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Draft for Development

Respiratory protective equipment

Part 13. Specification for powered particle filtering devices incorporating helmets and hoods

Projet à développer

Appareils de protection respiratoire

Partie 13. Dispositifs de filtration des particules avec casques et cagoules — Spécifications

Entwurf zur weiteren Ausarbeitung

Atemschutzgeräte

Teil 13. Elektrisch betriebene Filter mit integriertem Helm und Gesichtsschild

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This publication is not to be regarded as a British Standard

It is being issued in the Draft for Development series of publications and is of a provisional nature because the draft European Standard that it reproduces, prEN 146 'Respiratory protective equipment — Powered particle filtering devices incorporating helmets and hoods' is under further review to improve certain of its contents. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

A review of this Draft for Development will be carried out not later than two years after its publication.

Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development will be made in an announcement in the appropriate issue of *BSI News*. Observations which it is felt should receive attention before the official call for comments will be welcomed.

According to the replies received, the responsible BSI Committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

Foreword

This Draft for Development has been prepared under the direction of the Personal Safety Equipment Standards Committee and its technical content is identical with that agreed at the meeting of CEN/TC 79, Respiratory protection, held in November 1985.

This Draft for Development is one of a series dealing with respiratory protection devices based on CEN draft documents and is being published in this way to enable experience to be gained in its use within the UK.

Other Parts published or in preparation in this series are as follows:

- | | |
|----------|---|
| Part 1 | Glossary of terms |
| Part 2 | Classification |
| Part 3 | Nomenclature of piece parts |
| Part 4 | Schedule of equivalent terms |
| Part 5* | Specification for full face masks |
| Part 6* | Specification for half and quarter masks |
| Part 7* | Specification for mouthpieces |
| Part 8* | Specification for particle filters |
| Part 9* | Specification for gas and combined filters |
| Part 10* | Specification for fresh air hose breathing apparatus |
| Part 11* | Specification for compressed air line breathing apparatus |
| Part 12* | Specification for self-contained open circuit breathing apparatus |
| Part 14* | Specification for power assisted particle filtering devices incorporating full face masks, half masks or quarter masks. |

*In preparation.

Specification

0 Introduction

A given piece of respiratory equipment can only be approved when the individual components satisfy the requirements of specifications which may be complete standards or parts of standards and man tests have been carried out on complete apparatus where specified in the appropriate standard. If for any reason a complete apparatus is not tested then simulation of the apparatus is permitted provided the weight distribution and respiratory characteristics are similar to those of the complete apparatus.

1 Object and field of application

This Draft for Development specifies minimum requirements for powered particle filtering devices incorporating helmets and hoods used as respiratory protection devices except for escape purposes. It does not cover devices designed for use in circumstances where there is or might be an oxygen deficiency (i.e. oxygen less than 17 % by volume).

Laboratory tests are included for the assessment of compliance with the requirements.

2 References

- BS 3928 Method for sodium flame test for air filters (other than for air supply to i.c. engines and compressors)
- BS 4400 Sodium chloride particulate test for respirator filters
- BS 5501 Electrical apparatus for potentially explosive atmospheres
Part 7 Intrinsic safety 'i'
- BS 5969 Specification for sound level meters
- DD 97 Respiratory protective equipment
*Part 8 Specification for particle filters

3 Definitions and description

3.1 powered particle filtering device incorporating a helmet or hood (device). A device, dependent on the ambient air, which provides protection against solid or solid and liquid aerosols of negligible volatility and decomposition, or a combination of such aerosols. The device consists of a helmet or hood with an attachment for covering at least the face (eyes, nose, mouth, chin), a power-operated fan and one or more particle filters. These three components can be integrated into one unit. The fan provides a flow of filtered ambient air to the wearer. Air in

excess of the wearer's demand is discharged by exhalation valves or other outlets depending on the design.

3.2 manufacturer's minimum design flow rate. The flow rate, as stated by the manufacturer, above which the class requirements are met.

4 Classification and designation

Devices are classified and designated as a function of their maximum total inward leakage as given in table 1.

Table 1. Classification of devices	
Class	Maximum total inward leakage (power-on)
	%
PH 1	10
PH 2	5
PH 3	0.2

The total inward leakage shall be measured against sodium chloride at the manufacturer's minimum design flow rate which shall not be less than 120 L/min.

NOTE. The 'power-off' state is considered to be an abnormal situation. In this state there is no requirement for testing total inward leakage.

5 Requirements

5.1 Materials

5.1.1 Compatibility to skin. Materials that may come into contact with the wearer's skin shall be not known to be likely to cause skin irritation or any adverse effect to health.

