Dragon, Karen E.

From: Rehak, Timothy R.
Sent: Tuesday, April 29, 2003 10:25 AM
To: Dragon, Karen E.
Cc: Kovac, John G.
Subject: FW: Multi-Function PAPR project.


EN146-1991 tandard.pdf (805 K.


Max P2 EN 146 respiratory test...


Jacques_Group.jpg (73 KB)


Jacques1.jpg (47 KB)


Jacques2.jpg (48 KB)

Karen:

Please include this email and the attachments as part of the Docket for PAPRs (NIOSH 008). This is the information presented to NIOSH by Jacques W. Forrest (Centurion Safety Products, Ltd.) in an individual stakeholder meeting we held with them on April 10th in Arlington after our Public Meeting there.

Timothy R. Rehak, P.E.
General Engineer
NIOSH-NPPTL

-----Original Message-----
From: Kovac, John G.
Sent: Monday, April 28, 2003 6:34 AM
To: Rehak, Timothy R.
Subject: FW: Multi-Function PAPR project.

This must be their version of the public meeting?
-----Original Message-----
From: Forrest, Jacques [mailto:Jacques.Forrest@centurionsafety.co.uk]
Sent: Wednesday, April 23, 2003 12:11 PM
To: 'jkk5@cdc.gov'
Cc: 'LPtasnik@go-mpsinc.com'
Subject: FW: Multi-Function PAPR project.

> John,
> Further to Centurions presentation at the Key Bridge Marriott Public
> Meeting
> and our individual stakeholder meeting I present below the 3 points
> discussed at the
> individual meeting and some further information that may be of interest.
>
> At the individual stakeholder meeting:-
> 1/. We proposed that NIOSH should accept current recognised
> International/European
> respiratory standards for PAPRs until NIOSH can complete their new
> regulations.
> This recognition would be on an interim/temporary basis only until the
> NIOSH standards are completed.
> 2/. We proposed that NIOSH move away from standards that are all

> encompassing (and hence constrain design)
> to standards that recognise the risk the wearer will be exposed to.
> The " horses for courses" approach.
> 3/. We proposed moving away from the mandatory requirement for HEPA
> filters in PAPRs.
> This requirement is constraining the design of products and outlawing
> other filter media
> that would be more efficient against known contaminants.
>
> For your information I have included a copy of EN 146.
> This European standard in section 6.1 has a laboratory based complete
> equipment efficiency test.
> It includes walking, talking and head movements as well as side winds etc.
> Results are presented against sections 4 and 5.3.
> Whilst I accept that salt saturated vapour may not be wholly
> representative of NBC contaminants
> it is a very effective representation of particulate contaminants.
> I also enclose the results for MAX against the above standard.
> Perhaps you would like to note that Max also satisfies the Australian
> requirements for
> respiratory, head, face/eye, hearing protection and their Intrinsic Safety
> requirements.
> Furthermore, I also attach some photos of what I looked like after a mine
> owner had given me
> (the rookie) the underground "experience".
> I was underground for 8 hours and put to the sword of experience.
> The culmination of which was walking back out up the in by.
> 4 miles next to the out coal conveyor and against the incoming air up a 30
> degree slope.
> I can assure you I was blowing hard and very hot when we reached the
> shaft.
> The helmet was supplying 140 litres a minute.
> I think this shows that "peak inhalation rates" need to be treated with
> caution.
>
> If I can be of any further help please do not hesitate to contact me.
> Regards,
> Jacques Forrest
>
>
> <<EN146-1991 standard.pdf>> <<Max P2 EN 146 respiratory test report
> (inspec 9-2-98).pdf>> <<Jacques_Group.jpg>> <<Jacques1.jpg>>
> <<Jacques2.jpg>>
>

INSPEC
LABORATORIES LIMITED

NAMAS
TESTING
No.0316

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EN 146 : 1991

RESPIRATORY PROTECTIVE EQUIPMENT

POWERED PARTICLE FILTERING DEVICES

INCORPORATING HELMETS OR HOODS

TEST REPORT NO: 98.02.08

CLIENT: Martindale Protection
A Division of Centurion Safety Products Limited
21 Howlett Way
Fison Way Industrial Estate
Thetford
Norfolk
IP24 1HZ

MODEL: MAX - P2

DATES SAMPLES RECEIVED: 9 October 1997 to 7 January 1998

DATE ORDER RECEIVED: 29 September 1997

DATES OF TESTS: 17 November 1997 to 4 February 1998

Approved: A. Diamond ..... Checked: F. Pennington .....
A. DIAMOND F. PENNINGTON

Issued: 9 FEBRUARY 1998

The samples tested will be returned

INTRODUCTION

Martindale Protection, a Division of Centurion Safety Products Limited, commissioned assessment of their model MAX - P2 powered respirator to certain specified requirements of EN 146 : 1991 (BS EN 146 : 1992), as a class THP2 device.

It will be helpful to refer to the Standard whilst reading this report.

For Conclusions see page 5.

Note: Opinions, comments and interpretations expressed herein are outside the scope of UKAS accreditation and any clauses or sub-clauses where this applies are shown in italics in this report.

SAMPLE DETAILS

The manufacturer submitted various samples. Those required for testing were randomly selected and assigned INSPEC Laboratories' test sample identifications as detailed below.

Table 1 : Sample details

Component	Quantity submitted	INSPEC identification
Max helmet - complete	2	G75801 and G75802
Max helmet - partial	3	G75880 to G75882
Charger	2	G75803 and G75804
Filters - submission 1 (no foam seal)	20	G75805 to G75816, G75805A & G75806A
Filters - submission 2 (no foam seal)	4	G75817 to G75820
Filters - submission 3 (foam seal)	4	G75821 to G75824
Filters - submission 4 (foam seal)	10	G75825 to G75834
Air flow indicators	2	G75890/91 and G75892/93

For simplicity, the first four characters of the above identifications have been omitted throughout the remainder of this report.

Unless specified otherwise, helmet 01 was tested whilst fitted with filter 05, and helmet 02 whilst fitted with filter 06, where appropriate.

PROCEDURES

The tests were performed as specified in EN 146 : 1991 (BS EN 146 : 1992) taking into account Interpretation sheet No. 3 dated 06/95.

The initial flow rate and duration of each device was measured as specified in Clause 6.4, using the test arrangement shown in figure 4 (example 2).

Table 2 : Manufacturer's specifications

Manufacturer's minimum design flow rate	130 ℓ/min
Manufacturers design duration	8 hours

It should be noted that certain ambiguities are present in the Standard. For testing purposes, it has been necessary for INSPEC Laboratories Limited to make interpretations relating to these ambiguities. Where relevant, the INSPEC reference for the appropriate interpretation is included in the Results section of this report. Copies are available upon request.

RESULTS

5.1 Materials

5.1.1 Compatibility with skin

Not assessed.

5.1.2 Cleaning and disinfection

Cleaning and disinfection instructions were not supplied. Manufacturer to certify.

