

# Respiratory protective devices — Methods of test —

## Part 3: Determination of breathing resistance

The European Standard EN 13274-3:2001 has the status of a  
British Standard

ICS 13.340.30

## National foreword

This British Standard is the official English language version of EN 13274-3:2001.

The UK participation in its preparation was entrusted by Technical Committee PH/4, Respiratory protection, to Subcommittee PH/4/9, Test methods and interpretation, 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.

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This British Standard, having been prepared under the direction of the Health and Environment Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 07 November 2001

### Summary of pages

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English version

## Respiratory protective devices - Methods of test - Part 3: Determination of breathing resistance

Appareils de protection respiratoire - Méthodes d'essai -  
Partie 3: Détermination de la résistance respiratoire

Atemschutzgeräte - Prüfverfahren - Teil 3: Bestimmung des  
Atemwiderstandes

This European Standard was approved by CEN on 17 August 2001.

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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 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2002, and conflicting national standards shall be withdrawn at the latest by March 2002.

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.

EN 13274-3 is one of several Parts, which are as follows:

Part 1: Determination of inward leakage and total inward leakage

Part 2: Practical performance tests

Part 3: Determination of breathing resistance

Part 4: Flame tests

Part 5: Climatic conditions

Part 6: Determination of carbon dioxide content of inhalation air

Part 7: Determination of aerosol penetration of particle filters

Part 8: Determination of dolomite dust clogging of particle filters

The annexes A and B are normative.

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.

## Introduction

This European Standard is intended as a supplement to the specific device standards for respiratory protective devices. Test methods are specified for complete or parts of devices. If deviations from the test method given in this standard are necessary, these deviations will be specified in the relevant device standard.

## 1 Scope

This European Standard specifies the general procedure for measurement of breathing resistance of filters for respiratory protective devices and respiratory protective devices incorporating facepieces, except for diving for respiratory protective devices. The requirements and any special conditions for the apparatus, and of filter measurements are described in the relevant device 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 (including amendments).

EN 132, *Respiratory protective devices – Definitions*.

## 3 Terms and definitions

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

### 3.1

#### **inhalation resistance**

flow resistance of the device during inhalation

### 3.2

#### **exhalation resistance**

flow resistance of the device during exhalation

### 3.3

#### **static breathing resistance**

inhalation resistance or exhalation resistance at defined constant flow expressed as a pressure difference measured between ambient and a specified point within the device

### 3.4

#### **dynamic breathing resistance**

peak inhalation resistance or peak exhalation resistance at a defined sinusoidal flow expressed as a pressure difference measured between ambient and a specified point within the device

## 4 Pre-requisites

In order to implement this European Standard, at least the following parameters shall be specified in the relevant device standard:

- number of specimens;
- specimen pre-conditioning;

- which test method (1 or 2);
- mounting of the specimen;
- preparation of the specimen;
- which flow rates;
- deviations;
- number of repeat tests per specimen;
- size of facepiece;
- orientation of support for device;
- pass/fail criteria.

## 5 General test requirements

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 maxima or minima shall be subject to a limit deviation of  $\pm 5\%$ . Unless otherwise specified, the ambient temperature for testing shall be between 16 °C and 32 °C and the temperature limits shall be subject to a limit deviation of  $\pm 1$  °C.

## 6 Method 1: Static breathing resistance

### 6.1 Principle

The device is mounted on a support as described in the relevant device standard, and air is passed through the device at a constant flow.

NOTE The convention of reporting breathing resistance is that if during the inhalation resistance test, the pressure inside the facepiece relative to atmosphere is negative, no sign is used in front of the result. If the relative pressure inside the facepiece is positive, the result is prefixed with a '+’.

### 6.2 Equipment

**6.2.1** Pressure gauge, calibrated in the appropriate range and with a sensitivity better than 10% of the limit value of breathing resistance specified in the relevant device standard.

**6.2.2** Flowmeter(s) calibrated in the appropriate range.

**6.2.3** Regulated blower/compressed air source or a variable suction device.

**6.2.4** Support for the device (e.g. filter holder, Sheffield dummy head with insert or torso with insert) as described in the relevant device standard.

