BRITISH STANDARD

BS EN 13274-6:2002

Respiratory protective devices — Methods of test —

Part 6: Determination of carbon dioxide content of the inhalation air

The European Standard EN 13274-6:2001 has the status of a British Standard

ICS 13.340.30

National foreword

This British Standard is the official English language version of EN 13274-6:2001.

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.

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.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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 26 February 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 15 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 39195 7

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13274-6

December 2001

ICS 13.340.30

English version

Respiratory protective devices - Methods of test - Part 6: Determination of carbon dioxide content of the inhalation air

Appareils de protection respiratoire - Méthodes d'essai - Partie 6: Détermination de la teneur en dioxyde de carbone de l'air inhalé

Atemschutzgeräte - Prüfverfahren - Teil 6: Bestimmung des Kohlenstoffdioxid-Gehaltes der Einatemluft

This European Standard was approved by CEN on 16 November 2001.

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 Management Centre 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13274-6:2001 E

Contents

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 June 2002, and conflicting national standards shall be withdrawn at the latest by June 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.

This 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 the inhalation air

Part 7: Determination of particle filter penetration

Part 8: Determination of dolomite dust clogging

Annex A is normative. Annex B is informative.

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 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 test procedure for measuring the carbon dioxide content in the inhaled air (dead space) of respiratory protective devices.

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 of terms and pictograms.*

3 Terms and definitions

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

3.1
ambient conditions
atmosphere where the temperature is 16 °C to 32 °C and the relative humidity is 20 % to 80 %

3.2
dry atmosphere
atmosphere where the relative humidity is less than 20 %

3.3
wet atmosphere
atmosphere where the relative humidity is greater than or equal to 95 %

4 Prerequisites

In order to implement this part of EN 13274, at least the following parameters need to be specified in the appropriate device standard:

- number of samples;
- number of repeat tests per sample;
- sample preconditioning;
- size(s) of facepiece;
- use of dummy head or head/torso;
- method of sealing facepiece to dummy head/torso (if appropriate);

— complete equipment or facepiece only;

— device air supply on or off;

— direction of any supplementary air flow;

— pass/fail criteria;

— any deviations from test method.

5 Test method

5.1 Principle

The device is fitted, as described by the device standard, to a Sheffield dummy head/torso and, in the case of complete equipment tests, any air supply is operated in the manufacturer's minimum condition unless prescribed otherwise by that standard. Breathing air containing a defined concentration of carbon dioxide is supplied at a specified rate from a breathing machine to a dummy head/torso. The inhaled air is analysed for carbon dioxide content.

The carbon dioxide level measured gives an assessment of the "dead space" of the facepiece rather than a "real life" measurement of the level of carbon dioxide in the inhaled air.

5.2 Test equipment

5.2.1 General

A typical test arrangement using a single cylinder breathing machine is shown in Figure 1.

The total dead space of the gas path of the test installation, excluding the volume of the breathing machine, shall not exceed 2000 ml.

The test shall be carried out at ambient conditions.

5.2.2 Breathing machine

A breathing machine and associated equipment with solenoid valves controlled by the breathing machine. In order to avoid errors in the measurement of carbon dioxide in the inhaled air, it is important that the solenoid valves make a good seal on closing and that the timing of their action allows no overlap to occur.

5.2.3 Carbon dioxide sampling arrangement

A sample of the inhaled air is taken by an auxiliary lung driven by the breathing machine and in phase with it. It is set to inhale a known sample volume (a chosen percentage of the inhalation volume of the breathing machine) during the inhalation stroke of the breathing machine. This apparent "loss" in inhalation volume of the breathing machine is compensated for by the volume of carbon dioxide fed via the flowmeter into the breathing machine on its inhalation stroke. It is therefore important that these two volumes are equal.

The exhaled air is continuously monitored for carbon dioxide content at a flow determined by the analyser. The sample point is immediately before the solenoid valve in the exhalation circuit. To maintain equilibrium the sample is returned to the circuit upstream of the sample point.

The carbon dioxide absorber is necessary to prevent build-up of carbon dioxide in the test equipment circuit. The compensators allow constant conditions to be maintained for particular parts of the test circuit.