5.3 Total inward leakage

Samples 01 and 02 were tested.

For detailed results, see page 6.

The total inward leakage figures reported, were corrected for each test subject's individual background (no salt) reading.

5.4 Carbon dioxide content of the inhalation air

Table 3 : Carbon dioxide content of the inhalation air

Sample	CO_2 (%)
01	0.89
02	0.81

5.5 Breathing resistance

Table 4 : Breathing resistance

Sample	Resistance (mbar)
01 (+25)	0.21
02 (+30)	0.16

5.6 Air supply

5.6.1 Initial flow rate and duration

The minimum design flow rate was claimed as 130 l/min.

The manufacturer's design duration was claimed as 8 hours.

Table 5 : Air supply

Sample	Flow rate (l/min)	
	Initial	After 8 hours
01	182	147
02	176	149

5.11 Warning and measuring facilities

5.11.1 Table 6 : Flow checking facilities

Sample	Flow (l/min)
01 + 90/91	143
02 + 92/93	137

5.11.2 The device was claimed to be of class THP2 and was not fitted with a warning facility. Not applicable.

5.12 Visor

5.12.1 *There were no adverse comments regarding vision distortion or misting following the inward leakage testing.*

The manufacturer did not supply any anti-fogging compounds.

5.12.2 Field of vision

Table 7 : Field of vision

Sample	Effective (%)	Overlapped (%)
01	74.7	94.7
02	82.2	99.4

Copies of the apertometer diagrams are included as pages 8 and 9 of this report.

5.12.3 Samples 01, 02 and 80 to 82 were tested.

Following the test none of the samples exhibited any visible signs of damage.

5.13 Flammability

Samples 01 and 02 were tested.

No part of any sample deformed, decomposed or continued to burn after being subjected to the specified test.

CONCLUSIONS

Martindale Protection, a Division of Centurion Safety Products Limited, had commissioned assessment of their model MAX - P2 powered respirator to certain specified requirements of EN 146 : 1991 (BS EN 146 : 1992), as a class THP2 device.

When tested as detailed in this report, the samples satisfied those requirements which were assessed.

The following requested requirements were not assessed.

5.1 Materials
5.1.1 - Compatibility with skin
5.1.2 - Cleaning and disinfection

Please refer to the Results section of this report to determine the requirements requested for assessment.

Table 8 : Inward leakage

% NaCl Inward Leakage

Subject	Sample	Filter	Fan	Walk	Stand	Head * side/side	Head * up/down	Talk	Walk *	Stand
JT	01	26	Front	1.488	1.408	2.126	2.167	1.778	2.301	1.805
			Side			2.594	2.192		2.130	
			Rear			2.556	2.684		2.630	
GK	01	25	Front	0.910	1.121	1.435	1.471	1.403	1.462	1.290
SDJ	01	28	Side	1.065	1.167	1.977	1.814	1.311	1.837	1.387
AGP	01	29	Rear	1.352	1.377	1.935	2.204	1.729	1.998	2.494
IM	01	27	Front	1.904	1.887	2.439	2.554	2.517	2.657	2.970
DM	02	33	Side	3.478	2.842	3.080	3.288	2.461	3.181	3.097
CDB	02	34	Rear	2.111	1.965	3.835	4.211	2.148	4.186	2.989
NS	02	30	Front	1.026	1.208	1.866	2.069	1.201	2.091	1.417
DB	02	31	Side	3.456	2.710	3.548	3.522	2.370	3.145	3.477
FP	02	32	Rear	2.507	1.992	2.613	2.867	2.216	3.057	2.267
Min				0.910	1.121	1.435	1.471	1.201	1.462	1.290
Max				3.478	2.842	3.835	4.211	2.517	4.186	3.477
Mean				1.930	1.768	2.500	2.587	1.913	2.556	2.319

* = Fan on in relevant position

Facial dimensions of test panel

SUBJECT	FACE LENGTH (mm)	FACE WIDTH (mm)	FACE DEPTH (mm)	MOUTH WIDTH (mm)
JT	109	139	108	53
GK	125	146	103	51
SDJ	125	152	109	55
AGP	120	141	105	52
IM	115	140	114	49
DM	128	146	111	52
CDB	113	139	113	49
NS	120	135	112	52
DB	122	141	112	50
FP	122	141	115	53