### 6.3 Procedure

#### 6.3.1 Ambient conditions

If ambient conditions differ from 23 °C and 1 bar absolute, all flow rates shall be adjusted so that they give the correct flow rate when corrected to 23 °C and 1 bar absolute.

#### 6.3.2 Procedure for filters

Two methods of passing air through the filter are possible and typical examples are shown in Figures 1a) and 1b). The first method employs a chamber in which the filter holding device is fixed (see Figure 1a)). Air is directed into

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the chamber from a suitable controlled source and exits through the filter and holder system. The pressure drop across the system to ambient is measured at a pressure tapping mounted on the chamber wall. The second method draws air through the filter holding device (see Figure 1b)) and the pressure drop is measured between ambient and a pressure port fitted at a suitable point between the filter holding system and the connection to the suction device.

Ensure that the filter has been pre-conditioned according to the relevant device standard and that an equipment connector or the holder intended by the manufacturer to be used is available.

Mount the filter in a leaktight manner for horizontal airflow as indicated in Figures 1a) or 1b). Pass the appropriate airflow through the filter holding system. Measure and record the pressure drop,  $\Delta P_F$ , across the filter holding system

Remove the filter. Pass the same airflow through the filter holding system. Measure and record the pressure drop,  $\Delta P_H$ , of the set-up.

Report the breathing resistance of the filter at the flow rate as:

$$\Delta P_F - \Delta P_H$$

### 6.3.3 Procedure for other devices

Ensure that the device has been pre-conditioned according to the relevant device standard.

Fit the device in a leaktight manner without deformation on the Sheffield dummy head (see Figure 2) or torso (see Figure 3). Close off the tube for exhalation air, and the pressure port on the exhalation tube shown in Figure 3. See also Figure 4.

For hoods fitting around the neck, the fitting procedure given in annex A (see Figure A.1) shall be used.

For measurements of inhalation resistance, connect the inhalation tube to a suitable suction device and the pressure gauge connections to the pressure port and ambient respectively. Note the "zero" reading. Switch on and adjust the suction device to give the appropriate flow and note the pressure reading. Record the reading, corrected for the "zero" reading, as the inhalation resistance.

For measurements of exhalation resistance, connect the exhalation tube to a suitable blower and the pressure gauge connections to the pressure port and ambient respectively. Note the "zero" reading. With the support in one of the five defined orientations,

- a) upright and facing directly ahead;
- b) facing vertically, upwards;
- c) facing vertically, downwards;
- d) lying on the left side;
- e) lying on the right side;

switch on and adjust the blower to give the appropriate flow and note the pressure reading. Record the reading, corrected for the "zero" reading, as the breathing resistance on exhalation at that orientation. Repeat the procedure with the support successively placed in the other orientations. Report the highest value of the five results as the exhalation resistance.

## 7 Method 2 : Dynamic breathing resistance

### 7.1 Principle

The device is mounted on a support as described in the relevant device standard and connected to a breathing machine adjusted to a specified breathing minute volume.



NOTE The convention of reporting breathing resistance is that if during the inhalation resistance test, the pressure inside the facepiece relative to atmosphere is negative, no sign is used in front of the result. If the relative pressure inside the facepiece is positive, the result is prefixed with a '+'.

## 7.2 Equipment

**7.2.1** Breathing machine performing sinusoidal breathing.

**7.2.2** Support as described in the relevant device standard, e.g. Sheffield dummy head with insert or torso with insert (see Figures 2, 3 and 4).

**7.2.3** Pressure gauge, calibrated in the appropriate range and with a sensitivity better than 10 % of the limit value of breathing resistance specified in the relevant device standard.

The response time of this pressure gauge, including the recording device, shall be less than 30 ms. for a response of 10 % to 90 % of the full scale deflection of the range used.

