

# Respiratory protective devices — Half masks and quarter masks — Requirements, testing, marking

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The European Standard EN 140:1998 has the status of a  
British Standard

ICS 13.340.30

## National foreword

This British Standard is the English language version of EN 140:1998. It supersedes BS 7356:1990 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PH/4, Respiratory Protection, to Subcommittee PH/4/3, Facepieces, which has the responsibility to:

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

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

### Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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### Summary of pages

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English version

## Respiratory protective devices — Half masks and quarter masks — Requirements, testing, marking

Appareils de protection respiratoire —  
Demi-masques et quarts de masques — Exigences,  
essais, marquage

Atemschutzgeräte — Halbmasken und  
Viertelmasken — Anforderungen, Prüfung,  
Kennzeichnung

This European Standard was approved by CEN on 4 September 1998.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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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**CEN**

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

**Central Secretariat: rue de Stassart 36, B-1050 Brussels**

## 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 supersedes EN 140:1989 and amendment EN 140:1989/A1:1992.

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 March 1999, and conflicting national standards shall be withdrawn at the latest by March 1999.

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.

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## 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 successful practical performance 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 respiratory characteristics and weight distribution are similar to those of the complete apparatus.

## 1 Scope

This European Standard specifies minimum requirements for half masks and quarter masks for use as part of respiratory protective devices, except escape apparatus and diving apparatus.

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

## 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.

prEN 132, *Respiratory protective devices — Definitions.*

EN 134, *Respiratory protective devices — Nomenclature of components.*

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

prEN 148-2, *Respiratory protective devices — Threads for facepieces — Part 2: Centre thread connection.*

EN ISO 6941, *Textile fabrics — Burning behaviour — Measurement of flame spread properties of vertically oriented specimens.*

(ISO 6941:1984, including Amendment 1:1992)

## 3 Definition

For the purposes of this European Standard the definitions given in prEN 132 and the nomenclature given in EN 134 apply together with the following.

A **half mask** is a facepiece which covers the nose, mouth and chin. A **quarter mask** is a facepiece which covers the nose and mouth. They are intended to provide adequate sealing on the face of the wearer of a respiratory protective device against the ambient atmosphere, when the skin is dry or moist and when the head is moved.

## 4 Description

Air enters the facepiece and passes directly to the nose and mouth area of the facepiece. The exhaled air flows directly to the ambient atmosphere, via the exhalation valve(s) or by other appropriate means.

## 5 Designation

Half masks and quarter masks meeting the requirements of this standard shall be designated in the following manner:

half mask EN 140:1998;

quarter mask EN 140:1998.

## 6 Requirements

### 6.1 General

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

### 6.2 Nominal values and tolerances

Unless otherwise specified, the values stated in this standard are expressed as nominal values. Except for temperature limits, values which are not stated as maxima or minima shall be subject to a tolerance of  $\pm 5\%$ . Unless otherwise specified, the ambient temperature for testing shall be  $(24 \pm 8)^\circ\text{C}$ , the temperature limits shall be subject to an accuracy of  $\pm 1^\circ\text{C}$  and the relative humidity shall be  $(50 \pm 30)\%$ .

### 6.3 Visual inspection

The visual inspection shall include the marking and information supplied by the manufacturer.

Testing shall be done in accordance with 7.3.

### 6.4 Materials

The use of aluminium, magnesium and titanium or alloys containing such proportions of these metals as will, on impact, give rise to frictional sparks capable of igniting flammable gas mixtures for exposed parts, i.e. those which may be subjected to impact during use of the apparatus shall be restricted to a minimum.

Testing shall be done in accordance with 7.3.

### 6.5 Resistance to temperature

Following the conditioning in accordance with 7.2 and after being allowed to return to ambient temperature the facepiece shall show no appreciable deformation and any incorporated connector to prEN 148-1 shall be gauged and shall comply with the appropriate standard.

Testing shall be done in accordance with 7.3 and 7.4.

After this test the facepiece shall meet the requirements for inward leakage as specified in 6.16.

Testing shall be done in accordance with 7.13.

### 6.6 Flammability

Parts of the facepiece that might be exposed to a flame during use shall either not burn or not continue to burn for more than 5 s after removal from the flame.

Testing shall be done in accordance with 7.3 and 7.5.

It is not required that the facepiece still has to be usable after the test.

### 6.7 Cleaning and disinfecting

The materials used shall withstand the cleaning and disinfecting agents and procedures as recommended by the manufacturer.

Testing shall be done in accordance with 7.6.

### 6.8 Demountable parts

All demountable connections shall be readily connected and secured, where possible by hand. Any means of sealing used shall be retained in position when the connection is disconnected during normal maintenance.

Testing shall be done in accordance with 7.3.

### 6.9 Replaceable components

Unless integral with the half mask or quarter mask the following components (if fitted) shall be replaceable:

Head harness, connector(s), inhalation and exhalation valves.

Testing shall be done in accordance with 7.3.

### 6.10 Head harness

**6.10.1** The head harness shall be designed so that the facepiece can be donned and removed easily.

Testing shall be done in accordance with 7.13 and 7.14.

**6.10.2** The head harness shall be adjustable or self-adjusting and shall hold the facepiece firmly and comfortably in position.

Testing shall be done in accordance with 7.13 and 7.14.

**6.10.3** Each strap of the head harness, buckles and other adjusting means shall withstand a pull of 50 N applied for 10 s in the direction of pulling when the facepiece is donned. No breaks or sliding of the straps shall occur.

The requirement applies to the buckles and attachment lugs as well as to the straps.

Testing shall be done in accordance with 7.7.

### 6.11 Connector

**6.11.1** The connection between the facepiece and the apparatus may be achieved by a permanent or special (e.g. insert) type of connection or by a thread connection to prEN 148-1.

Testing shall be done in accordance with 7.3.

**6.11.1.1** A facepiece shall not have more than one thread connection to prEN 148-1.

Testing shall be done in accordance with 7.3.

If more than one connector is fitted the design of the facepiece or of the remainder of the equipment shall be such that the use of different types or combinations of respiratory protective devices does not present a risk.

**6.11.1.2** If any other screw thread is used it shall not be possible to connect it directly to the thread to prEN 148-1.

Testing shall be done in accordance with 7.3.

**6.11.1.3** Half masks and quarter masks shall not be equipped with a thread connection to prEN 148-2.

Testing shall be done in accordance with 7.3.

**6.11.2** The connection between the faceblank and the connector shall be sufficiently robust to withstand axially a tensile force of 50 N.

Testing shall be done in accordance with 7.8.

**6.11.3** Correct and reliable connection between facepiece and other parts of the equipment shall be assured.

Testing shall be done in accordance with 7.3.

### 6.12 Inhalation valves and exhalation valves

#### 6.12.1 General

Valve assemblies shall be such that they can be readily maintained and correctly replaced.

It shall not be possible to fit an exhalation valve assembly into the inspiratory circuit or an inhalation valve assembly into the exhalation circuit.

Inhalation and exhalation valve assemblies, sub-assemblies and piece parts that are by the manufacturer designed to be identical, are acceptable.

Differently designed inhalation and exhalation valves are acceptable if a precise and comprehensible description is given in the information manual supplied by the manufacturer. The description in the information manual supplied by the manufacturer should be supported by illustrations (photographs, drawings) on how to assemble the unit correctly.

To enable correct assembly, the parts have to be precisely and comprehensibly described or marked.

An appropriate method of checking correct assembly shall be described, e.g. visual inspection; check by the wearer; test by maintenance personnel etc.

Testing shall be done in accordance with 7.3.

#### 6.12.2 Inhalation valve

**6.12.2.1** The facepiece should preferably be provided with one or more inhalation valve(s). If a thread connection to prEN 148-1 is used, an inhalation valve shall be incorporated in the facepiece. Where the facepiece is intended to be used with filters it shall be provided with an integral inhalation valve, if there is no valve in the filter.

**6.12.2.2** Inhalation valves shall function correctly in all orientations and shall meet the requirements of 6.15.

Testing shall be done in accordance with 7.12.