BS.EN.146

SAMPLE Nº 01

Sign: DB

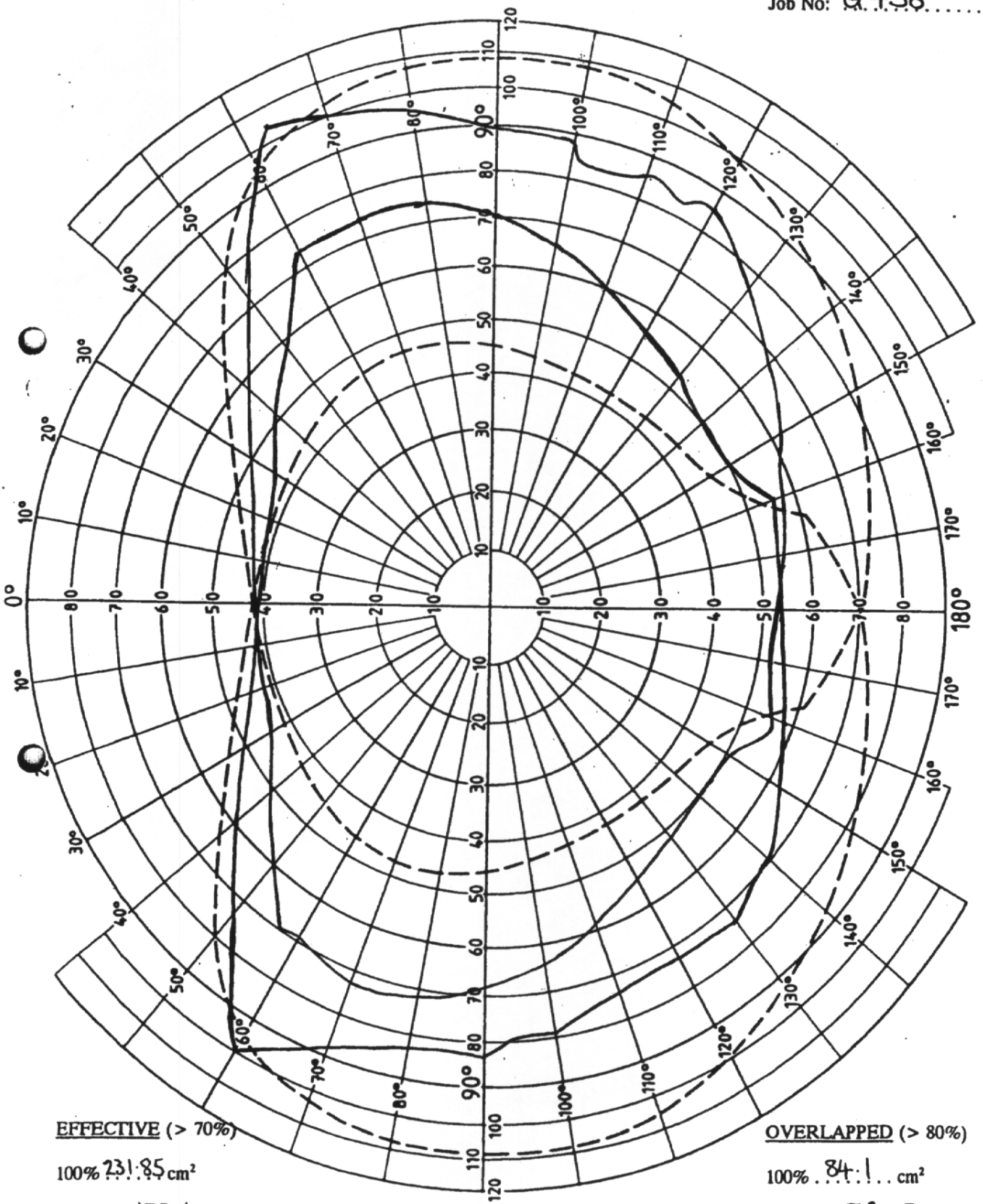
Date: 5/12/97

FIELD OF VISION

Report No: 98.02.08

Page: 8 of 9

Job No: G758



EFFECTIVE (> 70%)

100% 231.85 cm²

ACTUAL 173.1 cm²

% 74.66

OVERLAPPED (> 80%)

100% 84.1 cm²

ACTUAL 79.65 cm²

% 94.71

BS. EN. 146

SAMPLE Nº 02

Sign: .....

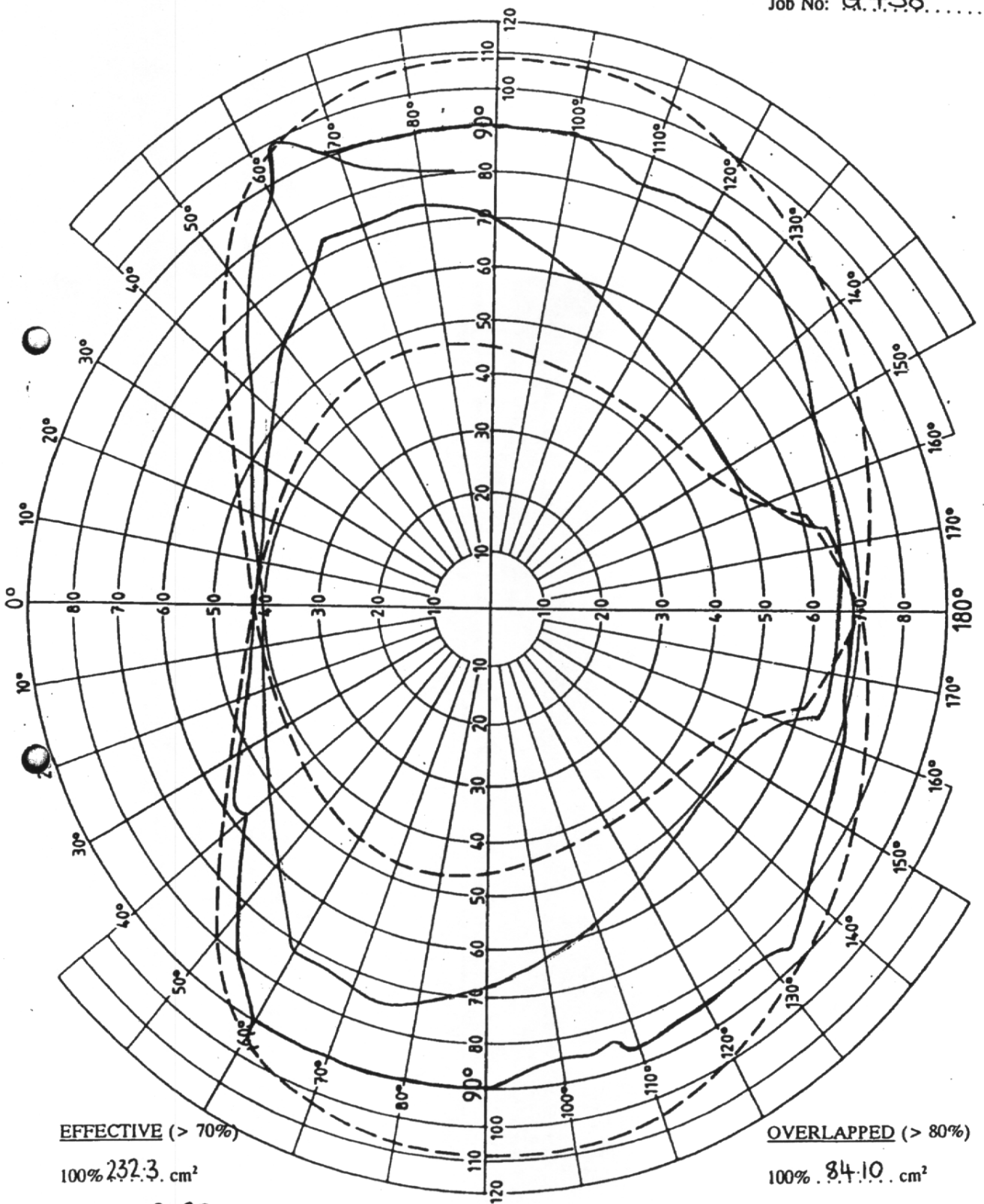
Date: 5/12/97.....

FIELD OF VISION

Report No: 98.02.08

Page: 9 of 9

Job No: G758.....



EFFECTIVE (> 70%)

100% 232.3 cm²

ACTUAL 190.95 cm²

% 82.20

OVERLAPPED (> 80%)

100% 84.10 cm²

ACTUAL 83.60 cm²

% 99.41

BS EN
146 : 1992

Respiratory protective devices Specification for powered particle filtering devices incorporating helmets or hoods

The European Standard EN 146 : 1991 has the status of a British Standard

Appareils de protection respiratoire: Appareils filtrants contre les particules à ventilation assistée avec casques ou cagoules

Atemschutzgeräte: Atemschutzhelme oder Atemschutzhauben mit Partikelfilter und Gebläse

Cooperating organizations

The European Committee for Standardization (CEN), under whose supervision this European Standard was prepared, comprises the national standards organizations of the following countries.

