

Respiratory protective devices — Particle filters — Requirements, testing, marking

The European Standard EN 143:2000, with the incorporation of amendment A1:2006, has the status of a British Standard

ICS 13.340.30

National foreword

This British Standard is the official English language version of EN 143:2000, including corrigenda July 2002 and March 2005 and amendment A1:2006. It supersedes BS EN 143:1991 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated in the text by **A1** **A1**.

The UK participation in its preparation was entrusted by Technical Committee PH/4, Respiratory protection, to Subcommittee PH/4/4, Filters, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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This British Standard, having been prepared under the direction of the Health and Environment Committee, was published under the authority of the Standards Committee on 15 June 2000

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Amendments issued since publication

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15725 Corrigendum No. 2	31 August 2006	Change to Key of Figure 3
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English version

Respiratory protective devices - Particle filters - Requirements, testing, marking

Appareils de protection respiratoire - Filtres à particules -
Exigences, essais, marquage

Atemschutzgeräte - Partikelfilter - Anforderungen, Prüfung,
Kennzeichnung

This European Standard was approved by CEN on 7 January 2000.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 79, Respiratory protective devices, the secretariat of which is held by DIN.

This European Standard replaces EN 143:1990.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2000, and conflicting national standards shall be withdrawn at the latest by August 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

This document (EN 143:2000/A1:2006) has been prepared by Technical Committee CEN/TC 79 “Respiratory protective devices”, the secretariat of which is held by DIN.

This Amendment to the European Standard EN 143:2000 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 89/686/EEC, Annex II.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

A given respiratory protective device can only be approved when the individual components satisfy the requirements of the test specification which may be a complete standard or part of a standard, and practical performance tests have been carried out successfully 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 respiratory characteristics and weight distribution are similar to those of the complete apparatus.

1 Scope

This European Standard specifies particle filters for use as components in unassisted respiratory protective devices with the exception of escape apparatus and filtering facepieces.

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

Some filters complying with this European Standard may also be suitable for use with other types of respiratory protective devices and, if so, shall be tested and marked according to the appropriate European Standard.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 132 *Respiratory protective devices - Definitions of terms and pictograms.*

EN 134 *Respiratory protective devices - Nomenclature of components.*

EN 148-1 *Respiratory protective devices - Threads for facepieces - Part 1: Standard thread connection.*

Ⓐ EN 13274-5:2001, *Respiratory protective devices - Methods of test - Part 5: Climatic conditions.* Ⓐ

3 Definitions

For the purposes of this European Standard the definitions in EN 132 and the nomenclature given in EN 134 apply, Ⓐ together with the following:

3.1

Re-usable filter

Filter intended to be used for more than a single shift Ⓐ

4 Description

Air enters the particle filter(s) and passes to the facepiece after removal of particles.

5 Classification

Particle filters are classified according to their filtering efficiency. There are three classes of particle filters: P1, P2 and P3 in ascending order of the filtering efficiency.

Ⓐ In addition, filters may be classified as single shift use only, or may be re-usable (more than one shift). Ⓐ

The protection provided by a P2- or P3-filter includes that provided by the filter of lower class or classes.

6 Designation

Particle filters meeting the requirements of this European Standard shall be designated in the following manner:

A_1 — particle filter EN 143, filter type, class, option e.g. particle filter EN 143 P3 NR A_1

7 Requirements

7.1 General

In all tests, all test samples shall meet the requirements.

7.2 Nominal values and tolerances

Unless otherwise specified, the values stated in this European Standard are expressed as nominal values. Except for temperature limits, values which are not stated as maximum or minimum shall be subject to a tolerance of $\pm 5\%$. Unless otherwise specified, the ambient temperature for testing shall generally be $(24 \pm 8)^\circ\text{C}$ but for the mechanical tests $(20 \pm 10)^\circ\text{C}$. Other temperature limits shall be subject to an accuracy of $\pm 1^\circ\text{C}$.

7.3 Visual inspection

The visual inspection shall be carried out prior to laboratory tests and as specified elsewhere in this standard.

Testing shall be done in accordance with 8.2.

7.4 Connection

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

The connection between filter and facepiece may be achieved by a permanent or special connector or by a screw thread including a thread conforming to EN 148-1.

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

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

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

Testing shall be done in accordance with 8.2.

7.5 Mass

The maximum mass of filter(s) designated to be used directly connected to a half mask is 300 g.

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

Testing shall be done in accordance with 8.1.

7.6 Multiple filters

Where filtering devices are designed to use more than one filter (i.e. multiple filter device), through which the flow is proportioned, all requirements given in this European 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 half mask shall not exceed 300 g).

If, however, it is possible that the single filter of a multiple filter device may be used alone, then the requirements at the full flow rate for the tests, as stated in this European 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 8.1 and 8.2.

7.7 Material

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 air flow through the filter shall not be known to constitute a hazard or nuisance for the wearer.

Testing shall be done in accordance with 8.2.

7.8 Packaging

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

Where appropriate, filters shall be factory sealed to protect the filter media against environmental influences and in such a way that the breaking of the factory sealing can be identified.

Testing shall be done in accordance with 8.2.

7.9 Mechanical strength (M.S.)

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 8.3.

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

Testing shall be done in accordance with 8.2.

7.10 Temperature conditioning (T.C.)

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 8.4.

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

Testing shall be done in accordance with 8.2.

7.11 Breathing resistance

The resistance imposed by filter(s) to the flow of air shall be as low as possible and in no case exceed the values shown in Table 1.

Four filters shall be tested, two after the test for mechanical strength according to 8.3 and two after the test for mechanical strength according to 8.3 followed by the temperature conditioning test according to 8.4.


Testing shall be done in accordance with 8.6.

Table 1 — Maximum breathing resistance

Filter class	Maximum breathing resistance in mbar ^{*)}	
	at 30 l/min	at 95 l/min
P1	0,6	2,1
P2	0,7	2,4
P3	1,2	4,2
*) 1 bar = 10 ⁵ N/m ² = 100 kPa		

7.12 Filter penetration

The requirements for maximum filter penetration are given in Table 2.

 For each aerosol, three filters shall be tested following mechanical strength according to 8.3 and temperature conditioning according 8.4.

Testing shall be done in accordance with 8.7.

Filters not meeting the requirement after storage shall be classified as single shift use only. 

Table 2 — Maximum filter penetration

Filter class	Maximum filter penetration of	
	test aerosols (%)	
	Sodium chloride test at 95 l/min	Paraffin oil test at 95 l/min
P1	20	20
P2	6	6
P3	0,05	0,05

7.13 Clogging

7.13.1 General

If the clogging test is performed for a single filter of a multiple filter device at the proportioned test air flow, the stated requirement for the breathing resistance of the filter after clogging holds for the stated dust loading proportioned by the number of filters of the filter set (e.g. for testing a single filter out of a twin filter, class P2, the clogging is performed at a flow rate of 47,5 l/min, until 5 mbar have been reached or until 263 mg·h·m⁻³ have been deposited, whichever occurs first).

7.13.2 Filter penetration

The filter penetration requirements of 7.12 shall be satisfied for each test aerosol before and after the clogging test with dolomite dust.

For each aerosol, four filters shall be tested, two after the test for mechanical strength in accordance with 8.3 and two after the test for mechanical strength in accordance with 8.3 followed by the temperature conditioning test in accordance with 8.4.

Testing shall be done in accordance with 8.7.2, 8.7.3 and 8.8.

7.13.3 Breathing resistance

The breathing resistance after clogging shall not exceed

Filter class P1	4 mbar
Filter class P2	5 mbar
Filter class P3	7 mbar

Four filters shall be tested, two after the test for mechanical strength according to 8.3 and two after the test for mechanical strength according to 8.3 followed by the temperature conditioning test according to 8.4.

Testing shall be done in accordance with 8.6 and 8.8.

8 Testing

8.1 General

Performance tests for the filters not having a connector in accordance with EN 148-1 shall be performed in the filter holder where it will be used in practice.

If no special measuring devices or measuring methods are specified, commonly used devices and methods shall be used.

8.2 Visual inspection

A visual inspection of the filters shall be carried out and the appropriate results reported. The visual inspection includes marking and informations supplied by the manufacturer.

8.3 Mechanical strength (M.S.)

8.3.1 Test equipment

The apparatus as shown schematically in Figure 1, consists of a steel case (K) which is fixed on a vertically moving piston (S), capable of being lifted up 20 mm by a rotating cam (N) and dropping down onto a steel plate (P) under its own mass as the cam rotates. The mass of the steel case shall be more than 10 kg.

The weight of the steel plate onto which the steel case falls should be (at least) 10 times the weight of the steel case. This may be achieved by bolting the base plate to a hard solid floor.

8.3.2 Test procedure

The filters shall be tested as received, removed from their packing but still sealed.

Unencapsulated filter(s) shall be tested in the smallest commercially available package.

The filters shall be placed on their sides in the steel case (K) so that they do not touch each other during the test, allowing 6 mm horizontal movement and free vertical movement. After the test any loose material that may have been released from the filter shall be removed prior to the performance testing.