#### 6.12.3 Exhalation valve

**6.12.3.1** Exhalation valves shall function correctly in all orientations and shall meet the requirements of 6.15.

Testing shall be done in accordance with 7.12.

**6.12.3.2** The facepiece shall have at least one exhalation valve or appropriate means to allow the escape of exhaled air and, where applicable, any excess air delivered from a supplied air source.

Testing shall be done in accordance with 7.3.



**6.12.3.3** Exhalation valves (if fitted) shall be protected against or be resistant to dirt and mechanical damage. They may be shrouded or include any other device that may be necessary to comply with **6.16**.

**6.12.3.4** Exhalation valves shall continue to operate correctly after a continuous exhalation flow of 300 l/min over a period of 30 s and meet the requirements of **6.15**.

Testing shall be done in accordance with **7.9**.

**6.12.4** When the exhalation valve housing is attached to the faceblank, it shall withstand axially a tensile force of 50 N applied for 10 s.

Testing shall be done in accordance with **7.10**.

### **6.13 Compatibility with skin**

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

Testing shall be done in accordance with **7.3**, **7.13** and **7.14**.

### **6.14 Carbon dioxide content of inhalation air**

The carbon dioxide content of the inhalation air (dead space) shall not exceed an average of 1,0 % (by volume).

Testing shall be done in accordance with **7.11**.

### **6.15 Breathing resistance**

The breathing resistance of the facepiece shall not exceed 2,0 mbar for inhalation and 3,0 mbar for exhalation when tested with a breathing machine (25 cycles/min, 2,0 l/stroke) or a continuous flow of 160 l/min.

The inhalation resistance shall not exceed 0,5 mbar at 30 l/min continuous flow and 1,3 mbar at 95 l/min continuous flow.

Testing shall be done in accordance with **7.12**.

### **6.16 Inward leakage**

When the facepieces are fitted in accordance with the information supplied by the manufacturer, at least 46 out of the 50 individual results for the inward leakage over each of the exercise periods as defined in **7.13.1.3** (i.e. 10 subjects  $\times$  5 exercise periods) shall be not greater than:

5 %;

and, in addition, at least 8 out of the 10 individual wearer arithmetic means (10 subjects) for the inward leakage, averaged over all exercise periods shall be not greater than:

2 %.

Testing shall be done in accordance with **7.13**.

### **6.17 Field of vision**

The field of vision shall be subjectively assessed for acceptability.

Testing shall be done in accordance with **7.14**.

### **6.18 Practical performance**

The complete apparatus shall undergo practical performance tests under realistic conditions. These general tests serve the purpose of checking the equipment for imperfections that cannot be determined by the tests described elsewhere in this European Standard. In addition to the tests described in this European Standard details of practical performance tests for breathing apparatus are given in the relevant European Standard. Where a half mask or quarter mask is to be used for filtering devices testing shall be in accordance with **7.14**.

Where practical performance tests show the apparatus has imperfections related to wearer's acceptance, the test house shall provide full details of those parts of practical performance tests which revealed these imperfections. This will enable other test houses to duplicate the tests and assess the results thereof.

## **7 Testing**

### **7.1 General**

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

Before performing tests involving human subjects account should be taken of any national regulations concerning the medical history, examination or supervision of the test subjects.

### **7.2 Conditioning**

Two samples in the state as received shall be subjected to the following thermal cycle:

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

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

### **7.3 Visual inspection**

The visual inspection is carried out where appropriate by the test house prior to laboratory or practical performance tests. This may involve some partial dismantling of the product.

### **7.4 Resistance to temperature**

Two samples shall be tested, both in the state as received.

The threaded connectors shall be gauged at room temperature.

### **7.5 Flammability**

Two samples shall be tested: both in the state as received.

The single burner test is carried out according to the following procedure. The facepiece is put on a metallic dummy head which is motorized such that it describes a horizontal circle with a linear speed, measured at the tip of the nose, of  $(60 \pm 5) \text{ mm/s}$ .

The head is arranged to pass over a propane burner the position of which can be adjusted. By means of a suitable gauge, the distance between the top of the burner and the lowest part of the facepiece (when positioned directly over the burner) shall be set to  $(20 \pm 2)$  mm.

A "TEKLU" burner or that described in EN ISO 6941 has been found suitable<sup>1)</sup>.

With the head turned away from the area adjacent to the burner, the propane gas is turned on, the pressure adjusted to between 0,2 bar and 0,3 bar and the gas ignited. By means of a needle valve and fine adjustments to the supply pressure, the flame height shall be set to  $(40 \pm 4)$  mm. This is measured with a suitable gauge. The temperature of flame measured at a height of  $(20 \pm 2)$  mm above the burner tip by means of a 1,5 mm diameter mineral insulated thermocouple probe, shall be  $(800 \pm 50)$  °C.

Failure to meet the temperature requirement indicates that a fault such as a partially blocked burner exists. This must be rectified.

The head is set in motion and the effect of passing the facepiece once through the flame shall be noted.

The test shall be repeated to enable an assessment to be made of all materials on the exterior of the device. Any one component shall be passed through the flame once only.

#### 7.6 Cleaning and disinfecting

As many samples shall be cleaned and disinfected following the description in the information supplied by the manufacturer as are used for the inward leakage tests.

Compliance shall be assessed during the tests described in 7.13 and 7.14.

#### 7.7 Head harness (pull test)

Two samples shall be tested: one in the state as received and one conditioned in accordance with 7.2. The force is to be applied to the free end of the straps. Where there is no "free end" the force is to be applied adjacent to the point where the strap is joined to the faceblank.

Where buckles or other adjusting means are present, they shall be firmly placed in their normal wearing position on the dummy head, with the head strap engaged in one end and pulled from the other.

#### 7.8 Connector

Two samples shall be tested: one in the state as received and one conditioned in accordance with 7.2. The test time shall be 10 s. The facepiece shall be supported on a dummy head which can be adjusted so that the load can be applied axially to the connection (Figure 1). Additionally, a system of restraining straps or bands shall be fitted over the faceblank around the connection, so that the load is applied as directly as possible to the fitting of the connection in the faceblank and the restraining force is not applied wholly to the head harness.

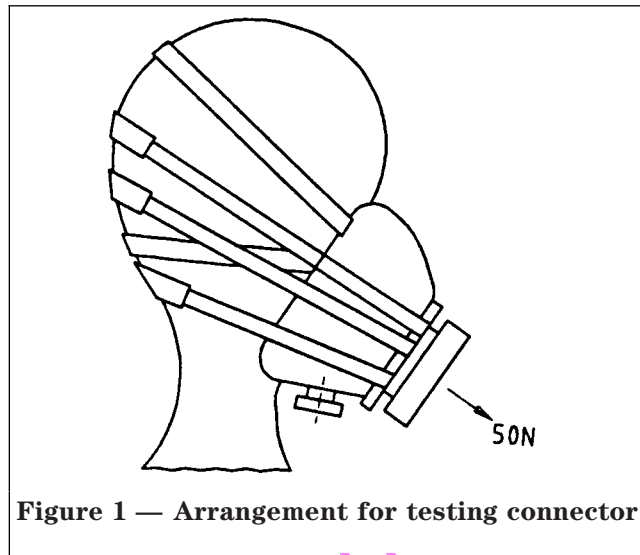


Figure 1 — Arrangement for testing connector

#### 7.9 Exhalation valve (flow test)

Two samples shall be tested: one in the state as received and one conditioned in accordance with 7.2.

#### 7.10 Exhalation valve housing (pull test)

Two samples shall be tested: one in the state as received and one conditioned in accordance with 7.2.

#### 7.11 Carbon dioxide content of inhalation air

Two samples of each size shall be tested: one in the state as received and one conditioned in accordance with 7.2.

The apparatus consists essentially of a breathing machine with solenoid valves controlled by the breathing machine, a connector, a CO<sub>2</sub> flowmeter and a CO<sub>2</sub> analyser.