Austria	Oesterreichisches Normungsinstitut
Belgium	Institut belge de normalisation
Denmark	Dansk Standardiseringsraad
Finland	Suomen Standardisoimisliito, r.y.
France	Association française de normalisation
Germany	Deutsches Institut für Normung e.V.
Greece	Hellenic Organization for Standardization
Iceland	Technological Institute of Iceland
Ireland	National Standards Authority of Ireland
Italy	Ente Nazionale Italiano di Unificazione
Luxembourg	Inspection du Travail et des Mines
Netherlands	Nederlands Normalisatie-instituut
Norway	Norges Standardiseringsforbund
Portugal	Instituto Português da Qualidade
Spain	Asociación Española de Normalización y Certificación
Sweden	Standardiseringskommissionen i Sverige
Switzerland	Association suisse de normalisation
United Kingdom	British Standards Institution

This British Standard, having been prepared under the direction of the Personal Safety Equipment Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
1 April 1992

The following BSI references relate to the work on this standard:
Committee reference PSM/14
Draft for comment 83/39516 DC

ISBN 0 580 20179 1

Amendments issued since publication

Amd. No.	Date	Text affected

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National foreword

This British Standard has been prepared under the direction of the Personal Safety Equipment Standards Policy Committee and is the English language version of EN 146 'Respiratory protective devices. Powered particle filtering devices incorporating helmets or hoods. Requirements, testing, marking', published by the European Committee for Standardization (CEN). It supersedes DD 97 : Part 13 : 1987 which is withdrawn.

EN 146 was produced as a result of international discussions in which the United Kingdom took an active part.

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

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 146

January 1991

UDC 614.894.3 : 621.61 : 001.4 : 620.1 : 62-777

Descriptors: Occupational safety, accident prevention, personal protective equipment, respiratory protective device, filters, powered filtering device, hoods, helmets, requirements, testing, marking

English version

Respiratory protective devices
Powered particle filtering devices incorporating helmets or hoods
Requirements, testing, marking

Appareils de protection respiratoire;
Appareils filtrants contre les particules à ventilation assistée avex casques ou cagoules;
Exigences, essais, marquage

Atemschutzgeräte;
Atemschutzhelme oder Atemschutzhauben mit Partikelfilter und Gebläse; Anforderungen, Prüfung, Kennzeichnung

This European Standard was approved by CEN on 27 September 1990. 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.

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

CEN

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

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

Ref. No. EN 146 : 1991 E

Brief History

This European Standard was drawn up by CEN/TC 79 'Respiratory protective devices', the secretariat of which is held by DIN.

In 1979, Sub-Group 3/4 (SG 3/4) 'Powered respirators' with BSI as secretariat started work on this draft proposal.

At the Plenary Meeting of CEN/TC 79 in Helsinki in October 1981 the draft proposal was presented and unanimously accepted by CEN/TC 79. It was then presented to the secretariat of CEN/TC 79 for publication as a draft European Standard.

In December 1983 the draft European Standard prEN 146 was circulated by CEN Central Secretariat to all CEN members for vote and comments. Within the voting period 8 member bodies approved and 3 member bodies disapproved the document.

The comments received were discussed and changes agreed during subsequent meetings of SG 3/4 and the resultant document was submitted to CEN members for formal vote.

At the meeting of SG 3/4 held in Paris in May 1988 it was confirmed that the document should go forward for formal vote and subsequent publication. It was also agreed that it would be withdrawn on publication of a specification to be developed which would cover powered filtering devices, incorporating helmets or hoods, and which would afford protection against particles, gases/vapours and combinations of these.

In accordance with the Common CEN/CENELEC Rules, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Preamble

A given respiratory protective device can only be approved when the individual components satisfy the requirements of the test specification which may be a complete standard or part of a standard and practical performance tests have been carried out 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 powered particle filtering devices incorporating helmets or hoods used as respiratory protective devices. It does not cover devices designed for use in circumstances where there is or might be an oxygen deficiency (oxygen less than 17 % by volume). It also does not cover respiratory protective devices designed for escape purposes.

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

2 References

EN 143 : 1989	Respiratory protective devices; Particle filters; Requirements, testing, marking
EN 50020 Part 7 : 1977	Electrical apparatus for potentially explosive atmospheres; Intrinisic safety 'i'
IEC 651 : 1979	Sound level meters

3 Definition and description

3.1 A powered particle filtering device incorporating a helmet or hood is a device dependent on the ambient air. The device provides protection against solid, or solid and liquid aerosols of negligible volatility and decomposition.

The device consists of a helmet or hood with an attachment for covering at least the face (eyes, nose, mouth, chin), a power-operated blower and one or more particle filters. These three components can be integrated into one unit. The fan provides a flow of filtered ambient air to the wearer. Air in excess of the wearer's demand is discharged by exhalation valves or other outlets depending on the design.

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

4 Classification and designation

Powered particle filtering devices incorporating helmets and hoods are classified and designated as a function of their maximum total inward leakage as given in table 1, when measured against sodium chloride at the manufacturer's minimum design flow rate.

Table 1. Classification of devices

Class	Maximum total inward leakage (%) (power-on)
THP1	10
THP2	5
THP3	0,2

NOTE. The 'power-off' state is considered to be an abnormal situation; in these circumstances there is no requirement for testing total inward leakage.

5 Requirements

5.1 Materials

5.1.1 *Compatibility with skin*

Materials that may 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.

5.1.2 *Cleaning and disinfection*

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

5.2 Helmet

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

5.3 Total inward leakage

When tested in accordance with **6.1** and calculated according to **6.1.5** the mean total inward leakage of the test aerosol for each of the exercises **6.1.4** (a), (c) (1), (c) (2), (c) (3) and (d) for each test subject shall be within the levels set out in clause **4**, when tested at the manufacturer's minimum design flow rate which shall not be less than 120 l/min.

NOTE. The leakage of exhalation valve(s) if provided, is measured as part of the total inward leakage.

5.4 Carbon dioxide content of the inhalation air

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

5.5 Breathing resistance

When the exhalation resistance is measured in accordance with **6.3** the positive pressure under the helmet or hood shall not exceed 7 mbar

5.6 Air supply

5.6.1 When tested in accordance with **6.4** at the extremes of operating temperatures and humidities as claimed in the instructions for use the flow into the helmet or hood shall exceed the manufacturer's minimum design flow rate which shall be not less than 120 l/min for the manufacturer's design duration which shall be not less than 4 h.

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

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

5.7 Clogging

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

5.8 Electrical components

Where a battery is used it shall be a non-spillable type, and where necessary shall be provided with a safe venting device.

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

If the device is claimed to be intrinsically safe it shall comply with the requirements of EN 50020 Part 7.

5.9 Hoses

Any breathing hose shall permit free head movement and shall not restrict or close off the air supply under chin or arm pressure as assessed during measurement of total inward leakage (see **6.1**).

5.10 Filters

Filters other than pre-filters, shall be designed to be irreversible. Filter(s) shall be readily replaceable without the use of tools. The performance of the filters shall conform to table 2 and shall be tested with the test methods described in EN 143 at the initial flow rate measured in **6.4.5**.

Table 2. Maximum initial penetration

Class	Maximum initial penetration (%)	
	Sodium chloride	Paraffin oil
THP1	10	4
THP2	5	2
THP3	0,2	0,1

NOTE 1. Filters suitable for use against solid and liquid aerosols shall be tested against sodium chloride and paraffin oil.
NOTE 2. Filters suitable only for use against solid aerosols and water based aerosols shall be tested against sodium chloride only.