The test rig shall be operated at the rate of approximately 100 rotations/min for approximately 20 min and a total of 2 000 rotations.

8.4 Temperature conditioning (T.C.)

The filter in its packaging if appropriate, shall be subjected to the following thermal cycle:

- a) to a dry atmosphere at $(70 \pm 3) ^\circ\text{C}$ for 24 h;
- b) to a temperature of $(-30 \pm 3) ^\circ\text{C}$ for 24 h;

and allowed to return to room temperature for at least 4 h between exposures and prior to subsequent testing.

The conditioning shall be carried out in a manner which ensures no thermal shock occurs.

8.5 Test flow conditions

8.5.1 General

All performance tests shall be conducted so that the test air or test aerosol will pass through the filter horizontally, except where the test procedure specifies otherwise.

8.5.2 Multiple filters

When one filter of a multiple filter device is tested separately, the air flow specified for a test shall be divided by the number of filters through which the air flow is proportioned. If, however, it is possible that one filter of a multiple filter device may be used alone, then the full air flow shall be used for testing.

If the filters' resistances meet the following equation

$$\frac{|\Delta \text{ flow resistance }|_{\max}}{\text{mean flow resistance}} \leq 0,2$$

then the filter may be tested as a single filter with a proportioned flow. If the filters' breathing resistances do not meet that equation, the filters shall be tested in a complete unit at the full flow rate.

When testing one filter of a multiple filter device with the proportioned test air flow, the appropriate performance requirements of this standard are to be met.

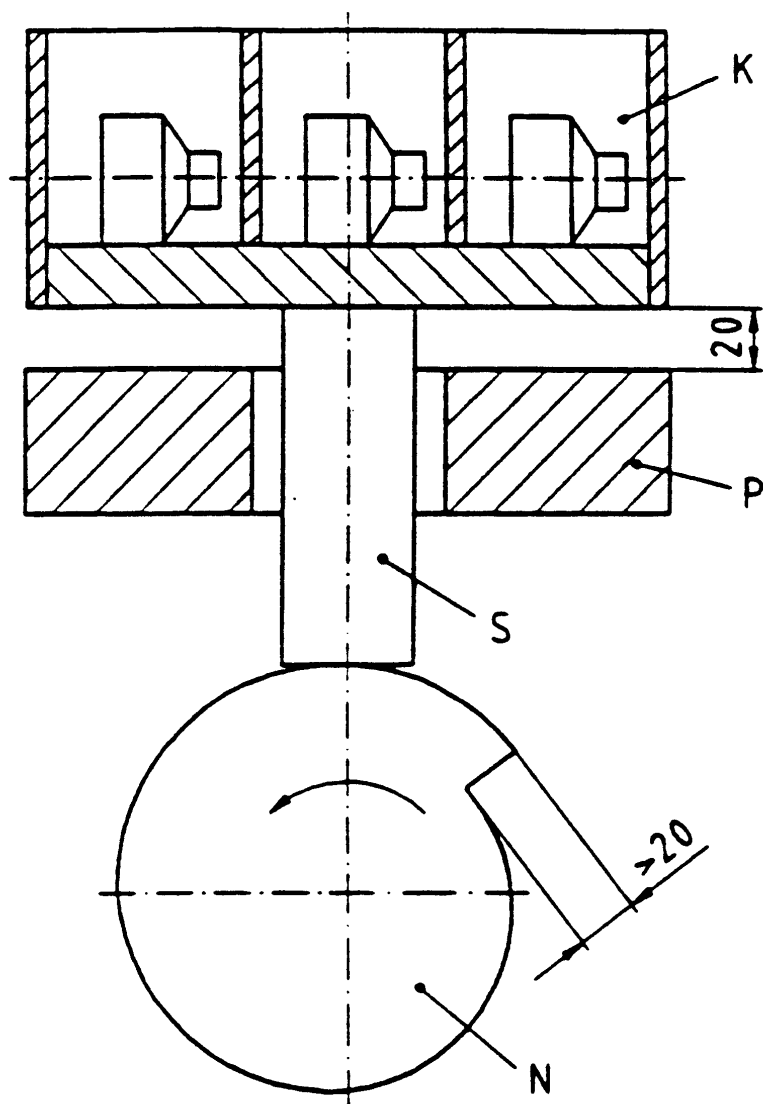
8.6 Breathing resistance

The filter shall be connected in a leaktight manner to the test equipment by means of a suitable adaptor.

Testing shall be carried out at two flow rates (30 and 95 l/min continuous flow or proportioned as appropriate) with air at room temperature, ambient atmospheric pressure and of such humidity that condensation does not occur.

The resistance values shall be corrected for the resistive value introduced by the adaptor. The flow rate at which the resistance is measured, shall be corrected to 23 °C and 1 bar absolute.

Dimensions in millimetres



Key

K	Steel case	S	Piston
P	Steel plate	N	Cam

Figure 1 — Test equipment for test of mechanical strength

8.7 Filter penetration

8.7.1 General

A1 Two test aerosols are used for measurement of filter penetration;

- a) sodium Chloride, using the equipment described in 8.7.3
- b) paraffin Oil, using the equipment described in 8.7.4

The general procedure is described in 8.7.2 and applies for testing using either test aerosols.

NOTE Laboratories should give consideration to the following factors:

- The test chamber should be designed to minimise air velocity variations across the surface of the filter under test. Localised high air velocity ("jets") , may result in artificially high filter penetration.
- Paraffin oil used for testing should not have been exposed to heating and compressed air for a long period of time, as this may alter the composition of the oil, possibly causing inaccurate results.
- Replacement of paraffin oil in the test rig should be done every 3 months.

8.7.2 Test procedure

The test aerosol is fed into the test chamber, where the filter under test is fixed. A flow of 95 l/min is passed through the filter and the aerosol concentration is measured immediately before and after the filter by the photometer.

Penetration shall be recorded throughout the test at sample intervals not exceeding 5 minutes.

- for filters being tested using paraffin oil, continue the test until the filter has been exposed to 120 mg of test aerosol.
 - for filters being tested using sodium chloride, continue the test until the filter has been exposed to 120 mg of test aerosol, unless;
- a) for single shift use filters, the penetration shows continued decline for 5 minutes or 5 sample intervals, whichever is the greater.
 - b) for re-useable filters, the penetration shows continued decline for 5 minutes or 5 sample intervals, whichever is the greater, and the maximum penetration is lower than when tested using paraffin oil test aerosol.

NOTE Continuous recording of penetration is recommended.

If these conditions are met, the exposure test may be terminated early.

Report the maximum penetration during exposure.

For re-usable filters, immediately continue testing as follows, but in the case of re-usable filters for which the sodium chloride test was terminated before full 120 mg exposure, further testing need only be performed using paraffin oil test aerosol.

Remove the filter from the penetration test chamber and store the filter in accordance with EN 13274-5, for a duration of (24±1) hours under ambient conditions as described in 3.1 of EN 13274-5:2001, ensuring that filters are not in contact with each other.

Remove the filter from storage and return it to the penetration test chamber.

Pass the test aerosol (the same aerosol used for the 120 mg exposure test) through the filter at a flow of 95 l/min.

Determine the penetration measured as the average over a time of (30±3) s, 3 min after the start of the test. Report this as the penetration after storage. **A1**

A1 8.7.3 **A1** Sodium chloride test

A1 8.7.3.1 **A1** General

An aerosol of sodium chloride particles is generated by atomizing an aqueous solution of the sodium chloride and evaporating the water. The concentration of this aerosol is measured before and after the filter under test by means of flame photometry. Accurate determinations are possible in the range from 0,0001 to 100 % filter penetration.

8.7.3.2 Test equipment

The apparatus is shown in Figure 2. The aerosol is generated by using a Collison atomizer filled with a 1 % solution of sodium chloride. The atomizer, an example of which is shown in Figure 3, consists of a glass reservoir into which is sealed an atomizer head having three spray nozzles. Air is supplied to the atomizer at a pressure of 3,45 bar and the resulting liquid spray impinges on a baffle which removes the large particles. The particles which do not impact are removed in the air flow and, on mixing with dry air, the water evaporates leaving a dry sodium chloride aerosol.

The aerosol produced by this method is polydisperse with a mass median particle diameter of approximately 0,6 μm . The particle size distribution is given in Figure 4. It has been found that the aerosol remains constant, within acceptable limits, with respect to particle size and concentration provided that the supply pressure is in the range from 3,31 to 3,59 bar and the flow rate of air to the three nozzles is from 12,5 to 13,0 l/min. The output is mixed with 82 l/min of dry air giving a total flow of 95 l/min.

The sodium chloride solution in the atomizer is consumed at a rate of approximately 15 ml/h. This loss is due in part to the atomization of the solution and in part to evaporation of water from the reservoir. The volume of the reservoir is such that the change in concentration and loss in volume of the solution during an 8 h period will not cause an appreciable change in the characteristics of the test aerosol.

The sodium chloride aerosol is analysed before and after the filter under test by flame photometry. The photometer used for this analysis can be any suitable instrument having the required sensitivity, however, a photometer specially designed to meet these requirements is available.*)

The instrument is a hydrogen flame photometer. The hydrogen burner is housed in a vertical flame tube which opens at its lower end into the sample tube through which the aerosol to be analysed flows. The flow of aerosol to the flame is controlled by convection and is held constant with a bleed valve.