The apparatus subjects the facepiece to a respiration cycle by the breathing machine.

The facepiece shall be fitted to the Sheffield dummy head securely but without deformation and shall be leaktight. If necessary, the facepiece can be sealed to the dummy head with, e.g. PVC tape or other suitable sealant.

The insert for measurement of breathing resistance shown in Figure 2 is not used when carbon dioxide content is measured.

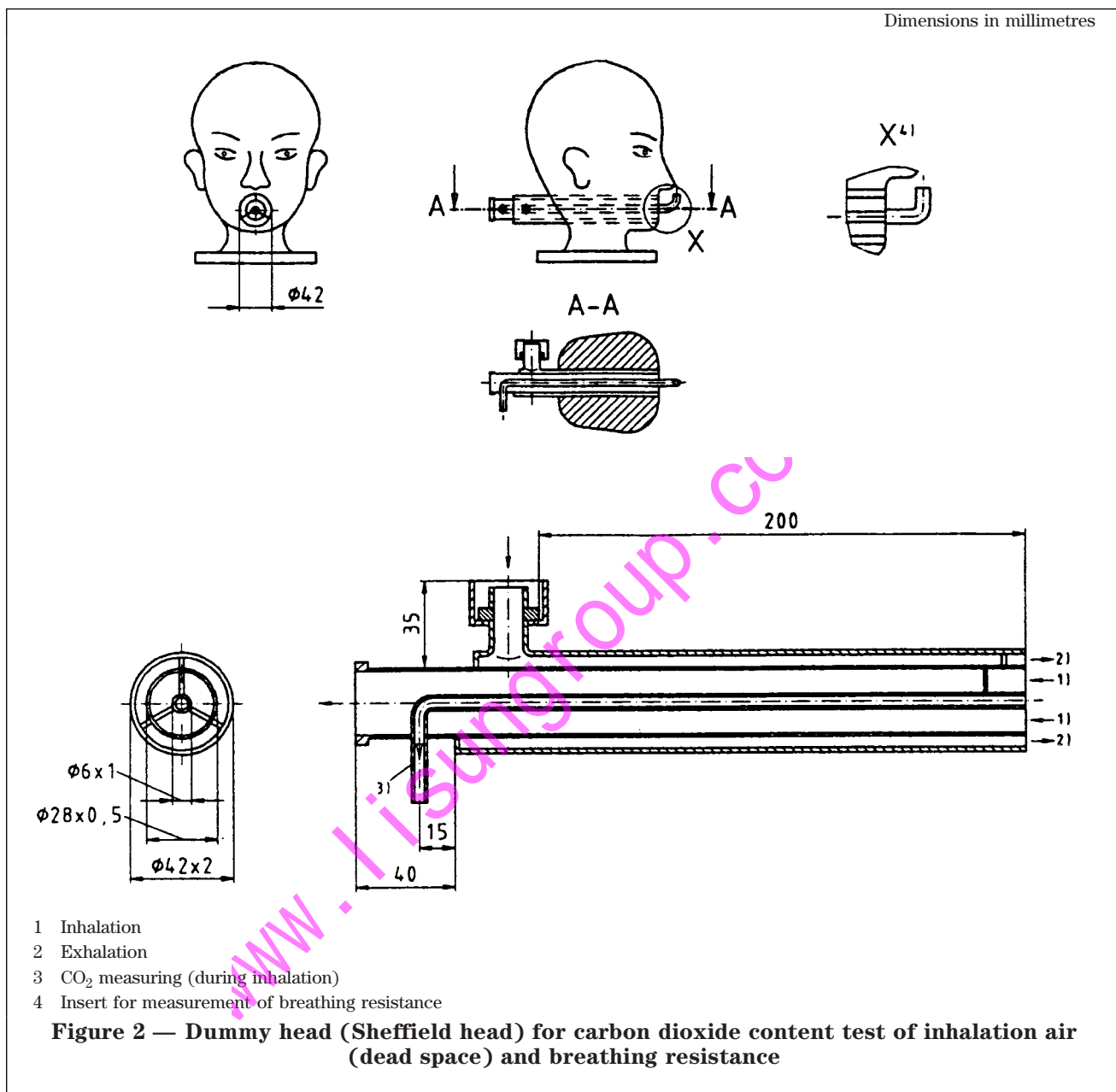
As in Figure 2, the concentric tubes shall end level with the "lips" of the dummy head and the sample tube shall be level with the end of the concentric tubes.

Facepieces without inhalation valves shall be tested with the complete apparatus. Air shall be supplied to the dummy head from a breathing machine adjusted to 25 cycles/min and 2,0 l/stroke and the exhaled air shall have a carbon dioxide content of 5 % by volume. A typical test arrangement is shown in Figure 3.

To prevent a CO<sub>2</sub> build-up due to design of the test equipment, a CO<sub>2</sub> absorber shall be used in the inhalation branch between solenoid valve and breathing machine.

<sup>1)</sup> Information on a source of supply of a suitable burner can be obtained from the Secretariat of CEN/TC 79.





The CO<sub>2</sub> is fed into the breathing machine via a control valve, a flowmeter, a compensating bag and two non-return valves.

Immediately before the solenoid valve, a small quantity of exhaled air is continuously withdrawn through a sampling line and then fed into the exhaled air via a CO<sub>2</sub> analyser.

To measure the CO<sub>2</sub> content of the inhaled air, 5 % of the stroke volume of the inhalation phase of the breathing machine is drawn off at the marked place by an auxiliary lung and fed to a CO<sub>2</sub> analyser.

The total dead space of the gas path (excluding the breathing machine) of the test arrangement shall not exceed 2 000 ml.

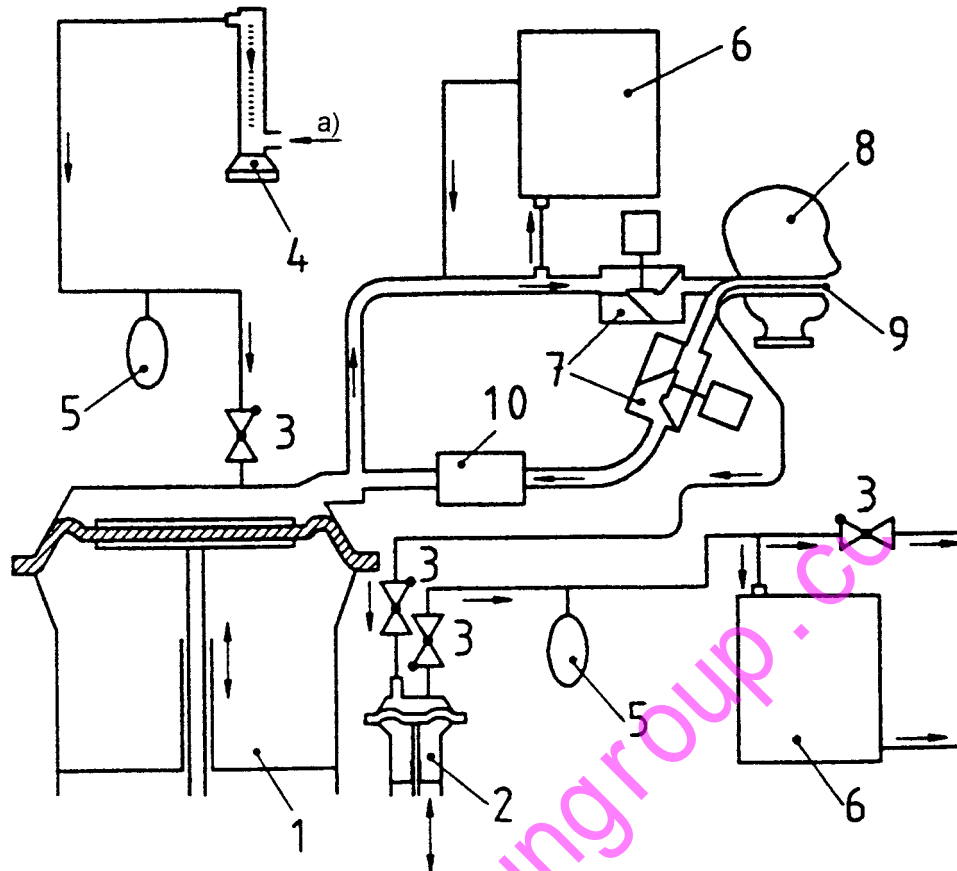
The carbon dioxide content of the inhalation air shall be measured and recorded continuously.