5.1.2 Cleaning and disinfection. The materials used shall withstand the cleaning and disinfection agents recommended by the manufacturer.

5.2 Helmet

If a device is intended to provide head protection it shall conform to the appropriate part of the national standard for protective helmets.

5.3 Total inward leakage

When tested in accordance with 6.1 and calculated according to 6.1.5 the mean total inward leakage of the test aerosol for each of the exercises 6.1.4(a), (c)(1), (c)(2), (c)(3) and (d) for each shall be within the levels set out in clause 4, when tested at the manufacturer's minimum design flow rate.

*In preparation.

5.4 Carbon dioxide content of the inhalation air

When tested in accordance with 6.2 the carbon dioxide content of the inhalation air shall not exceed an average of 1 % by volume.

5.5 Breathing resistance

When testing the exhalation resistance in accordance with 6.3 the positive pressure under the hood (helmet) shall not exceed 7 mbar*.

5.6 Air supply

5.6.1 When mounted on a dummy head/torso and tested in accordance with 6.4 at the extremes of operating temperatures and humidities as claimed in the instructions (see clause 8), the flow into the helmet or hood shall exceed the manufacturer's minimum design flow rate which shall not be less than 120 L/min for the manufacturer's design duration which shall not be less than 4 h.

The flow rate and distribution of the air under the helmet or hood shall not cause distress to the wearer by excessive local cooling of the head and face.

5.6.2 It shall not be possible to switch off the air supply inadvertently.

5.7 Resistance to clogging

At the end of the clogging test in accordance with 6.5 the flow rate shall not drop below the minimum design flow rate and the filters shall meet the penetration requirements of 5.10.

5.8 Electrical components

If the power supply is a battery it shall be a non-spillable type, and where necessary shall be provided with a safe venting device.

Electrical components shall be so designed that it is not possible to inadvertently reduce or reverse the air flow.

If the device is claimed to be intrinsically safe it shall comply with BS 5501 : Part 7.

5.9 Hose

Any breathing hose shall permit free head movement and shall not restrict or close off the air supply under chin or arm pressure.

5.10 Filters

Filters other than pre-filters shall be designed to be irreversible and shall be readily replaceable without the use of special tools. The performance of the filters shall conform to table 2 when tested in accordance with DD 97 : Part 8 at the initial flow rate measured in 6.4.

Filters suitable for use against solid and liquid aerosols shall be tested against sodium chloride and paraffin oil.

Filters suitable only for use against solid aerosols and water based aerosols shall be tested against sodium chloride only.

*1 mbar = 100 N/m² = 100 Pa.

Table 2. Maximum initial penetration

Class	Maximum initial penetration	
	NaCl	Paraffin oil
PH 1	%	%
PH 2	10	4
PH 3	5	2
	0.2	0.1

5.11 Warning and measuring facilities

5.11.1 A means shall be provided to check that the manufacturer's minimum design flow rate is exceeded prior to each use.

5.11.2 PH 3 equipment shall be fitted with a warning device which shall indicate when the flow rate under the helmet or hood drops below the manufacturer's minimum design flow rate. A means of checking the correct functioning of the warning device shall also be provided.

5.12 Visor

5.12.1 Visors shall not distort vision nor shall misting occur as subjectively determined in the course of testing as in 6.1.

NOTE. Where anti-fogging compounds are used or specified by the manufacturer, they should be compatible with eyes, skin and the device.

5.12.2 The effective field of vision shall be not less than 70 %, related to the natural field of vision, and the overlapped field of vision related to the natural overlapped field of vision, shall be not less than 80 % when tested in accordance with 6.6.

5.12.3 After the robustness of the visor has been tested in accordance with 6.7, the visor shall not be visibly damaged in such a way as to be likely to affect its performance.

5.13 Flammability

The device shall not grossly deform, decompose or continue to burn after testing in accordance with 6.8.

5.14 Noise

The noise generated by the device shall not exceed 75 dB(A) when measured using the method described in 6.9 and shall be measured using the complete set of filters designed to be used with the equipment.

6 Testing

6.1 Total inward leakage

6.1.1 *Principle.* Each test subject, wearing the complete device to be tested, walks on a horizontal treadmill surrounded by a standard cloud of sodium chloride

particles. The flow rate is adjusted to, and maintained at the manufacturer's minimum design flow rate using a variable voltage supply. The battery fitted to the device is not used. The percentage inward leakage of the test cloud into the breathing zone is measured by means of flame photometry. Determination of the inward leakage is possible in the range of 0.001 % to 100 % penetration. Dilution of the test cloud by the clean air emanating from the respirator under test does not affect the accuracy of measurement of inward leakage because of the large volume and continuous replacement.