A small quantity of filtered air is fed continuously into the sample tube downstream of the inlet to the flame tube. The function of this supply is to prevent room air, which may contain considerable quantities of sodium salts, from reaching the burner when there is no flow through the sample tube.

The hydrogen burner, which gives a flame symmetrical about the vertical axis, is surrounded by a heat proof glass tube. This tube shall be optically homogeneous to minimize the effect on the light transmitted by the flame.

Sodium chloride particles in air passing through the flame tube are vapourized giving the characteristic sodium emission at 589 nm. The intensity of this emission is proportional to the concentration of sodium in the air flow.

The intensity of the light emitted by the flame is measured by using a photomultiplier tube. To separate the sodium emission from background light of other wavelengths, a narrow band interference filter with appropriate sideband filters is used. This filter should preferably have a half-peak band width of no more than 5 nm.

As the photomultiplier output is only proportional to the incident light over a relatively small range, high light intensities are attenuated by neutral density filters. These filters are accurately calibrated in conjunction with the interference filter in use and so the actual light intensity can be calculated from the output of the photomultiplier. The signal from the photomultiplier is amplified and recorded.

Calibration of the flame photometer will depend on the detailed design of the instrument, and the manufacturer's informations should be followed if reliable results are to be obtained. In general, however, the methods which may be used are: multiple dilution of the aerosol, dilution of the atomizer solution or a combination of both. If aerosol or solution dilution is used alone the lower calibration limit is approximately two orders of magnitude higher than the ultimate sensitivity of the instrument.

Where a photomultiplier with attenuating filters is used for detection this is unimportant as the photomultiplier measures a constant range of light levels over the entire range of the instrument, and the values of the attenuating filters are known and invariable. Hence the calibration curve is linear at low concentrations and can safely be extrapolated to the lower values. The upper limit of linearity of the calibration curve is approximately 0,12 mg/m^3 due to re-absorption of light within the flame. Non-linear calibration is possible above this point up to approximately 15 mg/m^3 . Where other detectors are used this may not be the case and a combination technique would be required to reach the ultimate sensitivity.

*) Information concerning the supplier of the photometer and the aerosol generator can be obtained from the secretariat of CEN/TC 79.

8.7.3.3 Test conditions

Particle size distribution of the test aerosol, see Figure 4.

Flow rate of test aerosol	95 l/min
Aerosol concentration	$(8 \pm 4) \text{ mg/m}^3$
Air pressure to atomizer	$(3,45 \pm 0,14) \text{ bar}$
Flow rate to atomizer	$(12,75 \pm 0,25) \text{ l/min}$
Flow rate of diluting air	82 l/min
Flow rate of hydrogen to photometer	from 450 to 500 ml/min
Wavelength of sodium emission	589 nm
Air temperature	ambient
Relative humidity	less than 60 %.

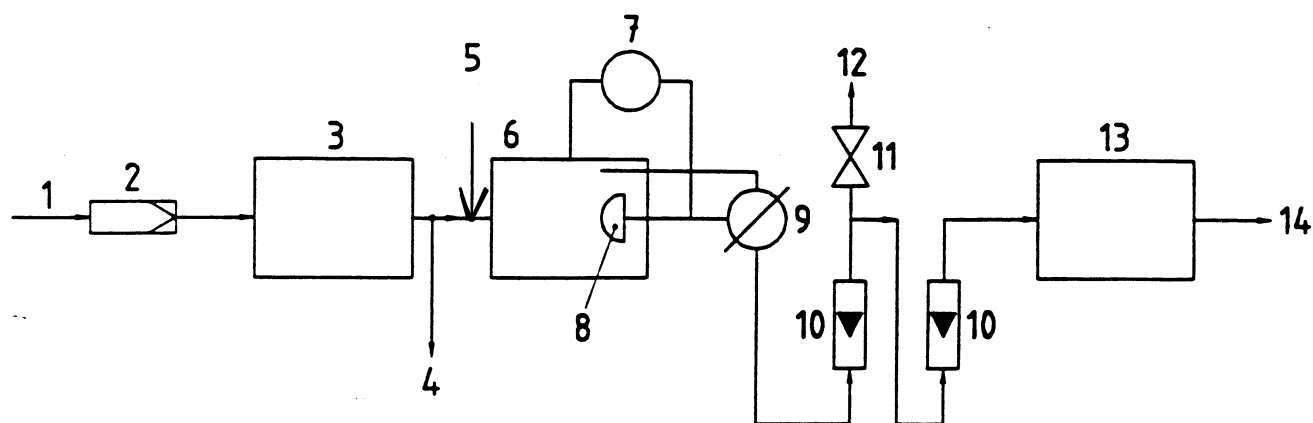
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8.7.3.4 Calculation of the penetration

$$P(\%) = \frac{C_2}{C_1} \times 100$$

where:

- P is the penetration;
- C_1 is the sodium chloride concentration before the filter;
- C_2 is the sodium chloride concentration after the filter.

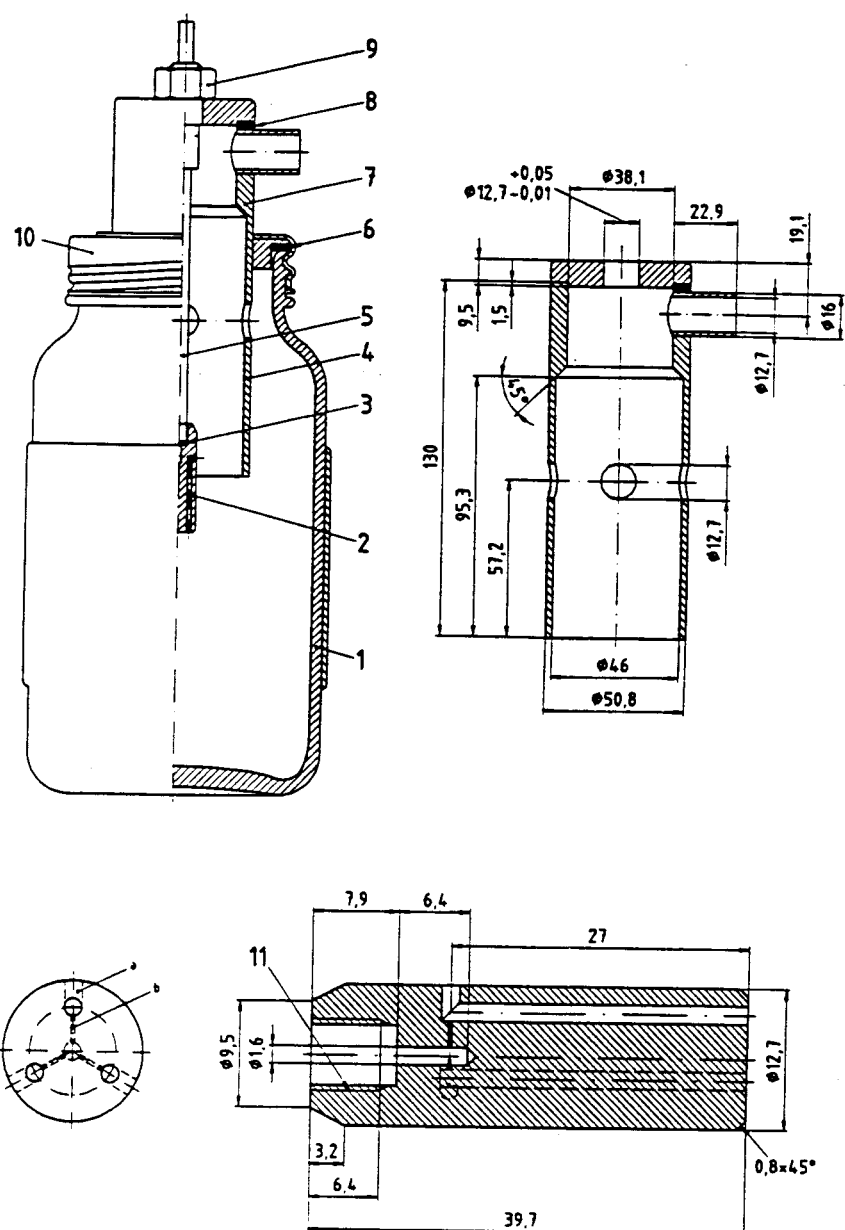


Key

1	Compressed air	8	Specimen
2	Air filter	9	3-way valve
3	Test aerosol generator	10	Flow meter
4	Bleed	11	Valve controlling flow rate
5	Clean air	12	Exhaust
6	Test chamber	13	Aerosol measuring apparatus
7	Pressure gauge (optional)	14	Exhaust