The ambient carbon dioxide level shall be measured 1 m in front of and level with the tip of the nose of the dummy head. The ambient level shall be measured once a stabilized level for carbon dioxide in the inhalation air has been attained. Alternatively the ambient level may be measured at the sampling tube with the carbon dioxide supply turned off.

The test shall be performed until a constant carbon dioxide content in the inhalation air is achieved.

The laboratory ambient level of carbon dioxide shall be subtracted from the measured value. Results are deemed acceptable only if the measured value of the ambient level of carbon dioxide is less than 0,1 %.

The carbon dioxide content of inhalation air shall be measured for three separate fittings of each sample. The average of the three results of each sample shall be reported as the carbon dioxide content of the inhalation air.



- |                           |   |
|---------------------------|---|
| 1 Breathing machine       | 7 Solenoid valve                                  |
| 2 Auxiliary lung          | 8 Dummy head                                      |
| 3 Non-return valve        | 9 Sampling tube for inhalation air (see Figure 2) |
| 4 Flowmeter               | 10 Carbon dioxide absorber                        |
| 5 Compensator             |   |
| 6 Carbon dioxide analyser | a) Carbon dioxide                                 |

**Figure 3 — Arrangement for testing carbon dioxide content of inhalation air**

### 7.12 Breathing resistance

Two samples shall be tested, one in the state as received and one conditioned in accordance with 7.2.

The breathing resistance is measured with the facepiece fitted securely but without deformation to the Sheffield dummy head and carried out successively in five defined orientations. These orientations are: with the facepiece looking ahead, vertically upwards, vertically downwards and then, with the normally vertical axis of the head horizontal, with the facepiece looking to the right and to the left. The resistance shall be measured at the opening for the mouth of the dummy head using a breathing machine adjusted to 25 cycles/min and 2,0 l/stroke or a continuous flow of 160 l/min. A suitable pressure transducer shall be used. When measuring the breathing resistance, the insert shown at "X" in Figure 2 shall be used.

The inhalation resistance shall also be tested at 30 l/min and 95 l/min continuous flow using the five orientations.

The flowrate at which the breathing resistance is measured shall be corrected to 23 °C and 1 bar absolute.

### 7.13 Inward leakage

Two samples shall be tested: one in the state as received and one conditioned in accordance with 7.2.

The sodium chloride and the sulfur hexafluoride methods are equally acceptable options.

#### 7.13.1 Test procedure

The test procedure is common to both test agents.

##### 7.13.1.1 Test samples

Prior to the test, there shall be an examination that the facepiece is in good working condition and that it can be used without hazard.

### 7.13.1.2 Test subjects

For the test, persons shall be selected who are familiar with using such or similar equipment.

A panel of ten clean-shaven persons (without beard or sideburns) shall be selected covering the spectrum of facial characteristics of typical users (excluding significant abnormalities). It is to be expected that, exceptionally, some persons cannot be satisfactorily fitted with a facepiece. Such exceptional subjects shall not be used for testing facepieces.

In the test report the faces of the ten test subjects shall be described (for information only) by the four following facial dimensions (in mm) illustrated in Figure 4.

If more than one size of facepiece is manufactured the test subjects shall be supplied with the appropriate size.

### 7.13.1.3 Test equipment

#### 7.13.1.3.1 Test atmosphere

The test atmosphere shall preferably enter at the top of the hood/chamber through a flow distributor and be directed downwards over the head of the test subject at a velocity of 0,1 to 0,2 m/s. The concentration of the

test agent inside the effective working volume shall be checked to be homogeneous. The velocity shall be measured close to the subject's head.

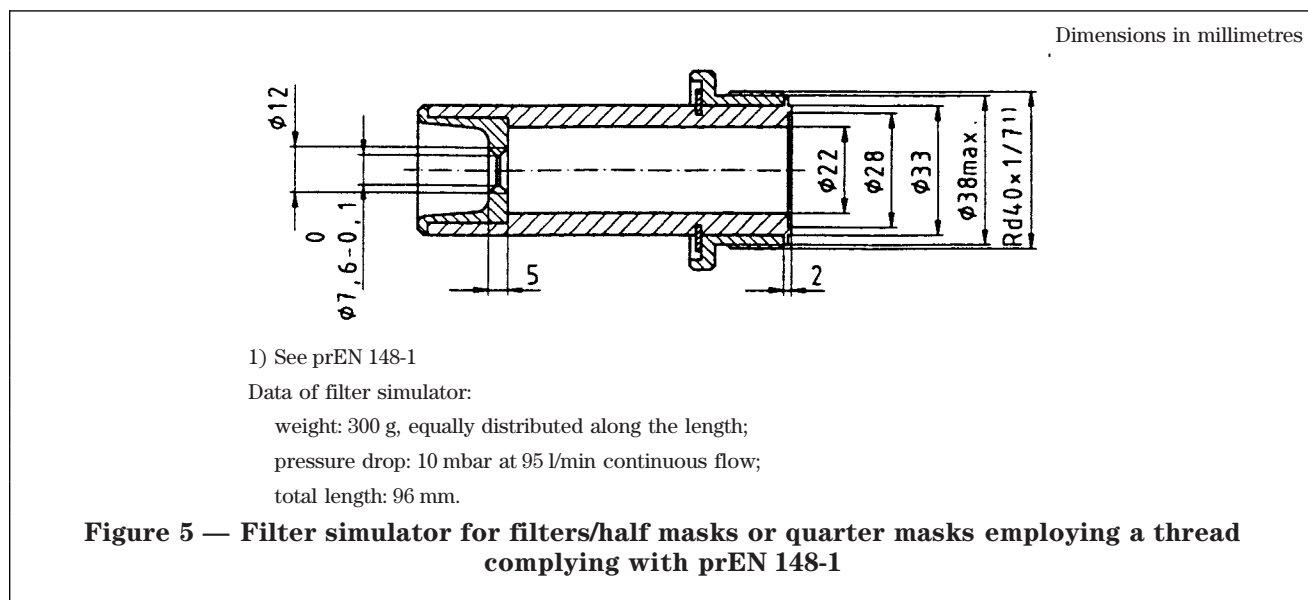
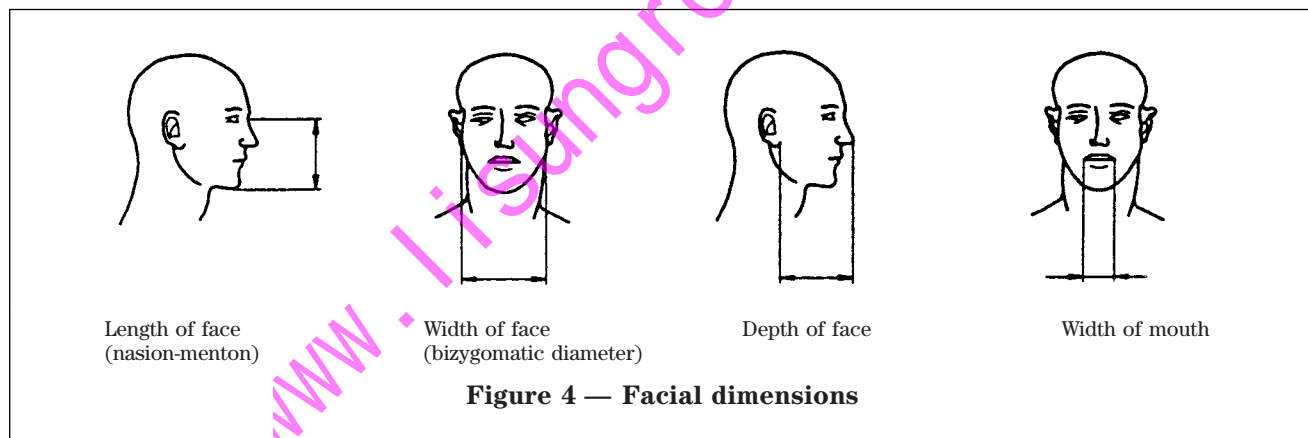
The design of the hood/chamber shall be such that the test subject wearing the facepiece under test can be supplied with breathable air (free of test atmosphere).