## 7.3 Procedure

### 7.3.1 General

If ambient conditions differ from 23 °C and 1 bar absolute, all flow rates shall be adjusted so that they give the correct flow rate when corrected to 23 °C and 1 bar absolute.

Ensure that the device has been pre-conditioned in accordance with the relevant device standard.

Adjust the breathing machine in accordance with Table 1 to give the breathing minute volume specified in the device standard.

Connect one port of the pressure gauge to the pressure port of the support for the device and the other port to ambient. Connect the pressure gauge to the recording device.

Fit the device in a leaktight manner without deformation on the support. For hoods sealing around the neck, the fitting procedure given in annex A (see Figure A.1) shall be used. Note the "zero" reading of the pressure gauge. Switch on the breathing machine and operate the device as defined in the relevant device standard and record the peak pressure.

### 7.3.2 Inhalation resistance

Record the peak pressure on inhalation. Record the reading, corrected for the 'zero' reading, as the inhalation resistance.

### 7.3.3 Exhalation resistance

With the support in one of the five defined orientations :

- a) Upright and facing directly ahead;
- b) facing vertically, upwards;
- c) facing vertically, downwards;
- d) lying on the left side;
- e) lying on the right side;

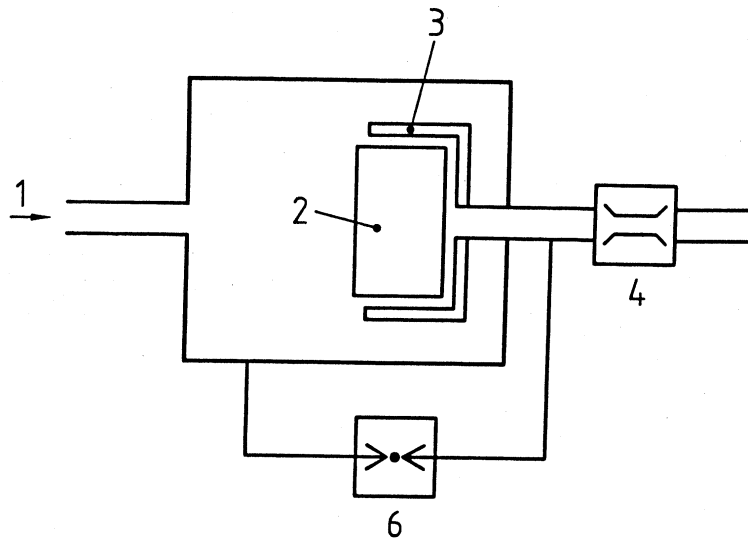
note the peak pressure reading on exhalation. Record the reading, corrected for the 'zero' reading, as the exhalation resistance at that orientation. Repeat the procedure with the support successively placed in the other orientations. Report the highest value of the five results as the exhalation resistance.

Table 1 — Setting of the breathing machine to give specified breathing minute volumes

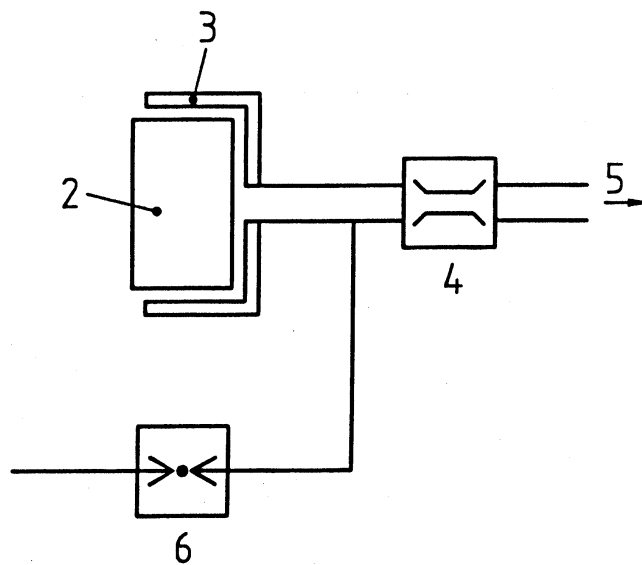
	Breathing minute volume l/min	Cycles/min	Volume per stroke l	Corresponding continuous flow specified in the relevant device standard l/min
A	10,0	10	1,00	30
B	30,0	20	1,50	95
C	35,0	20	1,75	110
D	40,0	20	2,00	125
E	50,0	25	2,00	160
F	62,5	25	2,50	195
G	70,0	30	2,33	220
H	100,0	40	2,50	315

NOTE 1 The peak pressure equates to the pressure at a constant flow which is equal to the average breathing minute volume for a sinusoidal flow multiplied by  $\pi$ .