Figure 2 — Apparatus for sodium chloride test

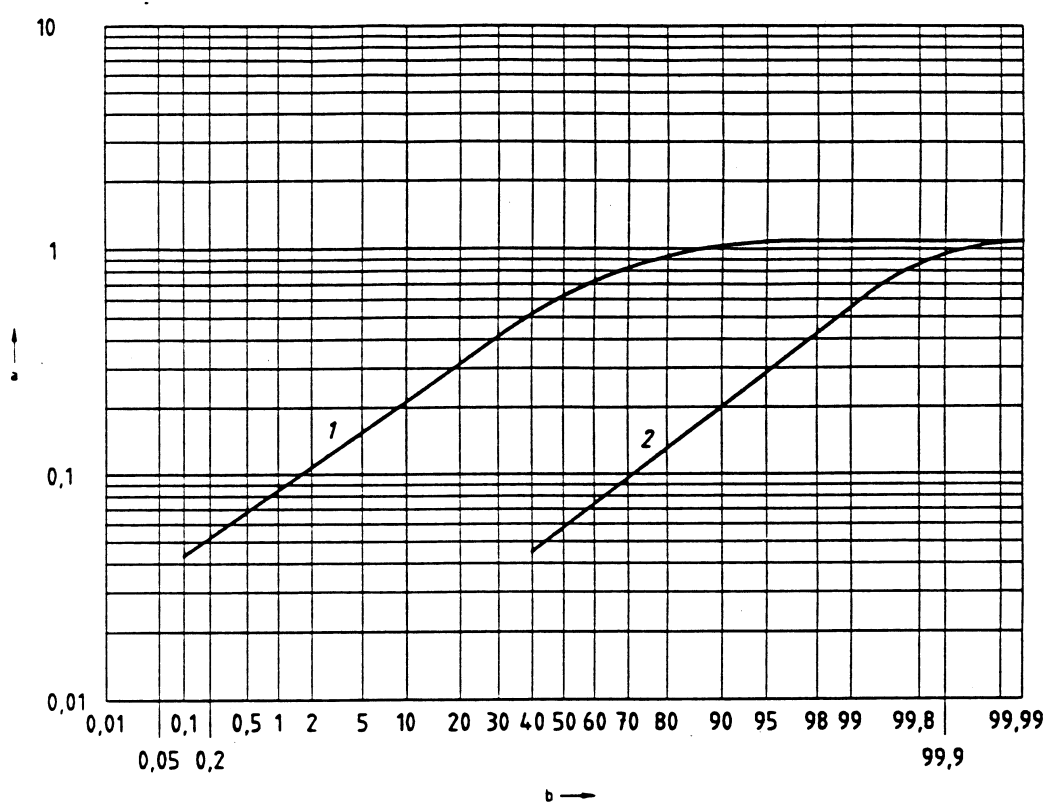
Dimensions in millimetres



Key

- | | | | |
|---|--------------------------|----|---|
| 1 | Glass screw top jar | 8 | Rubber gasket |
| 2 | Nozzle | | 25,0 mm external diameter |
| 3 | Fibre washer | | 10,0 mm internal diameter |
| | 4,5 mm external diameter | | 1,5 mm thickness |
| | 2,0 mm internal diameter | | Seals to be airtight |
| | 0,8 mm thickness | 9 | Nut |
| 4 | Sleeve | 10 | Screw cap |
| 5 | Stem | 11 | Tapped 6,4 |
| 6 | Rubber gasket | | |
| 7 | Head | a) | 3 holes 1,6 diameter
equally spaced on 7,9 P.C. diameter |
| | | b) | 3 holes 0,34 diameter |

Figure 3 — Schematic diagram of the atomizer



NaCl test aerosol

Size distribution produced by atomizing 1 % NaCl solution at 3,45 bar

Key

- 1 Mass
- 2 Number
- a Longest diagonal of NaCl particle (μm)
- b Percentage below stated size (%)

Figure 4 — Particle size distribution of sodium chloride aerosol

8.7.4 Paraffin oil test

8.7.4.1 General

An aerosol of paraffin oil droplets is generated by atomizing heated paraffin oil. The concentration of this aerosol is measured before and after the filter under test by means of an aerosolphotometer. Accurate determinations are possible in the range 0,003 % to 100 % filter penetration.

8.7.4.2 Test equipment

An example of the apparatus is shown in Figure 5. The aerosol is generated using an atomizer (Figures 6 and 8). The atomization vessel (6) is filled with paraffin oil (paraffinum perliquidum CP 27 DAB 7^{*}), so that the oil level is between the min/max-marks (10). The atomization vessel is heated by means of an electric heating device (8), so that the temperature of the oil is kept to nominally 100 °C by means of a thermostat (9). The temperature is measured by the thermometer (11). Filtered compressed air at 4 bar (3, 4) is preheated in (8) and blown through the multiple nozzle unit (12 and Figure 8). Large droplets in the generated oil mist are separated in the control nozzle (13) and in the spiral tube (15). In the mixing vessel (5) the oil droplets and oil vapour are diluted with 50 l/min filtered air, measured by the flowmeter (2). Since the diluting air is at room temperature, the oil vapour condenses in the mixing vessel. The generated aerosol is the test aerosol, which is reduced to the test concentration of $(20 \pm 5) \text{ mg/m}^3$ by wasting an appropriate fraction of the oil mist (see Figure 5, item 18 in connection with 11, 7, 10, 12 and 17) and by further dilution with filtered air at a flow rate of 83 l/min in the blowers actuated by air power (type Friedrichs-Antlinger, see Figure 5, item 5 and Figure 9). The test aerosol produced by this method is polydisperse. The particle size distribution is a logarithmic normal distribution with the median Stokes diameter of 0,4 μm (for the number distribution) and the logarithmic standard deviation 0,26 (see Figure 7).

The test aerosol is fed into the test chamber (Figure 5, (1)), where the filter under test is to be fixed (15). The excess of the aerosol is filtered by a high efficiency filter with a low flow resistance (10). A flow rate of 95 l/min is drawn through the filter under test. The test concentration is measured before and after the filter under test by means of an integrating light scattering photometer. The principle of the aerosolphotometer is shown in Figure 10. The instrument is a 45° scattering photometer. The light source is directed to the measuring cell and to the photomultiplier. The direct beam to the multiplier is interrupted by a chopper, so that the scattered light from the particles is always corrected for the source intensity variations. The reference beam is attenuated by means of neutral density filters and of a neutral density wedge automatically to the intensity of the scattered light beam.

The intensity of the scattered light, which is a measure for the aerosol concentration, is displayed.

^{*}) The physical properties of the oil are:

Density at 20 °C: 0,846 g/cm³

Viscosity at 20 °C: 0,026 to 0,031 Pa·s

Information concerning the suppliers of the paraffin oil, the aerosol generator and the aerosol photometer can be obtained from the secretariat of CEN/TC 79.

8.7.4.3 Test conditions

Particle size distribution of the test aerosol, see Figure 7.

Flow rate through the filter under test	95 l/min
Aerosol concentration	$(20 \pm 5) \text{ mg/m}^3$
Air temperature	ambient
Air pressure to atomizer	$(4,00 \pm 0,15) \text{ bar}$
Flow rate to atomizer	$(13,5 \pm 0,5) \text{ l/min}$
Mixing air flow rate in aerosol generator	50 l/min
Flow rate of diluting air	83 l/min
Temperature of the oil in the generator	from 100 to 110 °C.

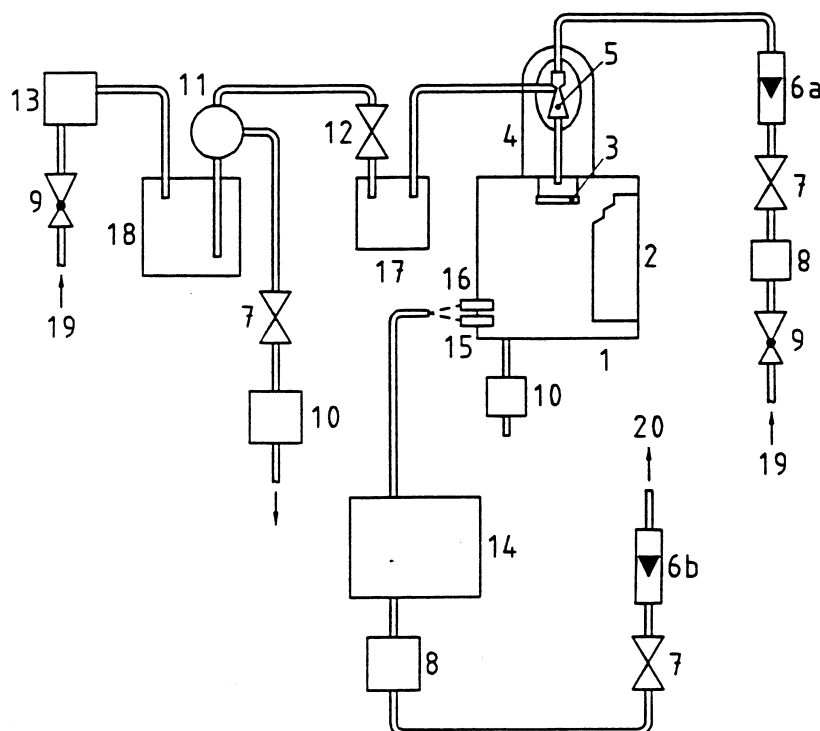
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8.7.4.4 Calculation of the penetration

$$P(\%) = \frac{I_2 - I_0}{I_1 - I_0} \times 100$$

where:

- P is the penetration;
- I_1 is the photometer reading before the filter;
- I_2 is the photometer reading after the filter;
- I_0 is the photometer zero reading for clean air.