5.2.4 Sheffield head/torso

Sheffield head fitted with concentric tubes and central carbon dioxide sampling tube, shown in Figure 2. Where a torso is fitted, the tubes are directed down the neck section to exit from the torso at a convenient point as shown in Figure A.2. The extra volume of this arrangement should be borne in mind (see 5.2.1).

The end of the concentric tubes is level with the top "lip" of the dummy head and the end of the sample tube is level with the end of the concentric tubes.

The arrangement for setting up and testing hooded devices which seal around the neck is given in annex A.

5.2.5 Auxiliary fan

In order to ensure that the device inhales laboratory air containing a minimum level of carbon dioxide, an auxiliary fan is arranged so that it blows the exhaled air emerging from the device away from the device inlet. The fan is arranged to deliver air at 0,5 m/s when measured at a point 50 mm in front of the device inlet.

NOTE The auxiliary fan arrangement is not required when carrying out tests on devices which have their own independent air supply (e.g. compressed airline devices).

5.2.6 Carbon dioxide sampling of ambient air

It is necessary to assess the level of carbon dioxide in the laboratory air in the immediate vicinity of the device inlet. This is achieved by using a sample probe placed at a point 50 mm in front of the device inlet. The probe is connected to the auxiliary lung used for measuring dead space. It samples during the inhalation phase of the breathing machine at the same sample rate as used to measure the carbon dioxide in the inhalation air.

5.3 Procedure for measurement of carbon dioxide in inhalation air

5.3.1 Confirm whether the device standard requires breathing machine settings and exhaled carbon dioxide levels which lead to sample volumes different to those specified in the following procedure. An example of the calculation necessary for different requirements is given in 5.3.10.

5.3.2 Fit the facepiece or complete equipment as directed by the device standard to the Sheffield head/torso as appropriate, and operate the device in its minimum design condition defined in the device standard. Ensure as far as possible that exhaled air from the device (which during subsequent testing will contain 5 % carbon dioxide) is not rebreathed by the device.

5.3.3 Connect the breathing circuit to the Sheffield dummy head/torso.

5.3.4 Switch on the breathing machine (and with it the auxiliary lung and valves) and operate at 25 cycles per minute and 2,0 l/stroke.

5.3.5 Switch on the auxiliary fan (if appropriate) and adjust the air velocity to 0,5 m/s at a point 50 mm in front of the device inlet(s), ensuring that the air is directed away from the device inlet(s).

5.3.6 Adjust the carbon dioxide supply into the breathing machine to 2,5 l/min (i.e. a carbon dioxide concentration equivalent to 5 % of the volume of the exhalation stroke of the breathing machine) via a control valve (if fitted), the flow meter, compensating bag and non-return valves. Check the carbon dioxide concentration in the exhaled air on a dry basis and adjust as necessary to achieve a stabilised level of 5 %.

5.3.7 Draw off a sample of the inhaled air during the inhalation phase by the auxiliary lung set at a rate of 100 ml displacement/stroke (i.e. 5 % of the volume of the inhalation stroke of the breathing machine).

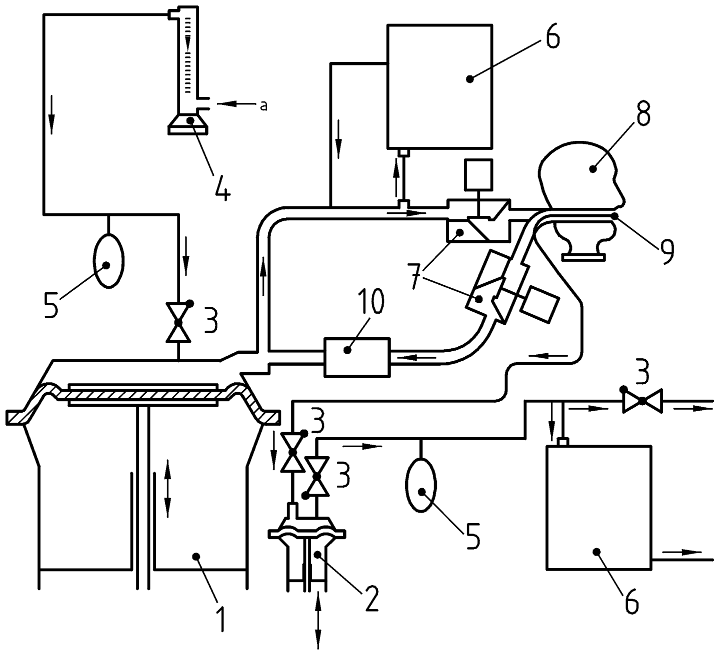
Measure the carbon dioxide concentration in the sample by means of the analyser. Continue the test until a steady value is obtained. Record this value as the uncorrected level of carbon dioxide in the inhaled air.