NOTE 2 When checking measurements at sinusoidal flow with those at constant flow, there should be good correlation when the constant flow rate is the sinusoidal flow average breathing minute volume multiplied by  $\pi$ .



a) 'Blowing through' device



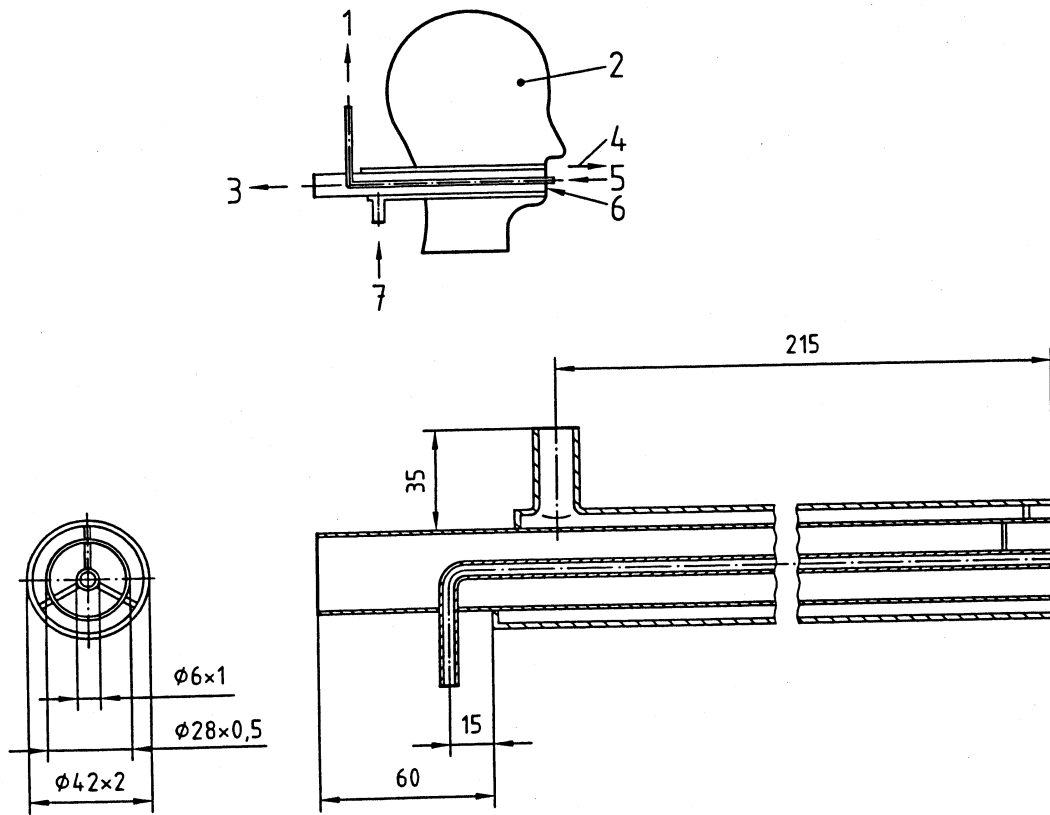
b) 'Sucking through' device

**Key**

- 1 Regulated air source
- 2 Filter
- 3 Filter housing

- 4 Flowmeter
- 5 Regulated suction
- 6 Pressure gauge

**Figure 1 —Examples of arrangement for measurement of breathing resistance of filters**

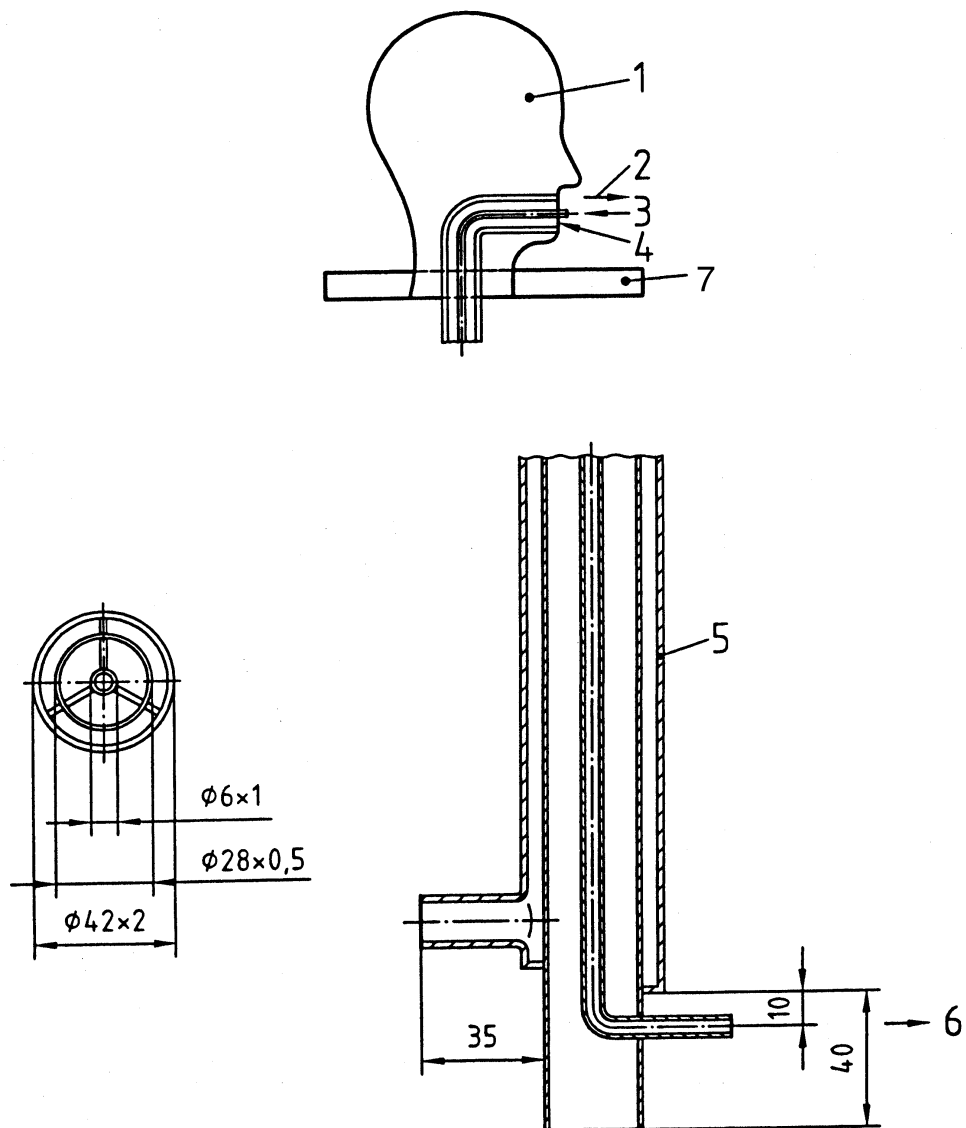


**Key**

- |   |                                  |   |                                    |
|---|----------------------------------|---|------------------------------------|
| 1 | To pressure gauge                | 5 | Pressure port with button probe    |
| 2 | Dummy head                       | 6 | Inhaled air                        |
| 3 | To breathing machine, inhalation | 7 | From breathing machine, exhalation |
| 4 | Exhaled air                      |   |                                    |