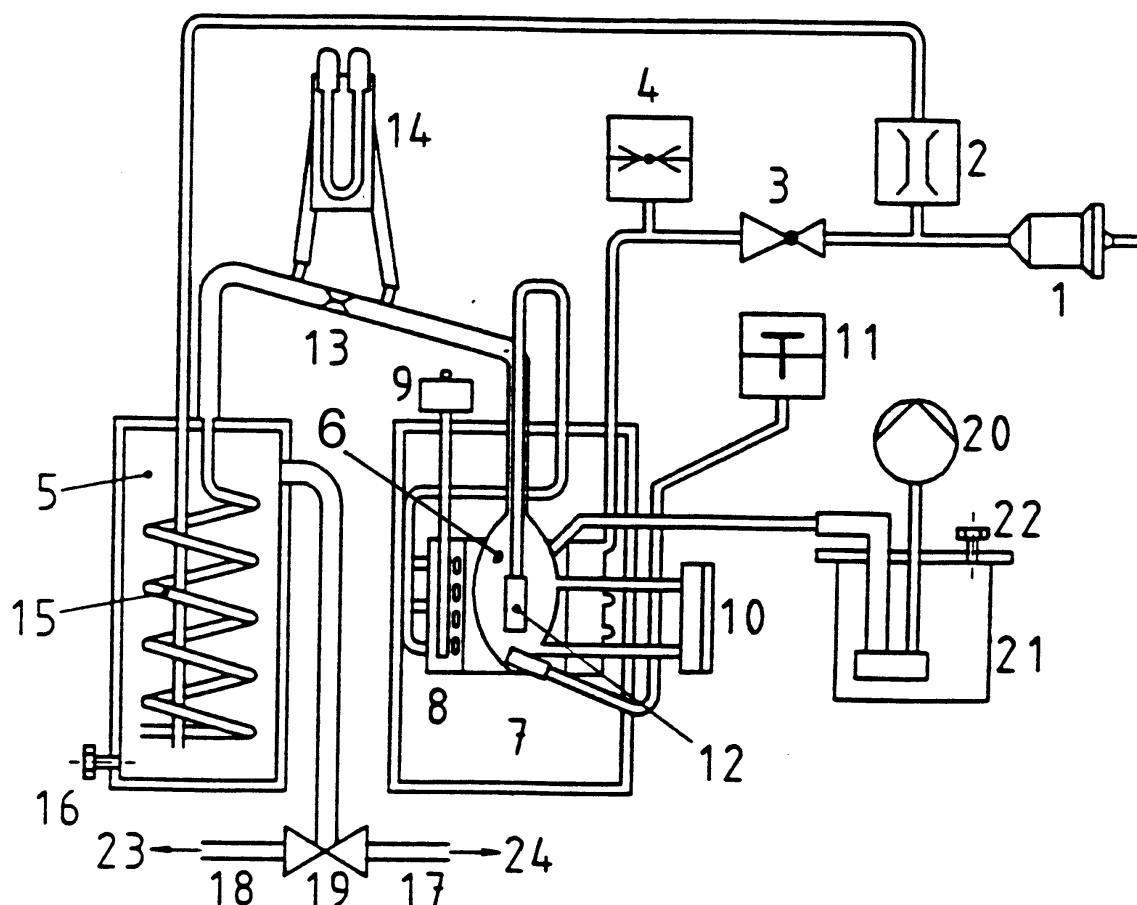


Key

- | | | | |
|----|--|----|---|
| 1 | Test chamber: Rigid transparent material, diameter 500 mm, height 500 mm, covered with plywood on both sides | 11 | T-piece for taking out the amount of oil mist necessary for testing |
| 2 | Tightly fitting door of the chamber | 12 | Needle valve controlling the oil mist concentration in the chamber |
| 3 | Dish for collecting oil running down the walls of the tube | 13 | Oil mist generator |
| 4 | Cover for the blowers actuated by air power | 14 | Aerosolphotometer |
| 5 | Blowers actuated by air power for taking the concentrated oil mist into the chamber | 15 | Connecting pipe to test object |
| 6 | Flowmeters, range from 800 to 8 000 l/h | 16 | Probe for measuring the oil mist concentration in the chamber |
| | a) for measuring the propellant air for the blowers (5 000 l/h) | | |
| | b) for measuring the test flow rate (95 l/min) | | |
| 7 | Valves controlling the flow rate | | |
| 8 | High efficiency filters | 17 | Woulfe's bottle |
| 9 | Reducing valves, range from 1 to 5 bar at a prepressure from 6 to 10 bar | 18 | Buffer volume of 5 l |
| 10 | High efficiency filter with low resistance | 19 | Compressed air |
| | | 20 | To vacuum pump |

The aerosolphotometer is connected with 15 or 16 as required by means of a short tube. The connecting pipe not employed is to be closed tightly. The tubes for the oil mist are textile-reinforced plastic tubes with an inner diameter of 19 mm.

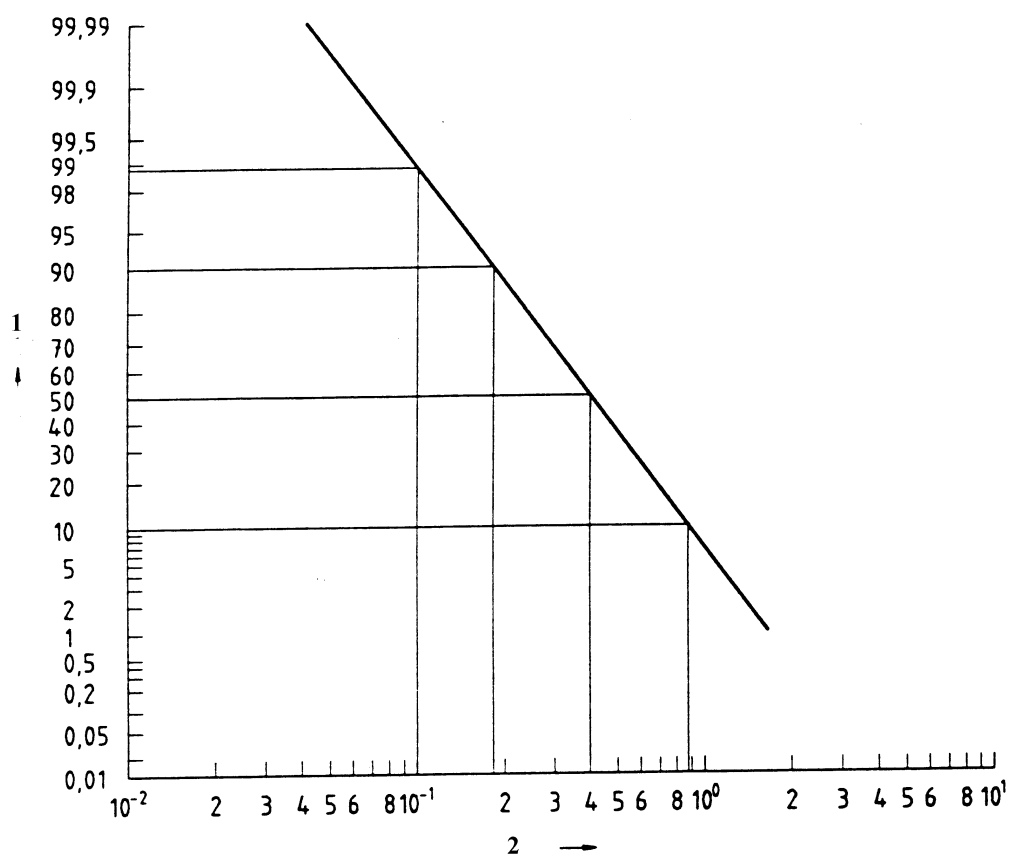
Figure 5 — Schematic diagram of apparatus for paraffin oil test



Key

1	5 bar air inlet with air filter	13	Control nozzle
2	Flowmeter	14	U-tube manometers
3	Pressure reducer	15	Spiral tube
4	Manometer	16	Drainage screw
5	Mixing vessel	17	Outlet to measuring device
6	Atomization vessel	18	Waste outlet
7	Thermostat vessel	19	Change-over valve
8	Heating jacket	20	Oil pump
9	Thermostat	21	Oil supply container
10	Oil-level indicator	22	Locking screw
11	Thermometer	23	Exhaust
12	Atomization nozzle	24	Measuring