#### 7.13.1.3.2 Treadmill

A level treadmill is required capable of working at 6 km/h.

#### 7.13.1.3.3 Filter simulator

If the facepiece is to be used with a filter having a thread to prEN 148-1, the device is required to simulate the maximum weight and resistance of filters permitted for that type of facepiece (Figure 5). This simulator shall be connected to a clean air supply by an ultra light-weight flexible hose. If the facepiece uses a special connection the clean air supply shall be attached to the filter or equipment normally used with the facepiece. It is important that the attachment of the clean air hose to the facepiece does not affect the fit of the facepiece and if necessary the hose shall be supported.



#### 7.13.1.4 Test procedure

The test subjects shall be asked to read the manufacturer's information and if necessary shown by the test supervisor how to fit the facepiece correctly, in accordance with the fitting instructions.

After fitting the facepiece each test subject shall be asked "Does the facepiece fit?". If the answer is "Yes", continue the test. If the answer is "No", take the test subject off the panel, report the fact and replace the person by another test subject.

The test subjects shall be informed that if they wish to adjust the facepiece during the test they may do so. However, if this is done, the relevant section of the test shall be repeated having allowed the system to resettle.

The test subjects shall have no indication of the results as the test proceeds.

The test sequence shall be as follows:

- a) the test atmosphere shall be off;
- b) the test subject is placed in the hood/chamber;
- c) the facepiece sampling probe is connected;
- d) the test subject walks for 2 min at 6 km/h;
- e) the test agent concentration inside the facepiece is measured to establish the background level;
- f) a stable reading shall be obtained;
- g) the test atmosphere is turned on;
- h) the test subject shall continue to walk for a further 2 min or until the test atmosphere has stabilized;
- i) whilst still walking the subject shall perform the following exercises:
  - walking for 2 min without head movement or talking;

- turning head from side to side (15 times) as if inspecting the walls of a tunnel for 2 min;
- moving the head up and down (15 times) as if inspecting the floor and the ceiling for 2 min;
- reciting the alphabet or an agreed text out loud as if communicating with a colleague for 2 min;
- walking for 2 min without head movement or talking;

j) record:

- chamber concentration;
- the leakage over each exercise period;

k) the test atmosphere is turned off and when the test agent has cleared from the chamber the test subject is removed.

After each test the facepiece shall be cleaned, disinfected and dried before being used for its second inward leakage test on another test subject.

#### 7.13.2 Sulfur hexafluoride (SF<sub>6</sub>) method

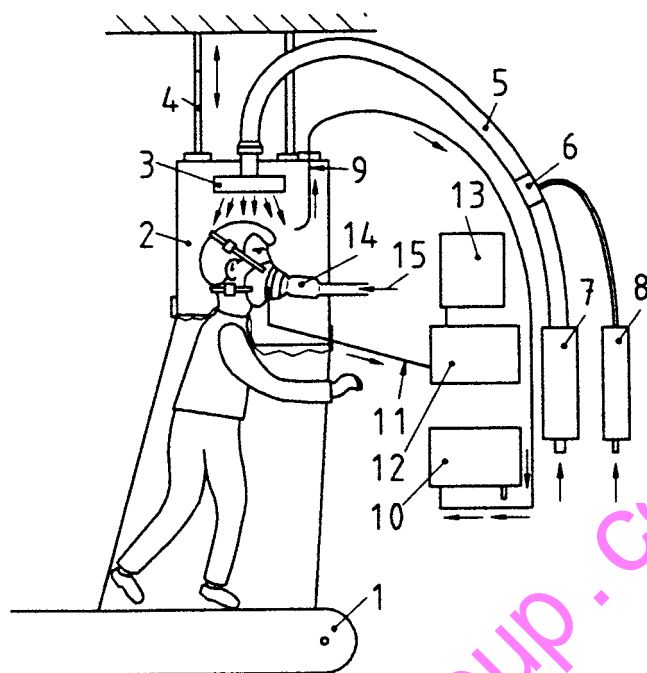
##### 7.13.2.1 Principle

The subject wearing the facepiece under test shall walk on a treadmill over which is a hood/chamber. Through this hood/chamber flows a constant concentration of SF<sub>6</sub>.

The air inside the facepiece is sampled and analysed. The sample is extracted by punching a hole in the faceblank and inserting a probe through which the sample is drawn.

##### 7.13.2.2 Test equipment

A typical arrangement for testing is shown in Figure 6.



- |  |   |
|--|---|
| 1 Treadmill  | 9 Test atmosphere sampling probe                      |
| 2 Hood/chamber   | 10 Measuring instrument for test atmosphere           |
| 3 Flow distributor   | 11 Sampling tube for the inhaled gas concentration    |
| 4 Suspension   | 12 Measuring instrument for inhaled gas concentration |
| 5 Test atmosphere supply hose                                  | 13 Recorder   |
| 6 Mixing point air/SF <sub>6</sub>                             | 14 Filter simulator                                   |
| 7 Flowmeter for air with superposed control device             | 15 Breathable air                                     |
| 8 Flowmeter for SF <sub>6</sub> with superposed control device |   |

**Figure 6 — Arrangement for testing inward leakage using sulfur hexafluoride**



#### 7.13.2.2.1 Test agent

This method employs SF<sub>6</sub> as a test gas. The test subject wearing the facepiece under test is standing with his head surrounded by the test atmosphere. Accurate determinations shall be possible within the range from 0,01 % to approximately 20 % dependent on the test atmosphere. It is recommended to use a test agent concentration between 0,1 % by volume and 1 % by volume.

#### 7.13.2.2.2 Detection

The test atmosphere shall be analysed for SF<sub>6</sub> preferably continuously by means of a suitable analyser (e.g., based on thermal conductivity or infrared spectroscopy).

The test atmosphere sampling probe shall not be positioned next to the exhalation valve. The SF<sub>6</sub> concentration inside the facepiece shall be analysed and recorded by an electron capture detector (ECD) or IR system. This concentration, measured as near as possible to the mouth of the test subject (approximately 5 mm, in the centre of the facepiece), is a measure of the inward leakage.

The test shall be performed at ambient temperature and humidity.

#### 7.13.2.3 Sampling

In order to prepare the facepiece for the test the faceblank has to be perforated. A thin tube, as short as possible, leading into the cavity shall be connected in a leaktight manner to the analysing instrument. The sampling rate should be constant and in the range between 0,3 l/min and 1,5 l/min.

#### 7.13.2.4 Calculation of the leakage

The leakage  $P$  shall be calculated from measurements made over the last 100 s of each of the exercise periods to avoid carry over of results from one exercise to the other.

$$P = \frac{C_2}{C_1} \times 100 \text{ in percentage}$$

where

$C_1$  is the challenge concentration;

$C_2$  is the measured mean concentration.

Measurement of  $C_2$  is preferably made using an integrating recorder.

### 7.13.3 Sodium chloride (NaCl) method

#### 7.13.3.1 Principle

The subject wearing the facepiece under test walks on a treadmill over which is a hood/chamber. Through this hood/chamber flows a constant concentration of NaCl aerosol. The air inside the facepiece is sampled and analysed during the inhalation phase of the respiratory cycle to determine the NaCl content. The sample is extracted by punching a hole in the faceblank and inserting a probe through which the sample is drawn. The pressure variation inside the facepiece is used to actuate a change-over valve so that inhaled air only is sampled. A second probe is inserted for this purpose.