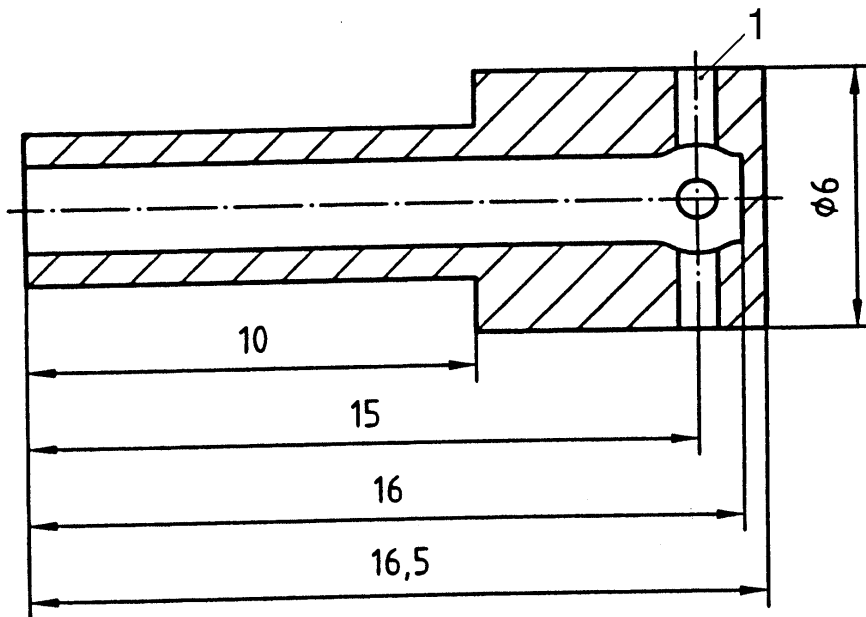
**Figure 2 —Typical arrangement of tubes in Dummy head for measurement of breathing resistance**

Dimensions in millimetres

**Key**

- |   |               |   |  |
|---|---------------|---|--|
| 1 | Dummy head    | 4 | Inhaled air                            |
| 2 | Exhaled air   | 5 | Tube                                   |
| 3 | Pressure port | 6 | To pressure gauge                      |
|   |               | 7 | Adjustable flow collar, see Figure A.1 |

**Figure 3** — Typical arrangement of tubes in Dummy head for measurement of breathing resistance for hoods sealing around the neck



**Key**

1 Two holes  $\phi 1$  mm through at 90° orientation

**Figure 4 — Details of button probe as shown in Figures 2 and 3**

## Annex A (normative)

### Fitting procedure for hoods which seal around the neck and which may or may not incorporate a head harness

#### A.1 Introduction

This fitting procedure was developed because under test conditions, hoods of the type described can move in the direction of all three major axes under the influence of the cyclic pressure set up by the action of the breathing machine, thus making difficult the provision of steady test conditions and reproducible results. In addition, the amount of air/exhale which escapes via gaps at the seal around the neck can vary according to how the device is fitted on the test apparatus.

#### A.2 Principle

The device is fitted to a Sheffield dummy head which, if necessary, is mounted on a suitable torso. The dummy head is fitted with the collar arrangement shown in Figure A.1. The neck seal of the hood is sealed to the outer circumference of the collar. The collar is sealed to the neck of the dummy and contains ports which allow air to pass out of the hood in a controlled and evenly distributed manner. By adjusting a sliding ring, more or less air is allowed out of the hood thereby controlling the pressure inside the hood to a value which approximates to that which occurs in practice on wearers. An elastic line is used to control the position of the hood on the head and the test result is determined with the hood in various positions on the dummy head. A typical arrangement is shown in Figure A.2. If the hood is provided with a head harness then the normal fitted position shall be used. The arrangement is connected to the breathing machine and the appropriate test result is determined when stable conditions have been achieved.

#### A.3 Apparatus

##### A.3.1 Sheffield dummy head/torso

Sheffield dummy head/torso fitted with concentric tubes. The tubes are directed down the neck section to exit from the torso at a convenient point. (see Figure A.2). The end of the concentric tubes is level with the top "lip" of the dummy head and the pressure probe is level with the end of the concentric tubes.