Figure 6 — Schematic diagram of generator for paraffin oil aerosol



Paraffin oil mist

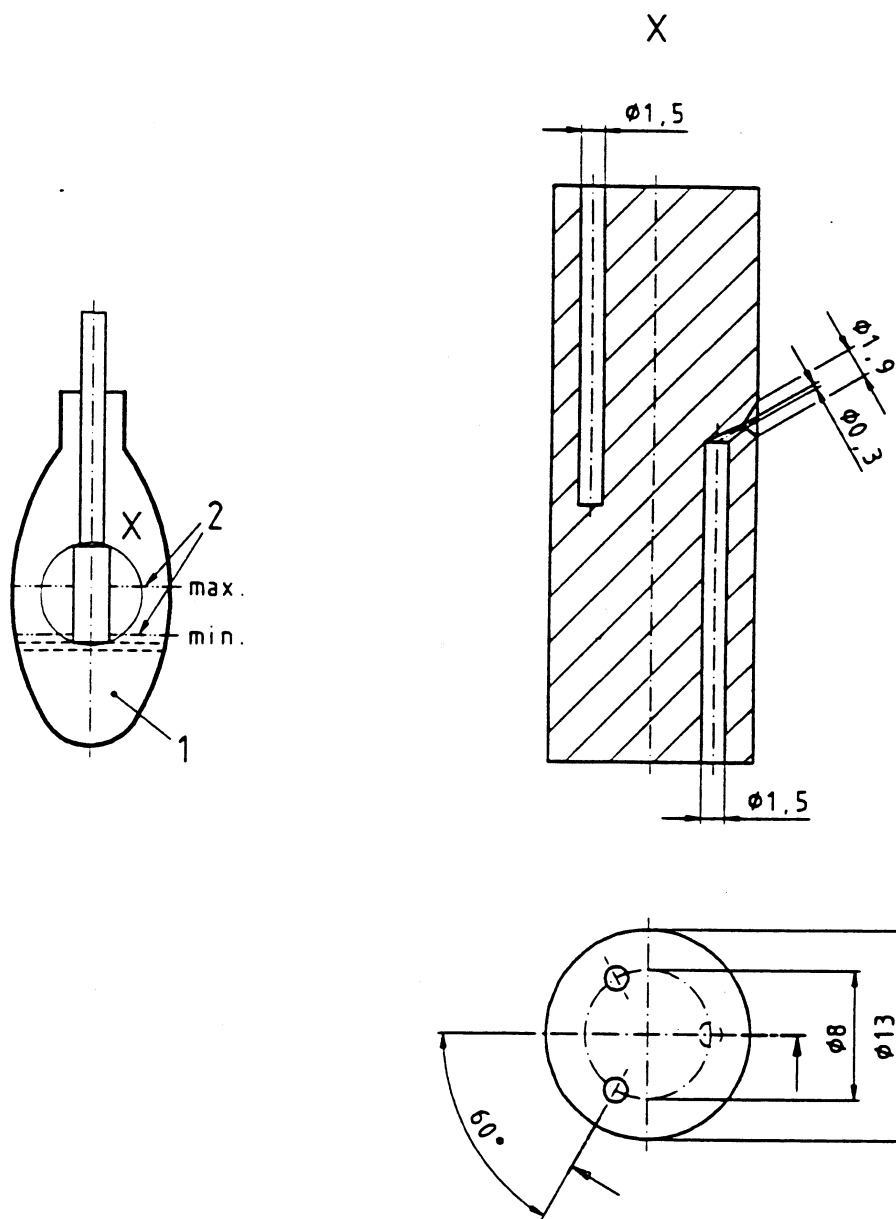
Number distribution $\sigma_{\log d} = 0,26$

Key

- 1) Percentage above stated size
- 2) Stokes diameter in μm

Figure 7 — Particle size distribution of paraffin oil mist

Dimensions in millimetres



Key

- 1 Paraffin oil
- 2 Oil level

Figure 8 — Atomizer

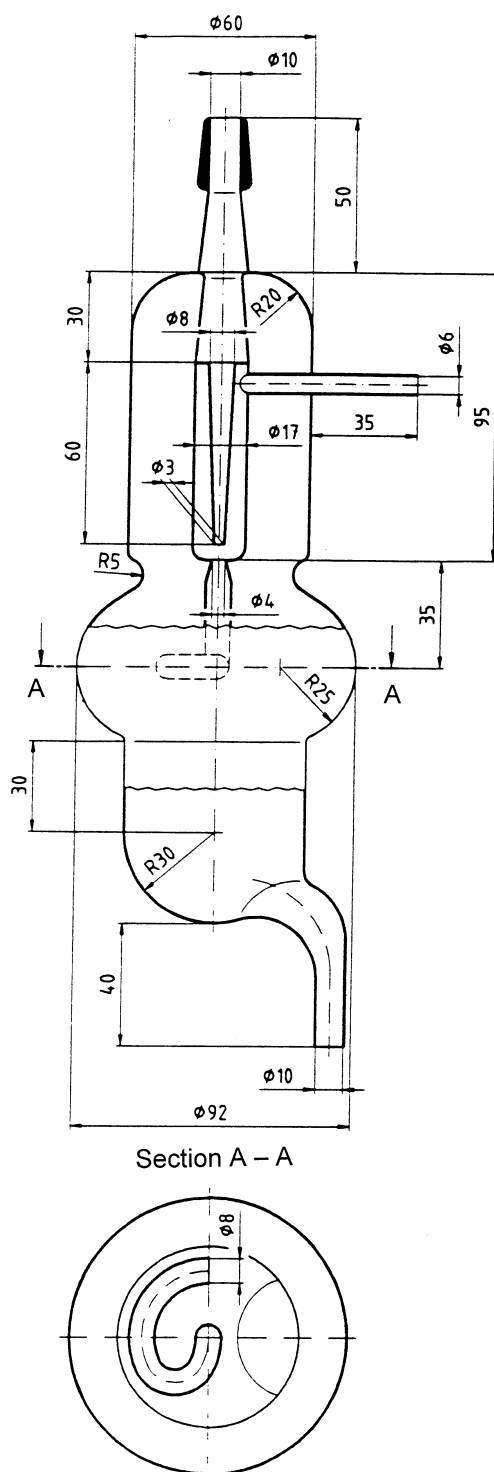
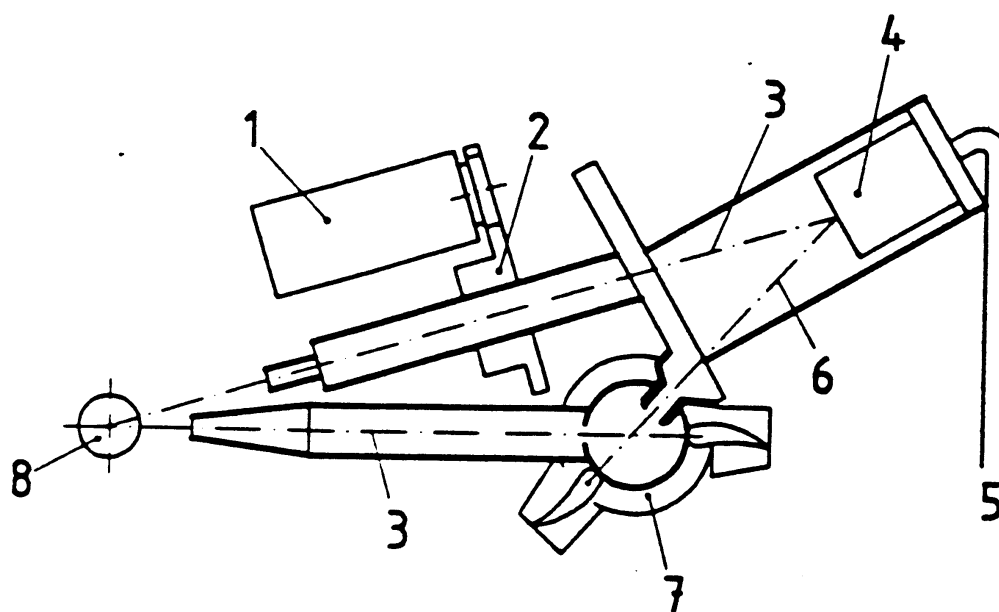


Figure 9 — Blowers actuated by air power

(Friedrichs-Antlinger, JENAer GLAS D 501)



Key

- 1 Regulating motor
- 2 Beam regulator
- 3 I_0 Direct light beam
- 4 Photo multiplier
- 5 Amplifier
- 6 I Scattered light beam
- 7 Measuring chamber
- 8 Light source

