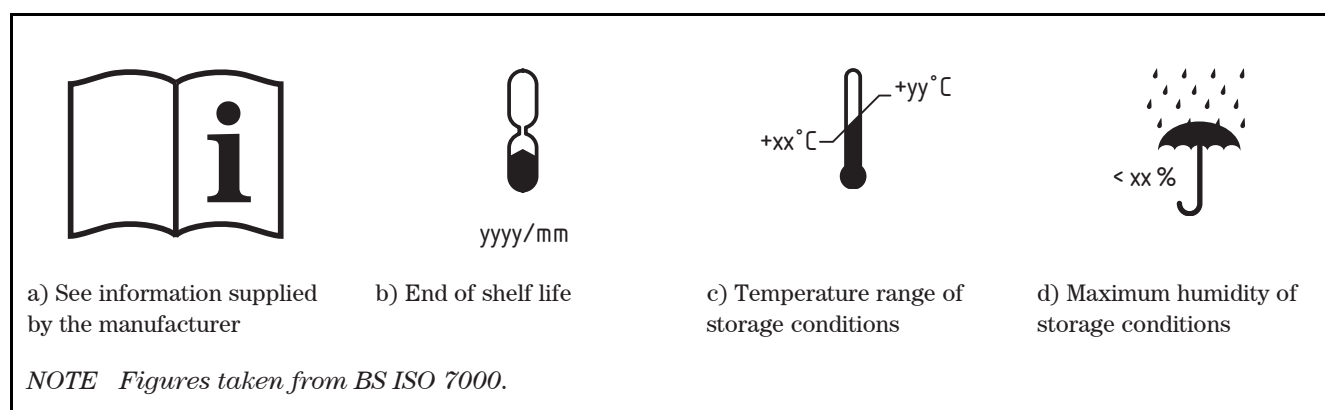
- b) a mark or symbol showing if the filter is for a multiple filter device;
- c) the sentence: "For single use only.";
- d) the designation and year of this standard, i.e. BS 8468-2:2006;
- e) the year and month of end of shelf life; the end of shelf life may be informed by a pictogram as shown in Figure 1 where the code "yyyy/mm" indicates the year and month;
- f) the manufacturer, supplier or importer shall be identified by name, trademark, or other means of identification;
- g) the sentence: "See information supplied by the manufacturer." at least in the official language(s) of the country of destination, or the appropriate pictogram as shown in Figure 1; and
- h) the manufacturer's model designation.

7.5 Filter package

The filter package shall be marked at least with the following information:

- year and month of the end of shelf life; the end of shelf life may be informed by a pictogram as shown in Figure 1 where the code “yyyy/mm” indicated the year and month;
- the manufacturer’s model designation;
- the manufacturer’s recommended conditions of storage (at least the temperature and humidity) or equivalent pictogram as shown in Figure 1.

Figure 1 Pictograms



7.6 Breathing hose(s) and couplings, belts and harness

Breathing hose(s) and couplings, belts and harness shall be marked, e.g. with a part number, at least so that they can be identified.

8 Information supplied by the manufacturer

On the delivery, the information supplied by the manufacturer:

- shall accompany the complete APD system and/or full face mask and/or filters (i.e. shall not necessarily accompany spare parts, valves, visors, etc.);
- shall be at least in the official language(s) of the country of destination;
- shall describe precisely and comprehensibly which permissible combinations of components are to be used;
- shall describe suitable procedures for decontamination;
- shall contain all information necessary for trained and qualified persons on:
 - application/limitations;
 - for type B APDs, which optical systems the APD is designed to be compatible with;