5.11 Warning and measuring facilities

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

5.11.2 THP3 equipment shall be fitted with a warning device which shall indicate to the wearer when the flow rate under the helmet or hood drops below the manufacturer's minimum design flow rate. A means of checking the correct functioning of the warning device shall also be provided.

5.12 Visor

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

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

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

5.12.3 After testing in accordance with **6.7** the visor shall not be visibly damaged in such a way as to be likely to affect the performance of the complete device.

5.13 Flammability

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

5.14 Noise

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

If national regulations are more stringent than this requirement, they shall be met.

6 Testing

6.1 Total inward leakage

6.1.1 ***Principle***

Each test subject, wearing the complete equipment on test, walks on a horizontal treadmill surrounded by a standard cloud of sodium chloride particles. The flow rate of the device is adjusted to, and maintained at the manufacturer's minimum design flow rate using a variable voltage supply. The battery fitted to the device is not used. The percentage inward leakage of the test cloud into the breathing zone is measured by means of flame photometry. Determination of the inward leakage is possible over the range of less than 0,001 % to 100 % penetration. Dilution of the test cloud by

the clean air emanating from the respirator under test does not affect the accuracy of measurement of inward leakage because of the large volume and continuous replacement.

6.1.2 ***Test subjects and number of tests***

Two devices shall be tested, each being tested on five test subjects; in total 10 different subjects. Each test shall be carried out using new filters.

6.1.3 ***Test equipment***

A typical test arrangement is shown in figure 1.

The test cloud of sodium chloride particles is formed by the evaporation of an atomized 2 % aqueous solution of reagent grade sodium chloride. The atomizer shall be of the large Collison type. Details of a suitable atomizer are shown in figure 9. The atomizer is supplied with air at a pressure of 7 bar and a flow of 100 l/min. The atomizer is situated in a duct through which a constant flow of air is maintained.

NOTE. It may be necessary to heat or dehumidify the air in order to obtain complete drying of the aerosol particles.

The duct shall lead into the top of an enclosure positioned over a treadmill; the enclosure shall be large enough to permit walking on the treadmill without interference. Provision shall be made for the positioning of a supplementary fan, not less than 350 mm in diameter, inside the enclosure such that an air flow of 2 m/s across the enclosure can be produced in the vicinity of the subject's head.

The mean air speed through the enclosure measured with a subject standing centrally on the treadmill, and without the supplementary fan in operation, shall be between 0,15 and 0,20 m/s. The air speed at any point in the effective working volume of the enclosure shall be not less than 0,1 m/s, i.e. measurements shall not be made at points nearer than 100 mm to the sides of the enclosure, below 0,75 m from the base of the enclosure nor above a height at which the sodium chloride concentration differs by more than 10 % from the average concentration. The relative humidity of the air within the enclosure when the atomizer is in operation shall not exceed 60 %, this may necessitate drying the air before it flows past the atomizer. The air temperature shall be not less than 15 °C.

The mean sodium chloride concentration within the effective working volume of the enclosure shall be (8 ± 4) mg/m^3 and the variation throughout the effective working volume shall be not more than ± 10 %. If necessary a baffle may be placed at the end of the duct in order to achieve these conditions.

The test cloud is composed of sodium chloride particles mainly within the size range 0,02 µm to 2 µm equivalent diameter with a mass median size of 0,6 µm. The concentration of sodium chloride shall be determined by flame photometry.

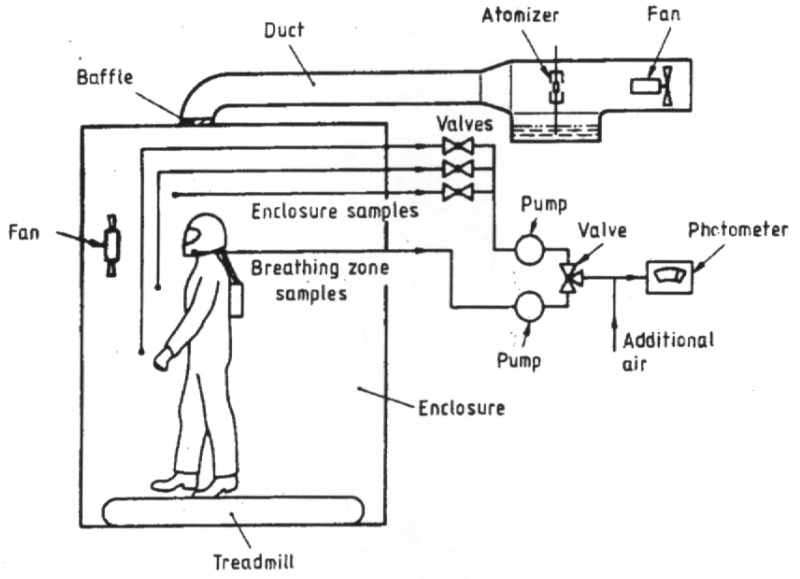


Figure 1. Schematic diagram of apparatus used in the determination of total inward leakage

Essential performance characteristics of a suitable photometer are:

- it should be specifically designed for the direct analysis of sodium chloride aerosol;
- it should be capable of measuring concentrations of sodium chloride aerosol between 15 mg/m^3 and 5 ng/m^3;
- the total aerosol sample required by the photometer should not be greater than 15 l/min;
- the response time, excluding sampling system, should not be greater than 500 ms;
- the response to other elements, particularly carbon, the concentration of which will vary during the breathing cycle, needs to be reduced by ensuring that the band pass width of the interference filter is no greater than 3 nm and that all necessary side band filters are included.

The sample tubes shall consist of plastics tubing with a nominal inside diameter of 4 mm through which air is drawn at a rate of 1,5 l/min to 3 l/min by means of a suitable pump. The pump shall be chosen so as to minimize aerosol losses within the pump and also to minimize the change in flow rate caused by changing pressure within the sampling zone. If necessary the sample shall then be diluted with a further 9 l/min of clean air before being fed to the flame tube of the photometer. Two separate sample tubes shall be provided, one to measure the ambient concentration within the enclosure and one to measure the concentration in the wearer's breathing zone.

A test probe with a minimum bore of 1,5 mm may be fitted to the latter sample tube in order to obtain a sample from the required region, the design of the probe shall be chosen to suit the equipment under test. The sample tube connected to the facepiece shall be as flexible as possible. Care shall be taken to ensure that the fitting of the tube and probe does not affect the face seal during head movements.

6.1.4 *Test procedure*

All sample tubes shall initially be placed in close proximity to one another within the enclosure and the resistance of the sample tubes adjusted, so that identical readings for the sodium chloride concentration are obtained from each sample tube.

Provide the test subject with the device and the manufacturer's fitting instructions and allow the test subject to fit the device to the satisfaction of the test subject and the testing officer.

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

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

Introduce the test aerosol into the chamber.