Figure 10 — Schematic drawing for the aerosolphotometer

8.8 Clogging

8.8.1 General

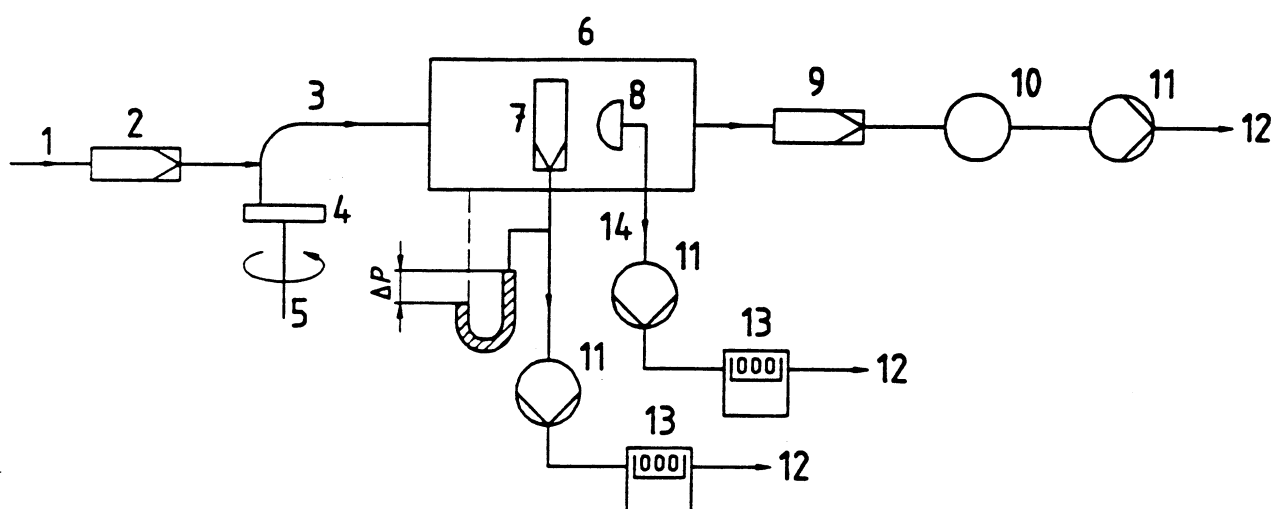
The test consists of drawing dust laden air through the filter under test, and determining the quantity of dust deposited on the filter when a specified breathing resistance is reached.

The filter is tested mounted on a suitable adaptor. Optionally it can be tested mounted on a facepiece, but then the pressure drop introduced by the features of the facepiece (inhalation valve, for instance) has to be taken into consideration in the results.

In both cases a tight seal on the holder is necessary.

8.8.2 Test equipment

The apparatus is shown schematically in Figure 11.



Key

1	Compressed air	8	Probe
2	Air filter	9	Filter
3	Injector	10	Flowmeter
4	Dust	11	Pump
5	Dust distributor	12	Exhaust
6	Dust test chamber	13	Gasmeter
7	Filter under test	14	Probe line

Figure 11 — Schematic diagram of apparatus for clogging test with dolomite dust

8.8.3 Test conditions

— Dust: DRB 4/15 dolomite.*)

The particle size distribution of the airborne dust at the working area of the dust chamber is given in Figure 12.

This characteristic is an essential parameter, which shall be verified if the geometry of the test chamber is different from the model described.

- Continuous flow through the dust chamber: $60 \text{ m}^3/\text{h}$, linear speed 4 cm/s ;
- Continuous flow through the filter: 95 l/min ;
- Concentration of the dust: $(400 \pm 100) \text{ mg/m}^3$;
- Temperature of the air: $(23 \pm 2) ^\circ\text{C}$;
- Relative humidity of the air: $(45 \pm 15) \%$;
- Testing time: To be tested until the product of dust concentration and the testing time is 263 mg.h.m^{-3} or the breathing resistance has reached 4 mbar for a P1 filter or 5 mbar for a P2 filter or 7 mbar for a P3 filter.

8.8.4 Test procedure

Dust from the distributor is conveyed to the dust chamber where it is dispersed into the air stream of $60 \text{ m}^3/\text{h}$.

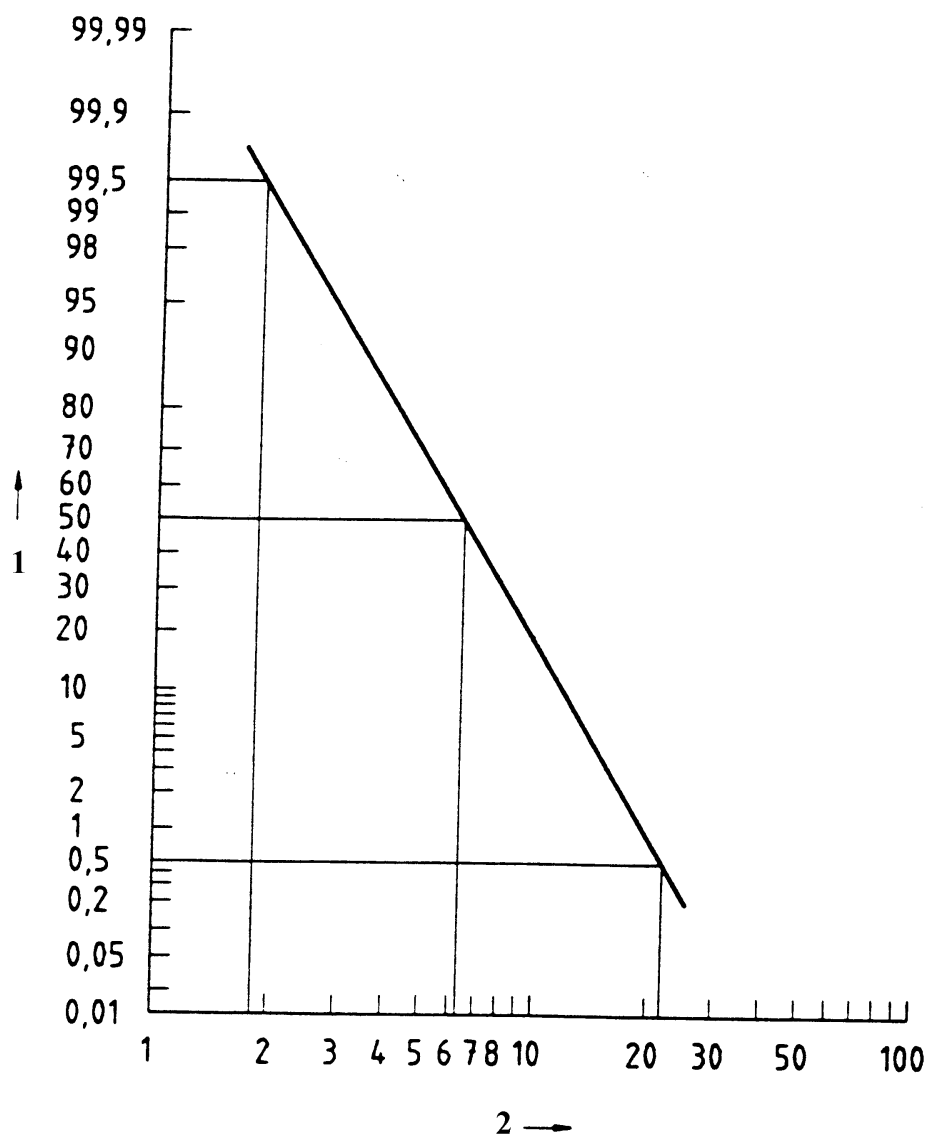
The filter under test is mounted on a suitable adaptor in a leaktight manner and located in the dust chamber. A flow of 95 l/min is drawn through the filter under test until the relevant limit given in clause 7.13 or the required testing time has been reached.

The concentration of dust in the test chamber may be measured by drawing air at 2 l/min through a sampling probe equipped with a pre-weighed, high efficiency filter (open face, diameter 37 mm) located near the test sample.

The dust concentration shall be calculated from the weight of dust collected, the flow rate through the filter and the time of collection.

NOTE Other suitable means for measurement of the concentration of dust may be used.

*) Information concerning the supplier of the dolomite dust can be obtained from the secretariat of CEN/TC 79



Size distribution (mass)