6.1.2 Test subjects and number of tests. Two devices shall be tested, each being tested on five test subjects. Each test shall be carried out using a new filter.

6.1.3 Test equipment. The test cloud of sodium chloride particles is formed by the evaporation of an atomized 2 % aqueous solution of reagent grade sodium chloride. The single atomizer is of the Collison type as specified in BS 3928. The atomizer is supplied with air at a pressure of 7 bar and a flow of 100 L/min. The atomizer shall be situated in a duct through which a constant flow of air is maintained. A typical test arrangement is shown in figure 1. The duct shall lead into the top of an enclosure positioned over a treadmill; the enclosure shall be large enough to permit walking on the treadmill without interference. Provision shall be made for the positioning of a supplementary fan, not less than 350 mm in diameter, inside the enclosure such that an air flow of 2 m/s across the enclosure can be produced in the vicinity of the subject's head.

The mean air flow through the enclosure measured with a subject standing centrally on the treadmill, and without the supplementary fan in operation, shall be between 0.15 m/s and 0.2 m/s. The air flow at any point in the effective working volume of the enclosure shall be not less than 0.10 m/s, i.e. measurements shall not be made at points nearer than 100 mm to the sides of the enclosure, below 750 mm from the base of the enclosure nor above a height at which the sodium chloride concentration differs by more than 10 % from the average concentration. The relative humidity of the air within the enclosure when the atomizer is in operation shall not exceed 60 %. This may necessitate drying the air before it flows past the atomizer. The air temperature shall be not less than 15 °C.

The mean sodium chloride concentration within the effective working volume of the enclosure shall be $8 \pm 4 \text{ mg/m}^3$ and the variation throughout the effective working volume shall be not more than $\pm 10 \%$. If necessary a baffle may be placed at the end of the duct in order to achieve these conditions. The particle size distribution shall be 0.02 μm to 2 μm equivalent aerodynamic diameter with a median diameter of 0.6 μm .

The concentration of sodium chloride is determined by flame photometry; the design of the photometer is specified in BS 3928 and BS 4400. The sample tubes shall consist of plastics tubing with a nominal inside diameter of 4 mm through which air is drawn at a rate of 3 L/min by means of a

suitable pump. The pump shall be chosen so as to minimize aerosol losses within the pump and also to minimize the change in flow rate caused by changing pressure within the sampling zone.

NOTE 1. Some types of reciprocating diaphragm pumps have proved to be suitable.

The sample shall then be diluted with a further 9 L/min of clean air before being fed to the flame tube of the photometer. Two separate sample tubes shall be provided, one to measure the ambient concentration within the enclosure and one to measure the concentration in the wearer's breathing zone. A test probe with a minimum bore of 1.5 mm may be fitted to the latter sample tube in order to obtain a sample from the required region, the design of the probe shall be chosen to suit the device being tested. The sample tube connected to the facepiece shall be as flexible as possible.

NOTE 2. The sample tube is preferably made of silicone or other rubber.

This tube or probe shall not affect the face seal during head movements.

6.1.4 Test procedure. All the sample tubes shall initially be placed in close proximity to one another within the enclosure and the resistance of the sample tubes adjusted, e.g. by means of a screw clip, so that identical readings for the sodium chloride concentration are obtained from each sample tube (this is in effect a calibration).

Provide the test subject with the device and the manufacturer's fitting instructions and allow the test subject to fit the device satisfactorily.

Check the zero reading of the test equipment before commencing the tests.

Adjust the flow rate to the manufacturer's minimum design flow rate.

The test subject, wearing the equipment, shall stand on the treadmill and the concentration of the test cloud shall be checked at head, chest and waist height.

The test subject shall then stand on the treadmill for a further two to three minutes in order to allow the concentration within the wearer's breathing zone to stabilize.

After this period the following exercises shall be performed by the test subject:

- (a) standing in an upright position for 2 min;
- (b) walking for 4 min at 6 km/h on the treadmill;
- (c) then whilst still walking
 - (1) turning head from side to side (approximately 15 times) at his own but normal speed for 2 min;
 - (2) moving head up and down (approximately 15 times) at his own but normal speed for 2 min;
 - (3) reciting alphabet aloud for 2 min;
- (d) followed by walking for 2 min at 6 km/h on the treadmill;
- (e) standing in an upright position for 2 min.