##### A.3.2 Stand and elastic string, for hoods which do not incorporate a head harness

A vertical stand with an elastic string. The string is fixed at one end to the stand and at its other to the top of the hood under test. The purpose of the elastic line is to allow movement of the hood to take place upwards and downwards and at the same time to keep the hood reasonably laterally symmetrical on the head. A light elastic line approximately 1 m in length has been found to be suitable. The stand should be of sufficient height such that when the hood is at its highest point under the action of the breathing machine, the string will clear the top of the hood and not restrain upward movement, as shown in Figure A.2.

##### A.3.3 Adjustable collar

A typical arrangement is shown in Figure A.1. The inner circumference of the upper (thicker) ring is sealed in a leaktight manner to the neck of the dummy head/torso. The outer circumference allows the neck seal arrangement of the hood to be fitted to it and to be suitably tightened. Thus, air allowed to pass from the hood must flow through the holes provided in both upper and lower collars and is controlled by turning the lower collar relative to the fixed upper.

## **A.4 Procedure**

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

A test subject dons and operates the device according to the manufacturer's instructions for use and at the maximum flow rate. The test subject holds their breath and the pressure within the hood is noted. The test is repeated using two further test subjects and the average value of the pressure over the minimum of three wearings is noted and recorded.

Using the complete equipment under test, the hood is fitted over the dummy head and the drawstring of the neck seal (if fitted) is tightened tightly around the collar or, if an elasticated neck band is fitted, it is located around the collar.

Attach the elastic line from the stand to the top of the hood noting the conditions mentioned in A.3.2.

Open the outlet port on the collar, and operate the device at the maximum flow rate. Close the outlet from the mouth of the Sheffield dummy head. Gradually close the outlet from the collar until the internal pressure is equal to the average pressure noted in the above tests using subjects. Do not then disturb the setting of the collar.

Re-adjust the airflow to the hood to the flow rate as specified by the relevant device standard and unseal the outlet from the mouth of the dummy head.

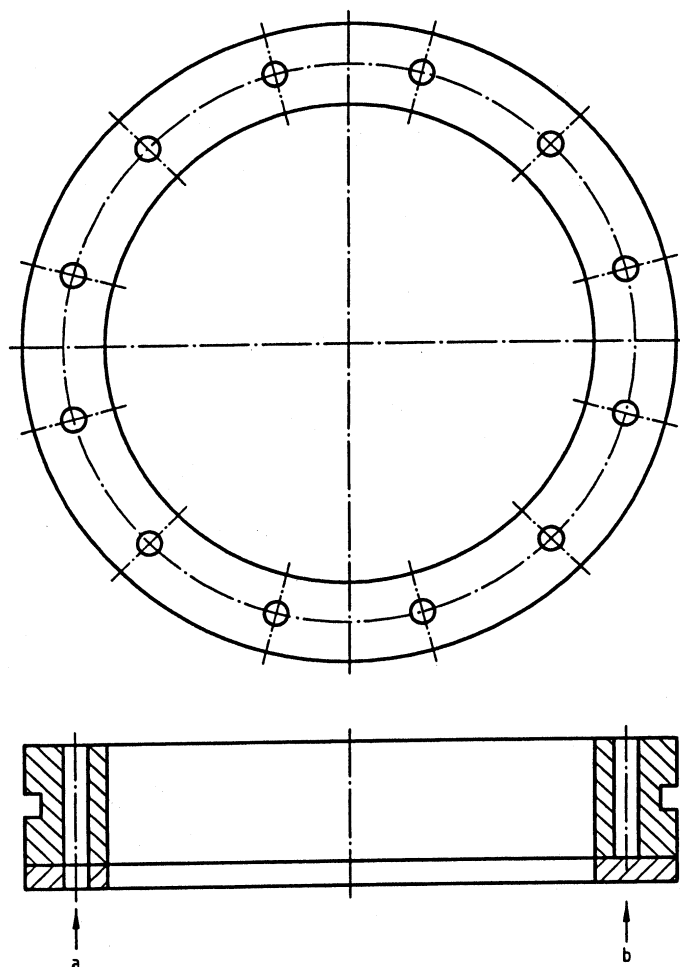
Connect the inlet of the concentric tubes to the breathing machine circuit and switch on the breathing machine. Adjust the height of the stand so that the top of the hood is not fouled by the elastic line at the limit of its vertical movement.