#### 7.13.3.2 Test equipment

##### 7.13.3.2.1 Aerosol generator

The NaCl aerosol shall be generated from a 2 % solution of reagent grade NaCl in distilled water. A single large Collison atomizer of the type described shall be used (Figure 7). This requires a flow rate of 100 l/min at a pressure of 7 bar. The atomizer and its housing shall be fitted into a duct through which a constant flow of air is maintained. It may be necessary to heat or dehumidify the air in order to obtain complete drying of the aerosol particles.

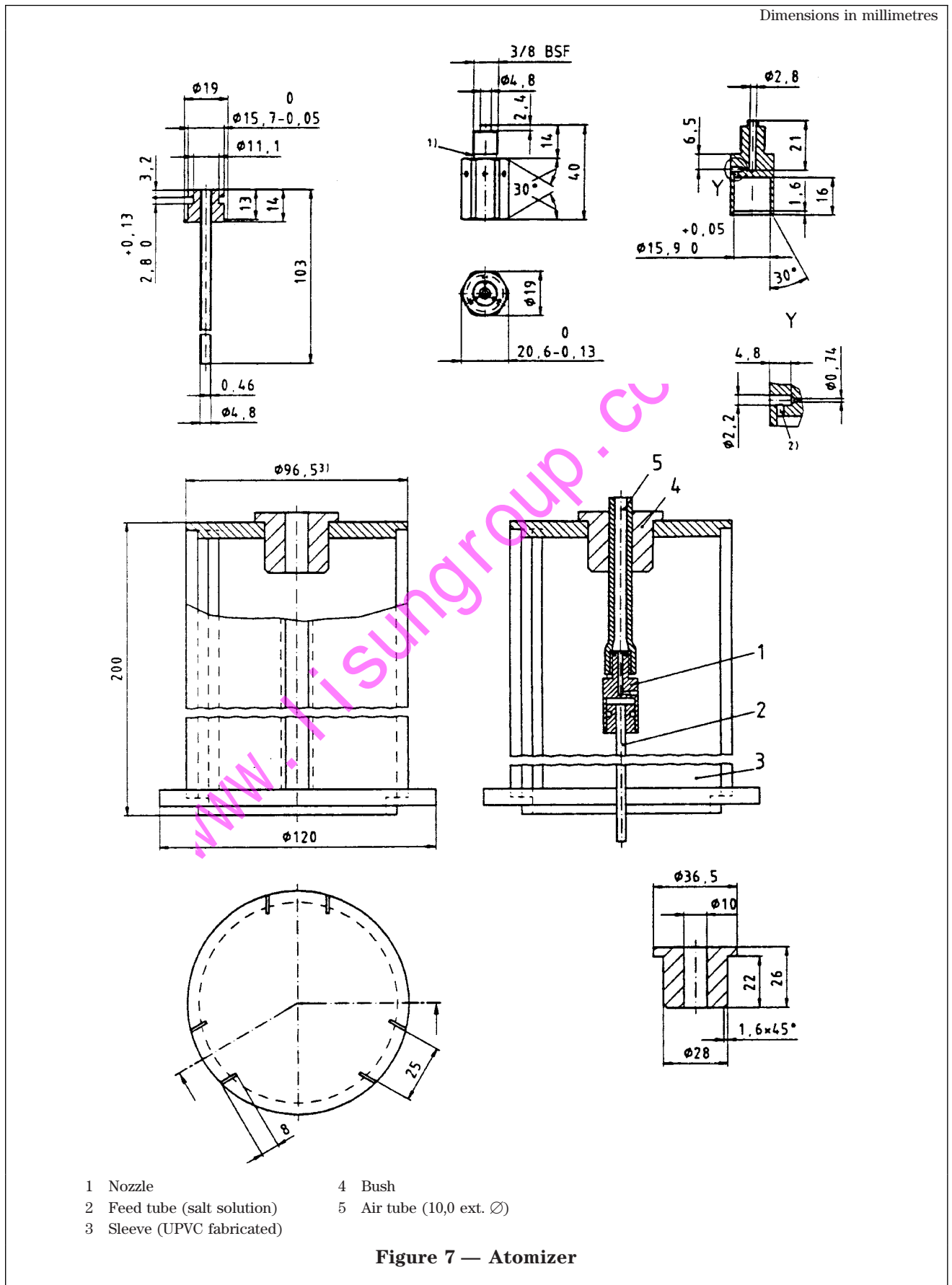
##### 7.13.3.2.2 Test agent

The mean NaCl concentration within the hood/chamber shall be  $(8 \pm 4)$  mg/m<sup>3</sup> and the variation throughout the effective working volume shall be not more than 10 %. The particle size distribution shall be 0,02 μm to 2 μm equivalent aerodynamic diameter with a mass median diameter of 0,6 μm.

##### 7.13.3.2.3 Flame photometer

A flame photometer shall be used to measure the concentration of NaCl inside the facepiece. Essential performance characteristics for a suitable instrument are:

- a flame photometer specifically designed for the direct analysis of NaCl aerosol;
- capable of measuring concentrations of NaCl aerosol between 15 mg/m<sup>3</sup> and 5 ng/m<sup>3</sup>;
- the total aerosol sample required by the photometer is not greater than 15 l/min;
- the response time of the photometer, excluding the sampling system, is not greater than 500 ms;
- it is necessary to reduce the response to other elements, in particular carbon, the concentration of which will vary during the respiratory cycle. This will be achieved by ensuring that the band pass width of the interference filter is not greater than 3 nm and that all necessary side-band filters are included.



7.13.3.2.4 *Sample selector*

A system is required which will switch the sample to the photometer only during the inhalation phase of the respiratory cycle. During the exhalation phase clean air shall be fed to the photometer. The essential elements of such a system are:

- an electrically operated valve with a response time of the order of 100 ms. The valve should have the minimum possible dead space compatible with straight-through, unrestricted flow when open;
- a pressure sensor which is capable of detecting a minimum pressure change of approximately 0,05 mbar and which can be connected to a probe inserted in the facepiece cavity. The sensor shall have an adjustable threshold and be capable of differential signalling when the threshold is crossed in either direction. The sensor shall work reliably when subjected to the accelerations produced by the head movements of the test subject;

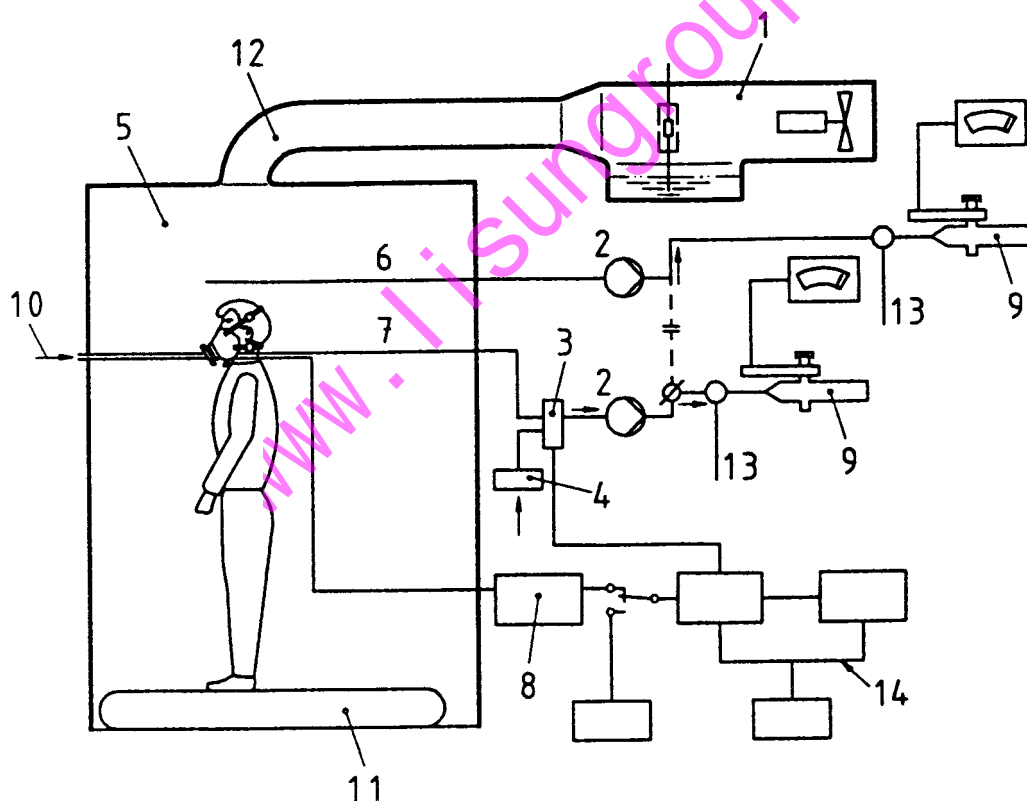
- an interfacing system to actuate the valve in response to a signal from the pressure sensor;
- a timing device to record the proportion of the total respiratory cycle during which sampling took place.