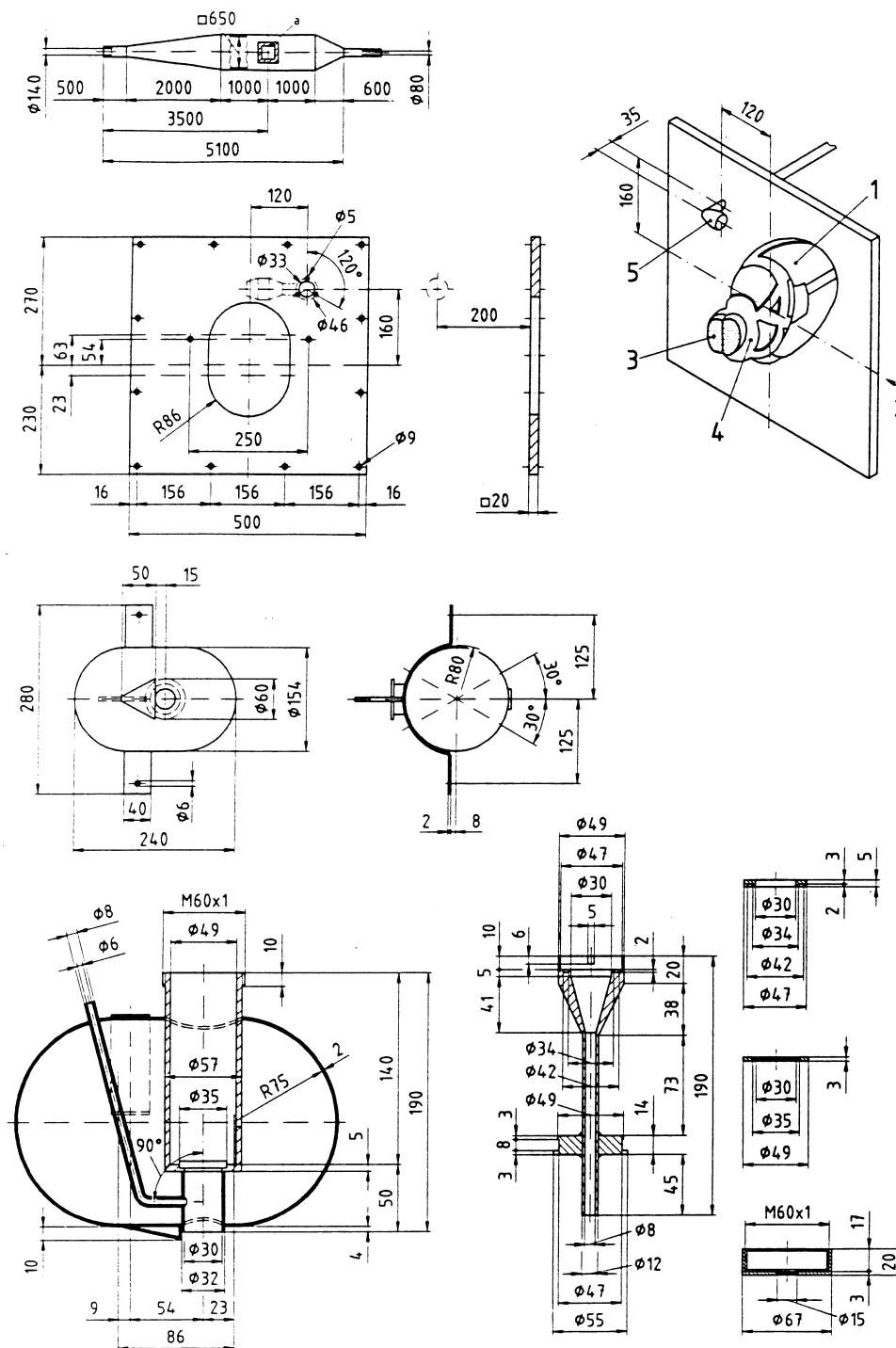
Dolomite DRB 4/15 Test Aerosol

Key

- 1) Percentage above stated size
- 2) Particle diameter mass basis μm

Figure 12 — Particle size distribution of dolomite dust

Dimensions in millimetres



Key

- 1 Dummy head
- 2 Airflow
- 3 Filter

- 4 Facepiece
- 5 Probe
- a) Dust test chamber opening

Figure 13 — Schematic drawing of dolomite dust clogging test apparatus

9 Marking


9.1 General

All the markings shall be readable and durable.

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


9.2 Encapsulated filters

All filters where the filtering material is contained within a casing shall be marked at least with:

 a) appropriate filter type and class (P1, P2 or P3), and white colour code followed by:


If the marking is not directly on the filter body, it 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) "NR" if the filter is limited to single shift use only: "Example: EN 143:2000 P3 NR" or
- c) "R" if the filter is re-usable **respectively**: Example: EN 143:2000 P2 R;
- d) a mark showing if the filter is for a multiple filter device;
- e) the number and year of publication of this European Standard;
- f) at least the year of end of shelf life. The end of shelf life may be informed by a pictogram as shown in Figure 14 where the code "yyyy/mm" indicates the year and month;
- g) the manufacturer's name(s), trade mark(s) or other means of identification;
- h) 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 14;
- i) type-identifying mark. 

9.3 Unencapsulated filters


Filters comprising entirely of filtering material (without casing) shall be marked at least with:


 a) the appropriate filter type and class (P1, P2 or P3), and white colour code followed by:

- b) "NR" if the filter is limited to single shift use only: "Example: EN 143:2000 P3 NR" or
- c) "R" if the filter is re-usable **respectively**: Example: EN 143:2000 P2 R;
- d) type-identifying mark. 

9.4 Filter package

The smallest commercially available filter package shall be marked at least with the following information, unless it is already on the filter:

 a) the appropriate filter type and class (P1, P2 or P3), and white colour code followed by:

- b) "NR" if the filter is limited to single shift use only: "Example: EN 143:2000 P3 NR" or
- c) "R" if the filter is re-usable **respectively**: Example: EN 143:2000 P2 R;
- d) the number and year of publication of this European Standard;
- e) at least the year of end of shelf life or equivalent pictogram as shown in Figure 14, if applicable;
- f) the manufacturer's name(s), trade mark(s) 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 14; 

- h) type-identifying mark;
- i) the manufacturer's recommended conditions of storage (at least the temperature and humidity) or equivalent pictogram as shown in Figure 14;
- j) multiple filter mark, if applicable.

The information specified in c), f) and g) shall be visible without opening the package.

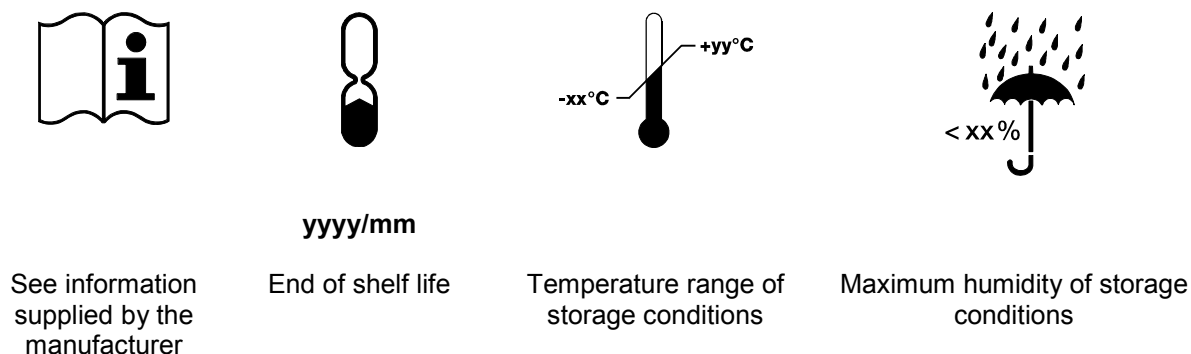


Figure 14 — Pictograms

10 Information supplied by the manufacturer

On delivery information supplied by the manufacturer



- a) shall accompany every smallest commercially available package;
- b) shall be at least in the official language(s) of the country of destination;
- c) of the filters shall contain all information necessary for trained and qualified persons on
 - application/limitations
 - give type-identifying marking to ensure that the filter can be identified
 - controls prior to use
 - fitting
 - describe how the filter(s) is inserted in the equipment for which it is (they are) designed and how that equipment is identified
 - use
 - maintenance
 - storage of filter
- d) shall be clear and comprehensible. If helpful, illustrations, part numbers, marking should be added;
- e) shall include warnings against problems likely to be encountered, for example:
 - hazards of oxygen deficiency;
 - hazards of oxygen and oxygen-enriched air;
 - air quality;
 - use of equipment in explosive atmosphere;
 - storage under conditions other than those specified by the manufacturer may affect the shelf life
 - guidance as to use of filter with both full face mask or half mask, or not with half mask as appropriate (weight of filter)
-  f) for single-shift use filters (marked "NR"), a warning shall be given that the device shall not be used for more than one shift.
- g) explanation of the used symbols shall be added. 

Table 3 — Summary of requirements and tests

Title	Requirement Clause	Number of Samples	Conditioning	Test Clause
Visual Inspection	7.3	all	-----	8.2
Connection	7.4	all	-----	8.2
Mass	7.5	all	-----	8.1
Multiple Filters	7.6	all	-----	8.1, 8.2
Packaging	7.8	all	-----	8.2
Mechanical Strength (M.S.)	7.9	-----	-----	8.2, 8.3
Temperature Conditioning (T.C.)	7.10	-----	-----	8.2, 8.4
Breathing Resistance	7.11	2 (for each flow rate)	M.S.	8.6
		2 (for each flow rate)	M.S. + T.C.	8.6
A₁ Filter Penetration	7.12	3 (for each aerosol)	M.S. + T.C.	8.7 A₁
Clogging	7.13	4	M.S.	8.8
		4	M.S. + T.C.	8.8
Test Flow Conditions	-----	all	-----	8.5

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives


This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 89/686/EEC.

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this European Standard.

The following clauses of this European Standard are likely to support requirements of Directive 89/686/EEC, Annex II:

Table ZA.1

EU DIRECTIVE 89/686/EEC, Annex II	Clauses of this European Standard
1.1.1	7.5, 7.7, 7.11, 7.12, 7.13
1.1.2.1	7.5, 7.11, 7.12, 7.13
1.1.2.2	5, 7.12
1.2.1.1	7.7
1.2.1.2	7.3
1.3.1	7.3, 7.4, 7.5
1.3.2	7.4, 7.5, 7.9, 7.10
1.3.3	7.4, 7.5
1.4	9, 10
2.4	9.2 d), 10c
2.10	7.4, 10 c)
2.12	9
3.10.1	4, 5, 6, 7, 9, 10

Compliance with the clauses of this European Standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations. 

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