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

The test subject shall then stand on the treadmill for a further 2 to 3 min in order to allow the concentration within the wearer's breathing zone to stabilize.

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

a) standing in an upright position for 2 min;

b) walking for 4 min at 6 km/h on the treadmill;

c) then whilst still walking:

1) turning head from side to side (approx. 15 times) at his/her own but normal speed for 2 min;

2) moving head up and down (approx. 15 times) at his/her own but normal speed for 2 min;

3) reciting alphabet aloud for 2 min;

d) followed by walking for 2 min at 6 km/h on the treadmill;

e) standing in an upright position for 2 min.

Measure the sodium chloride concentration within the breathing zone during the whole period of the exercises.

Carry out the exercises (c) (1), (c) (2) and (d) with the supplementary fan operating such that an additional air flow at a speed of 2 m/s is produced to impinge on the front, side and rear of the device in turn.

Repeat the procedure with the other nine test subjects but for these the exercises (c) (1), (c) (2) and (d) are performed with the additional air flow in one direction only. This will provide 4 sets of results for each of the directions for the additional air flow as shown in table 3 where 'X' indicates that a test is performed and a measurement made. Thus for the 10 test subjects, 4 sets of results for each direction of air flow are obtained.

Table 3. Experimental plan for exercises (c) (1) (c) (2) and (d)

Air velocity direction	Exercises	Test subject number									
		1	2	3	4	5	6	7	8	9	10
Front	(c) (1)	X	X			X			X		
	(c) (2)	X	X			X			X		
	(d)	X	X			X			X		
Side	(c) (1)	X		X			X			X	
	(c) (2)	X		X			X			X	
	(d)	X		X			X			X	
Rear	(c) (1)	X			X			X			X
	(c) (2)	X			X			X			X
	(d)	X			X			X			X

6.1.5 *Expression of results*

The total inward leakage (TIL) expressed as a percentage for each of the exercises shall be calculated from the equation:

$$TIL = \frac{C_b}{C_e} \times 100$$

where

C_b = the mean concentration in the breathing zone for each exercise and for each test subject;

C_e = the concentration in the enclosure.

6.2 Carbon dioxide content of the inhalation air

6.2.1 *Principle*

The device is fitted to a Sheffield dummy head/torso and operated at the minimum design flow rate. Air mixed with carbon dioxide is supplied at a specified rate from a breathing machine and the inhaled air is analysed for carbon dioxide content.

6.2.2 *Test equipment*

A typical test arrangement is shown in figure 2.

6.2.3 *Procedure*

Adjust the breathing machine to give air at 25 cycles/min and 2 l/stroke.

Adjust the carbon dioxide supply into the breathing machine to 2,5 l/min via a control valve, a flowmeter, a compensating bag and non-return valves.

Check the carbon dioxide content of the exhaled air and adjust as necessary to give 5 % by volume measured on a dry basis. Ensure that the sample drawn off for analysis is returned to the test circuit to maintain the correct volumetric flow.

Where the hood or helmet incorporates a head harness the device shall be positioned on the Sheffield dummy head/torso using the head harness. In the absence of a head harness the head shall be positioned centrally in the hood but in accordance with the manufacturer's instructions. The device shall be operated at the manufacturer's minimum design flow rate.

Draw off a sample of the inhaled air during the inhalation phase by the auxiliary lung set at a rate of 100 ml per stroke.

Measure the carbon dioxide content in the sample by means of the analyser. Continue the test until a steady value is obtained.

6.2.4 *Report*

Report the carbon dioxide content of the sample when a steady value has been obtained as the carbon dioxide content of the inhalation air.

6.3 Breathing resistance

The device shall be fitted on the Sheffield dummy head/torso and operated according to the instructions for use with fully charged batteries and new filters.

The exhalation resistance shall be measured near the mouth of the dummy to which either a breathing machine adjusted to 25 cycles/min and 2 l/stroke or a continuous flow of 160 l/min is applied.

6.4 Air supply flow rate

6.4.1 *Principle*

The flow of filtered air to the device is measured at zero back pressure. The initial flow rate and the flow rate after continuous operation for the manufacturer's claimed duration are measured

6.4.2 *Test equipment*

6.4.2.1 *A Sheffield dummy head*, (or torso)[1] fitted with mouth tube and pressure port at the mouth.

6.4.2.2 *A blower or suction device*, or other suitable means of providing at least 250 l/min of air, or extracting at least 250 l/min at −5 mbar pressure.

6.4.2.3 *Control means for blower*, such as a variable power regulator for the motor or an adjustable bleed in the air supply pipework.

6.4.2.4 *Flowmeter*, calibrated from 50 to 500 l/min.

6.4.2.5 *Micromanometer*, if used, capable of detecting a pressure difference of ± 0,05 mbar and with a range of not less than 10 mbar.

NOTE. An inclined liquid manometer or an electronic micromanometer is recommended.

6.4.2.6 *Lightweight plastics bag*, as shown in figures 3 and 4.

6.4.3 *Preparation of device*

Fit a fully charged battery and new filter(s) to the device.

NOTE. In order to ensure a fully charged battery the following procedure is recommended. Operate the device normally until there is an audible decrease in air flow. Switch off the device and place the battery on charge in accordance with the manufacturer's instructions.

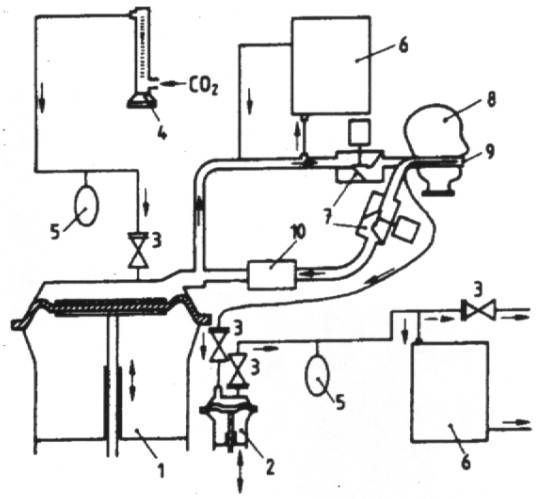
6.4.4 *Fitting the device into the apparatus*

Depending upon the design of the device, fit it into the apparatus in accordance with the appropriate arrangement shown in figures 3, 4 or 5. Ensure that all joints are leak tight.

Where an adaptor is used care should be taken to ensure that it does not give rise to any pressure/flow losses.

Devices with tight fitting neck seals should be fitted to the dummy head with the neck seal adjusted as if the device were being worn and with the micromanometer connected to the breathing zone of the visor cavity in such a manner as to be free from velocity effects.

[1] Information concerning the supply of the Sheffield dummy head or torso can be obtained from the Secretariat of CEN/TC 79.