Figure 8 shows an arrangement of such a sampling system.

7.13.3.2.5 *Sampling probe*

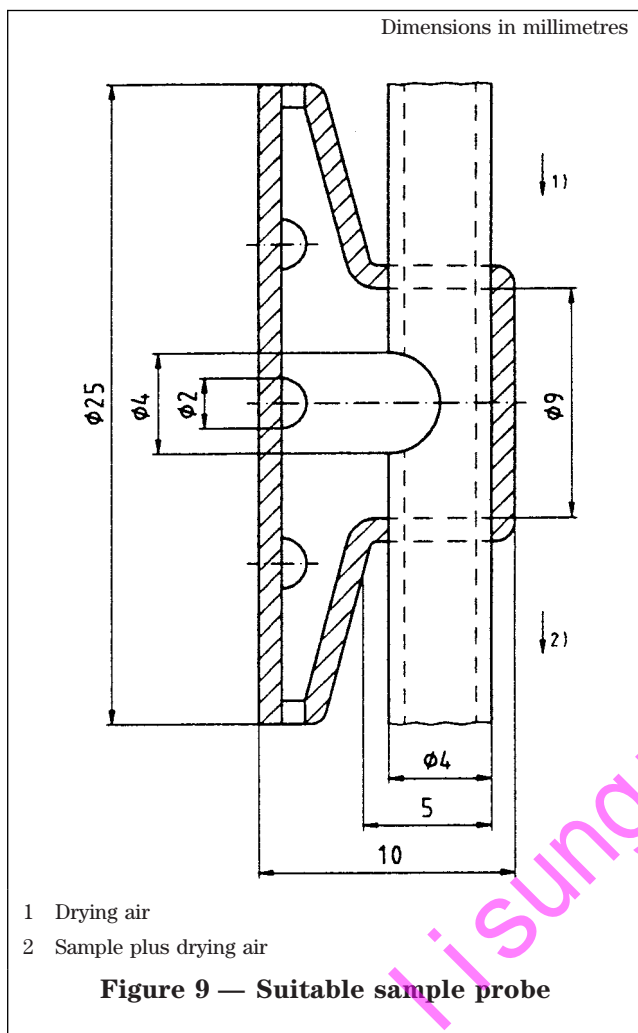
The probe consists of a length of 1 mm bore hypodermic tube fitted securely in an airtight manner to the facepiece as near as possible to the centre line of the facepiece. A plastic ball of approximately 20 mm diameter with 8 holes each of 1,5 mm diameter and spaced equidistant around the circumference of the ball is fitted onto the hypodermic tube. The probe is adjusted so that the ball just touches the wearer's lips.

Another design is a multiple hole sampling probe. Figure 9 shows a design that has been found suitable.



- |                       |                               |
|-----------------------|-------------------------------|
| 1 Atomizer            | 8 Manometer                   |
| 2 Pump                | 9 Photometer                  |
| 3 Change-over valve   | 10 Filter simulator/fresh air |
| 4 Filter              | 11 Treadmill                  |
| 5 Hood/chamber        | 12 Ducting and baffle         |
| 6 Hood/chamber sample | 13 Additional air             |
| 7 Facepiece sample    | 14 Pulsed sampling interface  |

Figure 8 — Arrangement for testing inward leakage using sodium chloride



#### 7.13.3.2.6 Sample pump

If no pump is incorporated into the photometer an adjustable flow pump is used to withdraw an air sample from the facepiece under test. This pump is so adjusted as to withdraw a constant flow of 1 l/min from the sample probe. Dependent on the type of photometer it can be necessary to dilute the sample with clean air.

#### 7.13.3.2.7 Sampling of hood/chamber concentration

The hood/chamber aerosol concentration is monitored during the tests using a separate sampling system to avoid contamination of the facepiece sampling lines. It is preferable to use a separate flame photometer for this purpose.

If a second photometer is not available, sampling of the hood/chamber concentration using a separate sampling system and the same photometer may be made. However, time will then be required to allow the photometer to return to a clean background.

#### 7.13.3.2.8 Pressure detection probe

A second probe is fitted near to the sample probe and is connected to the pressure sensor.

#### 7.13.3.3 Calculation of leakage

The leakage  $P$  shall be calculated from measurements made over the last 100 s of each of the exercise periods to avoid carry over of results from one exercise to the other.

$$P = \frac{C_2}{C_1} \times \left( \frac{t_{IN} \times t_{EX}}{t_{IN}} \right) \times 100 \text{ in percentage}$$

where

- $C_1$  is the challenge concentration;
- $C_2$  is the measured mean concentration;
- $t_{IN}$  is the total duration of inhalation;
- $t_{EX}$  is the total duration of exhalation.

Measurement of  $C_2$  is preferably made using an integrating recorder.

### 7.14 Practical performance

#### 7.14.1 General

Two samples shall be tested: one each worn by different test subjects, one in the state as received and one conditioned in accordance with 7.2.

All tests shall be carried out by two test subjects at ambient temperature. The test temperature and humidity shall be recorded. For the test, persons shall be selected who are familiar with using such or similar equipment.

During the tests the facepiece shall be subjectively assessed by the wearer. After the test comments on the following shall be recorded:

- a) harness comfort;
- b) security of fastenings and couplings;
- c) accessibility of controls (if fitted);
- d) clarity of vision;
- e) field of vision (to be determined with the component to be used directly on the facepiece);
- f) any other comment reported by the wearer on request.

#### 7.14.2 Walking test

The test subjects are wearing normal working clothes and the facepiece. A filter simulator (Figure 5) shall be used for facepieces with a thread to prEN 148-1. For other facepieces a filter or other equipment normally used with the facepiece shall be used. The test subjects shall walk at a regular rate of 6 km/h on a level course. The test shall be continuous, without removal of the facepiece, for a period of 10 min.

#### 7.14.3 Work simulation test

Facepieces with a thread connection to prEN 148-1 shall be fitted with a filter simulator (Figure 5).