5.3.8 Continue the test and measure the ambient carbon dioxide level 50 mm in front of the inlet(s) to the device. Take the measure once a stabilised level for carbon dioxide in the inhalation air has been attained. The reference level shall be less than 0,1 %. For devices with an independent air supply, the carbon dioxide level in the supply air shall be less than 0,1 %.

5.3.9 Subtract either the laboratory ambient carbon dioxide level or that in the independent air supply, as appropriate, from the measured value in the inhaled air and record this as the corrected carbon dioxide content of the inhaled air.

5.3.10 Example of calculation for alternative requirements.

Breathing machine setting	20 cycles per minute and 1,75 l/stroke
Exhaled carbon dioxide	4,5 %
Volume of input CO_2 / stroke	= 4,5 % of 1,75 l = 0,07875 l
Flow rate of CO_2	= 0,07875 x 20 cycles/min. = 1,575 l/min
Inhalation sample volume	
(auxiliary lung displacement)	= 4,5 % of 1,75 l = 78,75 ml



Key

1 Breathing machine

2 Auxiliary lung

3 Non-return valve

4 Flowmeter

5 Compensator

6 Carbon dioxide analyser

7 Solenoid valve

8 Dummy head

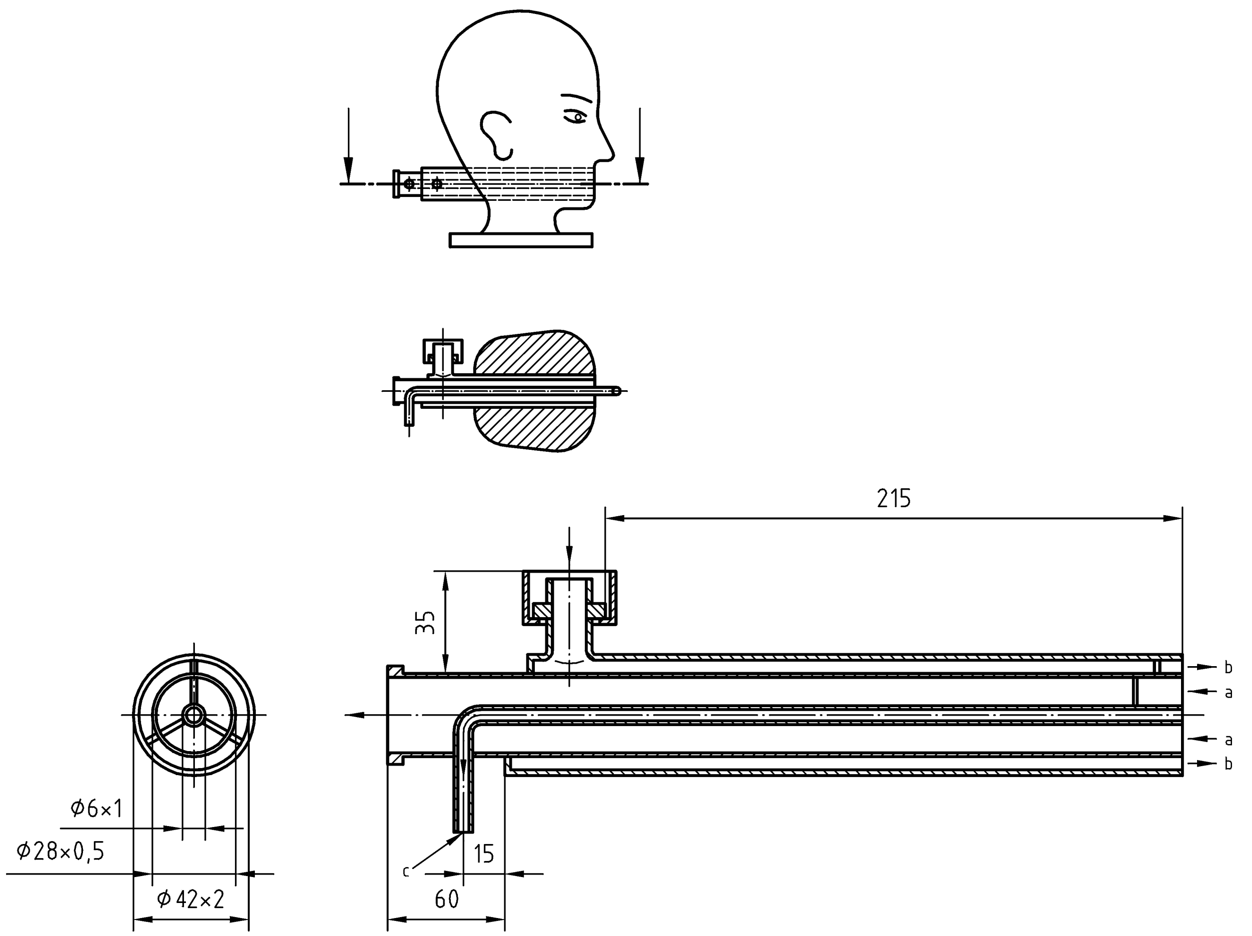
9 Sampling tube for inhalation air

10 Carbon dioxide absorber

a Carbon dioxide supply

Figure 1 — Schematic of a typical arrangement for testing carbon dioxide content of the inhalation air

Dimensions in millimetres



Key

a Inhalation

b Exhalation

c Carbon dioxide measuring during inhalation

Figure 2 — Schematic of a Sheffield dummy head for testing carbon dioxide content of the inhalation air (dead space)

Annex A
(normative)

Fitting procedure for hoods (with or without head harness) which seal around the neck