1	Breathing machine	6	Carbon dioxide analyser
2	Auxiliary lung	7	Solenoid valves
3	Non-return valve	8	Dummy head
4	Flowmeter	9	Sampling tube for inhalation air
5	Compensator	10	Carbon dioxide absorber (necessary to prevent build up of carbon dioxide in the test equipment circuit)

Figure 2. Schematic diagram of test rig for carbon dioxide content of the inhalation air

6.4.5 ***Procedure: initial flow rate***

6.4.5.1 *Devices tested according to figure 3 or figure 4*

Switch on the device and adjust the blower (figure 3) or suction device (figure 4) until the plastics bag neither inflates nor deflates, i.e zero back pressure.

NOTE. The micromanometer should indicate zero pressure but observation of the plastics bag is often a more precise method of monitoring the pressure within such a flexible enclosure.

Record the reading of the flowmeter. Continue to ensure zero back pressure and repeat the flow measurement at intervals of 5 min until a total time of 30 min has elapsed.

Calculate the average of the seven flow measurements and report as the initial flow rate.

6.4.5.2 *Devices tested according to figure 5*

Switch on the device and adjust the suction means until the micromanometer indicates zero back pressure.

Record the reading of the flowmeter. Continue to ensure zero back pressure and repeat the flow measurement at intervals of 5 min until a total time of 30 min has elapsed.

Calculate the average of the seven flow measurements and report as the initial flow rate.

6.4.6 ***Procedure: design duration***

After measuring the initial flow rate as described in **6.4.5**, disconnect the measuring apparatus from the device and switch off the blower/suction device.

Leave the device running whilst fitted to the dummy head for 1 h less than the manufacturer's claimed duration and then reconnect the measuring apparatus as in figure 3, 4 or 5 as appropriate.

Measure and record the flow rate as described in **6.4.5** at a total elapsed time (including the first 30 min for initial flow rate measurement) equal to the manufacturer's claimed duration.

Report the flow rate at the manufacturer's claimed duration.

6.5 Clogging test

Starting with new filters and a fully charged battery the clogging test shall be that described in EN 143.

At least the filter and/or the fan entry shall be in the test atmosphere for the test. The device shall be operated in a dust concentration of (400 ± 100) mg/m^3 until the product of dust concentration and the testing time is:

400 mg · h/m^3 for THP1 and THP2 and

200 mg · h/m^3 for THP3

e.g. for a THP1 device, 400 mg/m^3 for 1 h or 300 mg/m^3 for 1 h 20 min.

At the end of the test the device shall be taken out of the dust chamber, cleaned on the outside if necessary, and tested for flow rate according to **6.4** and for the penetration requirements at this flow rate as specified in **5.10**.

6.6 Field of vision

The field of vision shall be measured with a Stoll apertometer (figure 6) modified to support the helmet or hood under test in the same manner as worn. The diagram shown in figure 7 shall be used for the evaluation. The test shall be carried out with the air supply maintained at the manufacturer's minimum design flow rate.

6.7 Visor

The complete assembled device shall be mounted on a dummy head supported in the same manner as worn and with the normal vertical axis of the head in a horizontal plane, with the head facing upwards. The centre of the visor shall be impacted by a steel ball (22 mm diameter, mass approximately 44 g) allowed to fall a distance of 130 cm. The impact shall be perpendicular to the surface of the visor. The test shall be carried out with the air supply maintained at the manufacturer's minimum design flow rate.

Five visors shall be tested.

6.8 Flammability

6.8.1 *Principle*

The device is mounted on a dummy head, passed through a flame and the effects of the flame on the device observed.

6.8.2 *Apparatus*

6.8.2.1 *A dummy head*, mounted on a support which enables it to be rotated to describe a horizontal circle (see figure 8).

6.8.2.2 *Gas supply rig*, consisting of a propane storage tank with flow control valve and fine pressure gauge, flame arrester and a propane burner [2]. The burner shall be adjustable in height.

6.8.3 *Procedure*

Fit the device to the dummy head and ensure that a speed of rotation of 60 mm/s can be obtained.

Rotate the head and device so that it is over the burner.

Adjust the position of the burner such that the distance between the top of the burner and the lowest part of the device which is to pass through the flame is 20 mm. Rotate the head away from the burner.

Ignite the gas at the burner and adjust the pressure to be 0,5 bar. Ensure that the burner air vent is fully closed and adjust the flow control valve to give a flame height of 40 mm above the burner top.

NOTE. These settings should give a flame temperature of (800 ± 50) °C at a point 20 mm above the burner top.

Pass the device mounted on the dummy head once through the flame at the set speed of 60 mm/s.

Using two further samples, repeat the test to enable an assessment to be made of all materials on the exterior of the device. Any one sample shall be passed through the flame once only.

6.8.4 *Assessment and test report*

Examine the device after it has passed through the flame and report whether it has grossly deformed or decomposed or whether it continues to burn.

6.9 Noise level

6.9.1 *Principle*

The device is worn by a test subject and the noise level in dB(A) measured at the test subject's ears.Z

6.9.2 *Apparatus*

6.9.2.1 *Microphones*, capable of being fitted at the test subject's ears.

6.9.2.2 *Sound level meter of type 1 or 2*, as specified in IEC 651.

6.9.3 *Procedure*

6.9.3.1 Calibrate the sound level meter in accordance with the manufacturer's instructions.

6.9.3.2 Ensure that the device to be tested is equipped with a fully charged battery and one of the filter types designed to be used with the device.

6.9.3.3 Fix the microphones to the test subject at the centres of each of the external ears and level with the tragions.

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[2] Information on a source of supply of a suitable burner may be obtained from the Secretariat of CEN/TC 79.

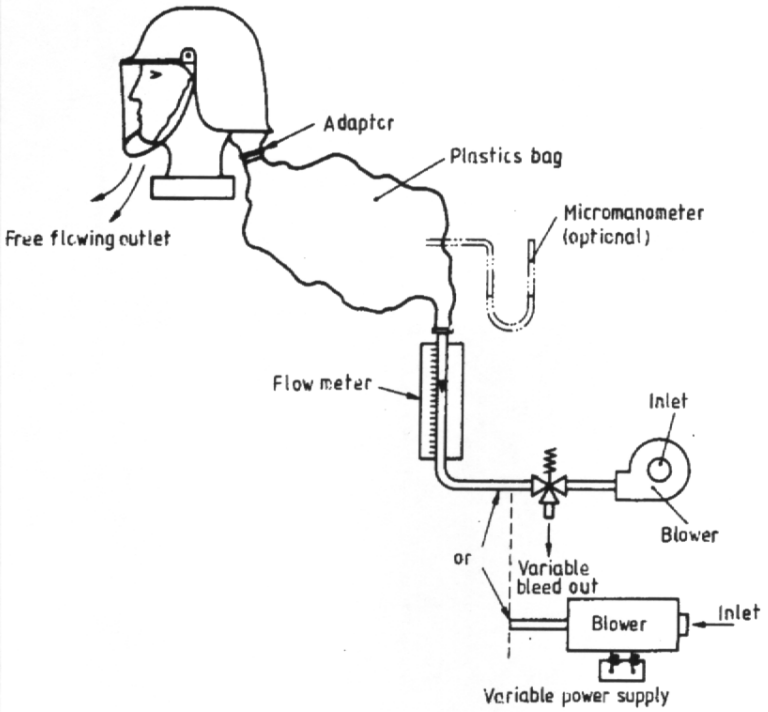


Figure 3. Measurement of air supply flow rate (example 1)

6.9.3.4 Have the test subject don the device.

6.9.3.5 Switch on the power supply on the device and measure, in succession, the sound pressure level at each of the two ears with the sound level meter set to indicate frequency weighting characteristics A.