Measure the breathing resistance with the hood in the following three positions:

- a) just touching the nose;
- b) just touching the back of the head;
- c) central.

The position of the hood is adjusted by means of the elastic line. Throughout the duration of the test the hood has to remain as laterally symmetrical as possible about the head and vertical movement should not be restricted. The appropriate test result is taken as the average of the three readings.

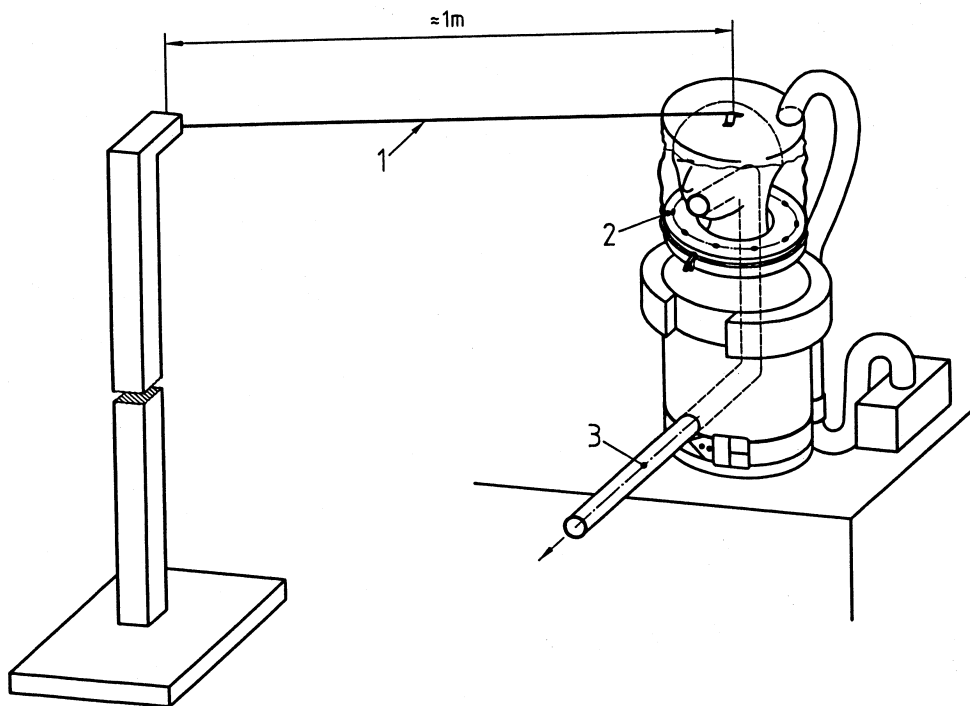


**Key**

Half sections showing lower ring adjusted to give

- a) open
- b) closed

**Figure A.1 — Adjustable flow collar**



**Key**

- 1 Elastic line (allows unrestricted movement of hood)
- 2 Adjustable flow collar (See Figure A.1)
- 3 Concentric tubes connected to breathing machine

**Figure A.2 —Typical details of fitting arrangement using collar, elastic line and dummy torso**

## **Annex B**

(normative)

### **Test results - Uncertainty of measurement**

For each of the required measurements performed in accordance with this European Standard, a corresponding estimate of the uncertainty of measurement shall be evaluated. This estimate of uncertainty shall be applied and stated when reporting test results, in order to enable the user of the test report to assess the reliability of the data.

**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 standard.

The clauses of this standard are likely to support requirements in 3.10.1 of Annex II of Directive 89/686/EEC.

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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