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/exhalate 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/carbon dioxide circuit 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 and central carbon dioxide sampling tube. The tubes are directed down the neck section to exit from the torso at a convenient point (see Figure A.2).

The extra volume of this arrangement should be borne in mind (see 5.2.1).

The end of the concentric tubes is level with the top "lip" of the dummy head and the end of the sample tube is level with the end of the concentric tubes.

A.3.2 Stand and elastic string

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 shall 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, fit the hood over the dummy head and tighten the drawstring of the neck seal (if fitted) tightly around the collar or, if an elasticated neck band is fitted, locate it around the collar. The outlet from the collar shall be fully open.

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

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 minimum design flow rate as specified by the manufacturer and unseal the outlet from the mouth of the dummy head.

Connect the inlet of the concentric tubes to the carbon dioxide/breathing machine circuit adjusted as 5.3 and shown in Figure 1. Switch on the breathing machine only and 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.

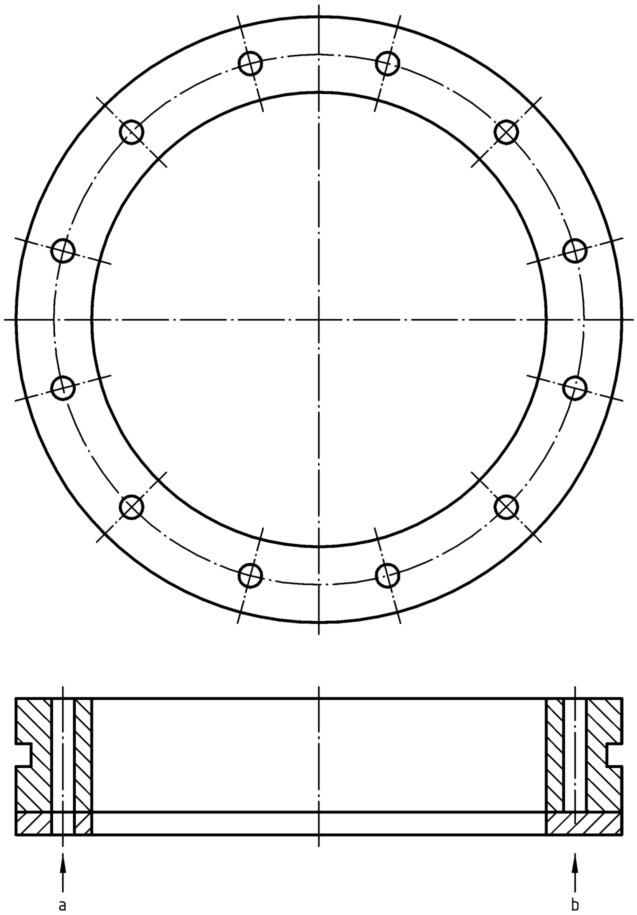
Turn on the supply of carbon dioxide and measure the rebreathed level as described in 5.3 with the hood in the following three positions:

a) just touching the nose;

b) just touching the back of the head;

c) central.