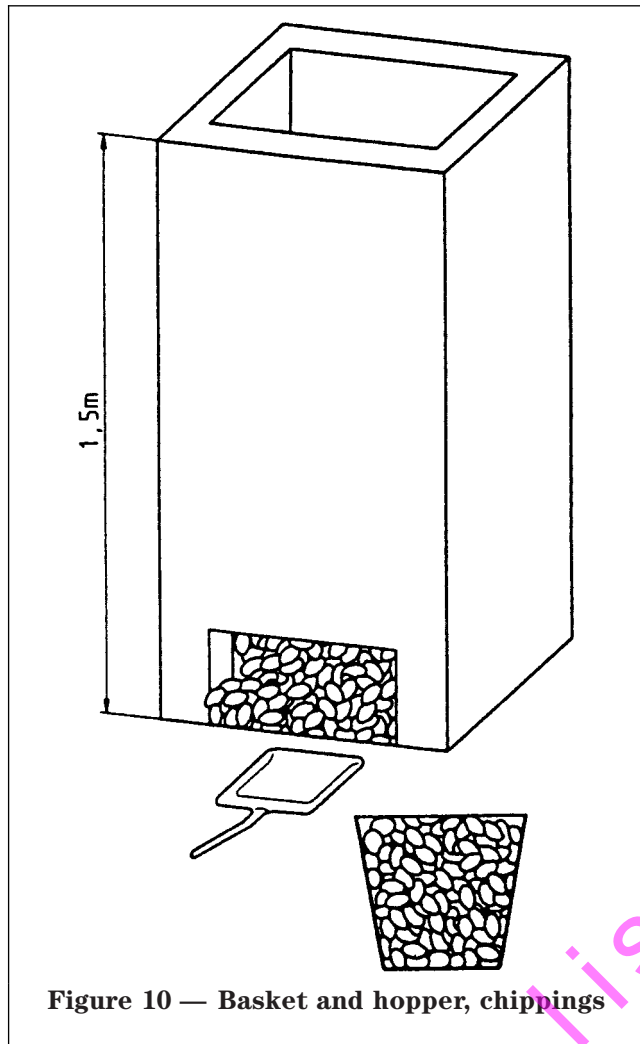


Figure 10 — Basket and hopper, chippings

Facepieces with special connections shall be fitted with the filters supplied by the manufacturer.

The sequence of activities is at the discretion of the test house. The individual activities shall be arranged so that sufficient time is left for the comments prescribed. The test shall be completed within a total working time of 20 min. During this test the following activities shall be carried out in simulation of the practical use of the apparatus:

- a) walking on the level with headroom of  $(1,3 \pm 0,2)$  m for 5 min,
- b) crawling on the level with headroom of  $(0,70 \pm 0,05)$  m for 5 min,
- c) filling a small basket (Figure 10, approx. volume 8 l) with "chippings" or other suitable material from a hopper which stands 1,5 m high and has an opening at the bottom to allow the contents to be shovelled out and a further opening at the top where the basket full of chippings shall be returned.

The subject shall stoop or kneel as he wishes and fill the basket with chippings. He shall then lift the basket and empty the contents back into the hopper. This shall be repeated 19 times in 10 min.

## 8 Marking

### 8.1 Facepiece

8.1.1 The manufacturer shall be identified by name, trade mark or other means of identification.

8.1.2 All units of the same model shall be provided with a type-identifying marking.

8.1.3 Size (if more than one size is available).

8.1.4 The number and the year of this European Standard.

8.1.5 Where the reliable performance of components may be affected by ageing, means of identifying the date (at least the year) of manufacture shall be given.

For parts which cannot reasonably be marked e.g. straps of head harness, the relevant information shall be included in the information supplied by the manufacturer.

8.1.6 Parts which are designed to be replaced by the authorized user and sub-assemblies with considerable bearing on safety shall be readily identifiable.

For parts which cannot reasonably be marked e.g. straps of head harness, the relevant information shall be included in the information supplied by the manufacturer.

8.1.7 The marking shall be clearly visible and durable.

### 8.2 Packaging

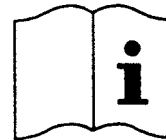
8.2.1 The manufacturer shall be identified by name, trade mark or other means of identification.

8.2.2 Type-identifying marking.

8.2.3 Size (if more than one size is available).

8.2.4 The number of this European Standard.

8.2.5 Attention shall be drawn to the information supplied by the manufacturer by the following pictogram.

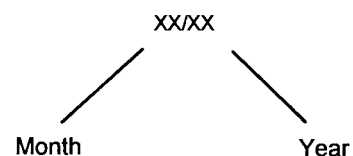


8.2.6 The end of shelf life may be indicated e.g. by the following pictogram



XX/XX

#### Code for dates





## 9 Information supplied by the manufacturer

9.1 On delivery information shall accompany every facepiece.

9.2 The information shall be in the official language(s) of the country of destination.

9.3 The information shall contain all information necessary for trained and qualified persons on:

- application/limitation;
- checks prior to use;
- donning, fitting;
- use;
- cleaning/disinfection;
- maintenance (preferably separately printed instructions);
- storage;
- shelf life or equivalent.

9.4 The information shall be precise and comprehensible. If helpful, illustrations, part numbers, marking shall be added.

9.5 Warning shall be given against problems likely to be encountered, for example

- fit of facepiece (check prior to use);
- it is unlikely that the requirements for leakage will be achieved if facial hair passes under the face seal;
- hazards of oxygen and oxygen-enriched air;
- air quality;
- use of equipment in explosive atmosphere.

Table 1 — Summary of requirements and tests

Title	Requirement clause	Number of samples <sup>1)</sup>	Conditioning <sup>2)</sup>	Test clause
Visual inspection	6.3	All	—	7.3
Materials	6.4	All	—	7.3
Resistance to temperature	6.5	2	a.r.	7.3, 7.4, 7.13
Flammability	6.6	2	a.r.	7.3, 7.5
Cleaning and disinfecting	6.7	2 (in the course of inward leakage test)	1 a.r., 1 acc. 7.2	7.6
Demountable parts	6.8	—	—	7.3
Replaceable components	6.9	—	—	7.3
Head harness	6.10	2	—	7.13, 7.14
— pull test	6.10.3	2	1 a.r., 1 acc. 7.2	7.7
Connector	6.11	2	1 a.r., 1 acc. 7.2	7.3, 7.8, EN 148-1
Inhalation and exhalation valves	6.12	2	1 a.r., 1 acc. 7.2	7.3, 7.12
— exhalation valve: flow test	6.12.3.4	2	1 a.r., 1 acc. 7.2	7.9
— exhalation valve: pull test	6.12.4	2	1 a.r., 1 acc. 7.2	7.10
Compatibility with skin	6.13	2	—	7.13, 7.14
CO <sub>2</sub> content of inhalation air	6.14	2	1 a.r., 1 acc. 7.2	7.11
Breathing resistance	6.15	2	1 a.r., 1 acc. 7.2	7.12
Inward leakage	6.16	2	1 a.r., 1 acc. 7.2	7.13
Field of vision	6.17	2	1 a.r., 1 acc. 7.2	7.14
Practical performance	6.18	2	1 a.r., 1 acc. 7.2	7.14
Marking	8	—	—	7.3
Information supplied by the manufacturer	9	—	—	7.3

<sup>1)</sup> Most samples are used for more than one test.

<sup>2)</sup> acc.= in accordance with;

a.r.= as received ("as received" shall be taken as meaning "not conditioned").

## Annex A (informative)

### Marking

It is recommended to consider for marking the following components and sub-assemblies to be identifiable.

**Table A.1**

Components/Sub-assemblies	Part-marking	Date of manufacture	Remarks
Inhalation valve disc	—	—	1
Exhalation valve disc	—	+	1
Connector (if fitted)	+	—	—
Faceblank	+	+	—
Head harness	—	—	1
<p>+ The marking is necessary.                      — The marking is not necessary.                      1 For parts which cannot reasonably be marked the relevant information shall be included in the information to be supplied by the manufacturer.</p> <p>The components of a sub-assembly do not have to be marked when the sub-assembly is identifiable. Those components not offered as spare parts by the manufacturer do not have to be marked but the relevant information has to be given in the information to be supplied by the manufacturer.</p>			

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## 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 products falling within the scope of this standard.

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

EU Directive 89/686/EEC, Annex II	Clauses of this standard
1.1.1	6.16, 6.18
1.1.2.1	6.10, 6.11, 6.16, 6.18
1.2.1	6.4, 6.5, 6.6, 6.18
1.2.1.1	6.4, 6.5, 6.6, 6.13
1.2.1.2	6.18
1.2.1.3	6.17, 6.18
1.3.1	6.10, 6.18
1.3.2	6.10.3, 6.11.2
1.4	9
2.1	6.10, 6.18
2.3	6.17
2.4	8, 9
2.6	6.4
2.8	9
2.9	6.8, 6.9
2.12	8
3.10.1	6.7, 6.12, 6.14, 6.15, 6.18, 9

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

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