Adjust the position of the hood by means of the elastic line. Throughout the duration of the test the hood shall remain as laterally symmetrical as possible about the head and vertical movement shall not be restricted. Take the appropriate test result as the average of the three readings.

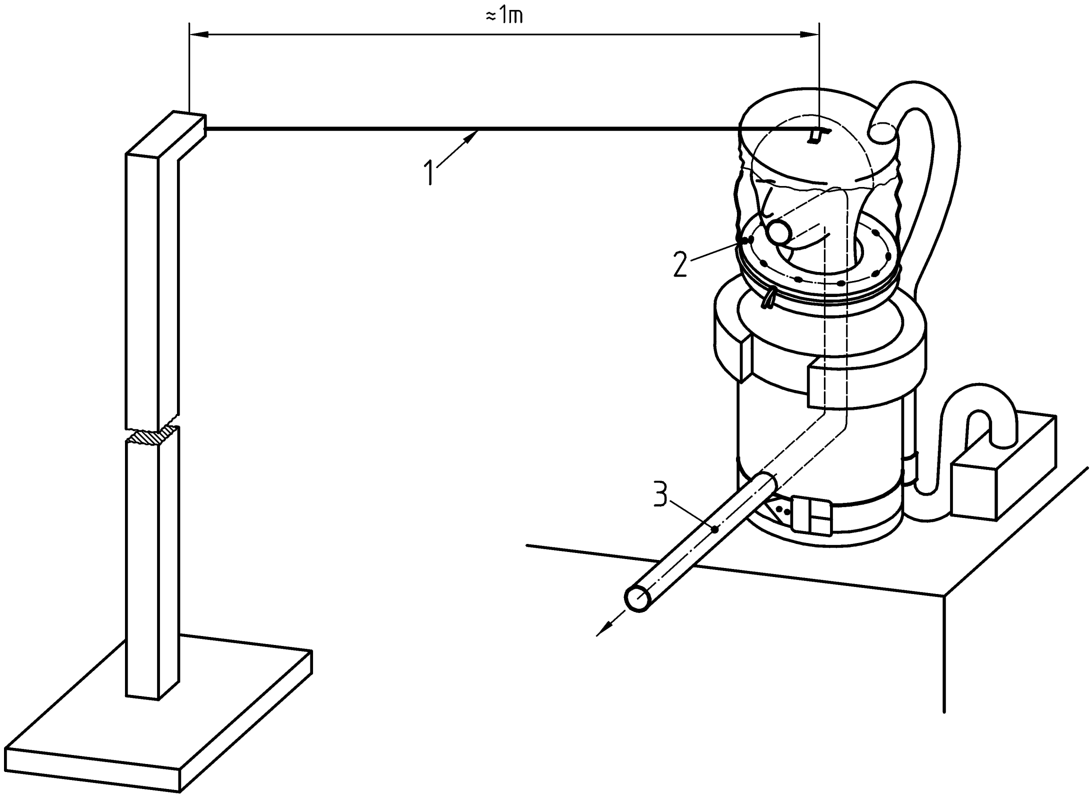


Half section showing lower ring adjusted to give

a Open position

b Closed position

Figure A.1 - Schematic of a typical adjustable flow collar



Key

1 Elastic line which allows unrestricted vertical movements of the hood

2 Adjustable collar (see Figure A.1)

3 Concentric tubes connected to breathing machine

Figure A.2 - Schematic of a typical fitting arrangement using collar, elastic line and dummy torso

Annex B
(informative)

Test results - Uncertainty of measurement

For each of the required measurements performed in accordance with this standard, a corresponding estimate of the uncertainty of measurement should 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 clauses 1.2.1 and 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.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover.
Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001.
Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre.
Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration.
Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001.
Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

Details and advice can be obtained from the Copyright & Licensing Manager.
Tel: +44 (0)20 8996 7070. Fax: +44 (0)20 8996 7553.
Email: copyright@bsi-global.com.

BSI
389 Chiswick High Road
London
W4 4AL