6.9.3.6 Average the readings from the two ears on an energy equivalent basis.

6.9.3.7 Check that the background noise level in the test room is not less than 10 dB(A) lower than that measured for the device and adjust the background level as necessary to meet this condition.

6.9.3.8 Report the average of the results from the two ears (**6.9.3.6**) as the noise generated by the device as experienced by the wearer.

6.9.3.9 Repeat the procedure for the complete set of filter types designed to be used with the device.

7 Instructions for use

7.1 Instructions for use shall accompany every device.

7.2 Instructions for use shall be in a language acceptable to the country of application.

7.3 The instructions for use shall contain all information necessary for trained and qualified persons on:

- applications/limitations;
- controls prior to use;
- donning, fitting;
- use;
- maintenance (preferably separately printed instructions);
- storage of the equipment.

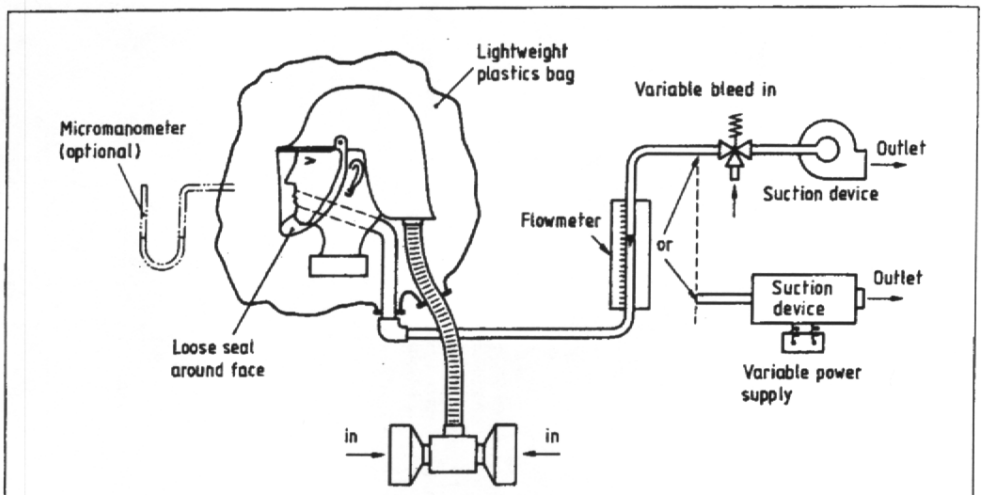


Figure 4. Measurement of air supply flow rate (example 2)

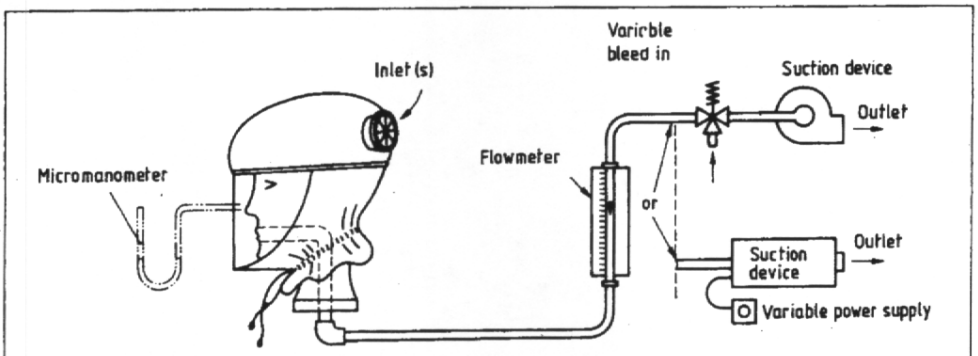


Figure 5. Measurement of air supply flow rate (example 3)

7.4 The instructions for use shall be unambiguous. If helpful, illustrations, part numbers, marking, etc. shall be added.

7.5 The instructions for use shall clearly describe which filter shall be used for a specific type and class of device.

7.6 The instructions for use shall explain the use of filters marked 'For use against solid aerosols only' against water based aerosols, defined as aerosols produced from solutions and/or suspensions of particulate materials in water such that the only workplace contaminant is attributed to this solid material.

7.7 The instructions for use shall state the minimum design flow rate, and include details of how the flow rate should be checked prior to each use.

7.8 Where a warning device in accordance with **5.11.2** is provided the instructions for use shall describe a method for checking the correct functioning of the warning device.

7.9 Warning shall be given against problems likely to be encountered for example:

- incorrect use;
- in the power-off state little or no respiratory protection is to be expected and there may be an immediate build up of carbon dioxide; this is to be considered an abnormal situation;
- with the fit of facepiece (check prior to use);
- where there is a face seal it is unlikely that the requirements for leakage will be achieved if facial hair or spectacle side arms pass under the face seal;
- at very high work rates the pressure in the device may become negative at peak inhalation flow;
- problems where high wind velocities exist;
- hazards of oxygen deficient or oxygen enriched air;
- nature of the hazard;
- use of equipment in explosive atmospheres.

7.10 Any other information that the manufacturer may consider relevant.

8 Marking

8.1 The helmet or hood shall be durably and legibly marked with at least the following information:

- the name, trademark or other means of identification of the manufacturer;
- the size if more than one is available;
- type identifying mark;
- year of manufacture.

8.2 The blower and battery casing (if separate from the blower) shall each be durably and legibly marked with at least the following information:

- the name, trademark or other means of identification of the manufacturer;
- type identifying mark;
- if appropriate, a statement that the device is intrinsically safe for use in explosive atmospheres and reference to EN 50020;
- month and year of manufacture.

8.3 Filter(s) or filter package(s)

All encapsulations of encapsulated filters and all packages containing unencapsulated filters shall be durably and legibly marked at least with:

- Type and class: THP1, THP2 or THP3.
- Colour code: white
  Silver and light metal is regarded as a neutral colour.
- Subassemblies and piece parts with considerable bearing on safety shall be marked so that they can be identified.
- The name, trademark or other means of identification of the manufacturer.
- The number of this European Standard.
- All filters, including unencapsulated, which do not pass the paraffin oil test shall be clearly marked 'For use against solid aerosols only'.*)
- The year of manufacture or the expiry of shelf life, where reliable performance may be affected by ageing.
- The sentence 'See instructions for use' in languages acceptable to the country of application.

*) This may include water based aerosols (see **7.6**).

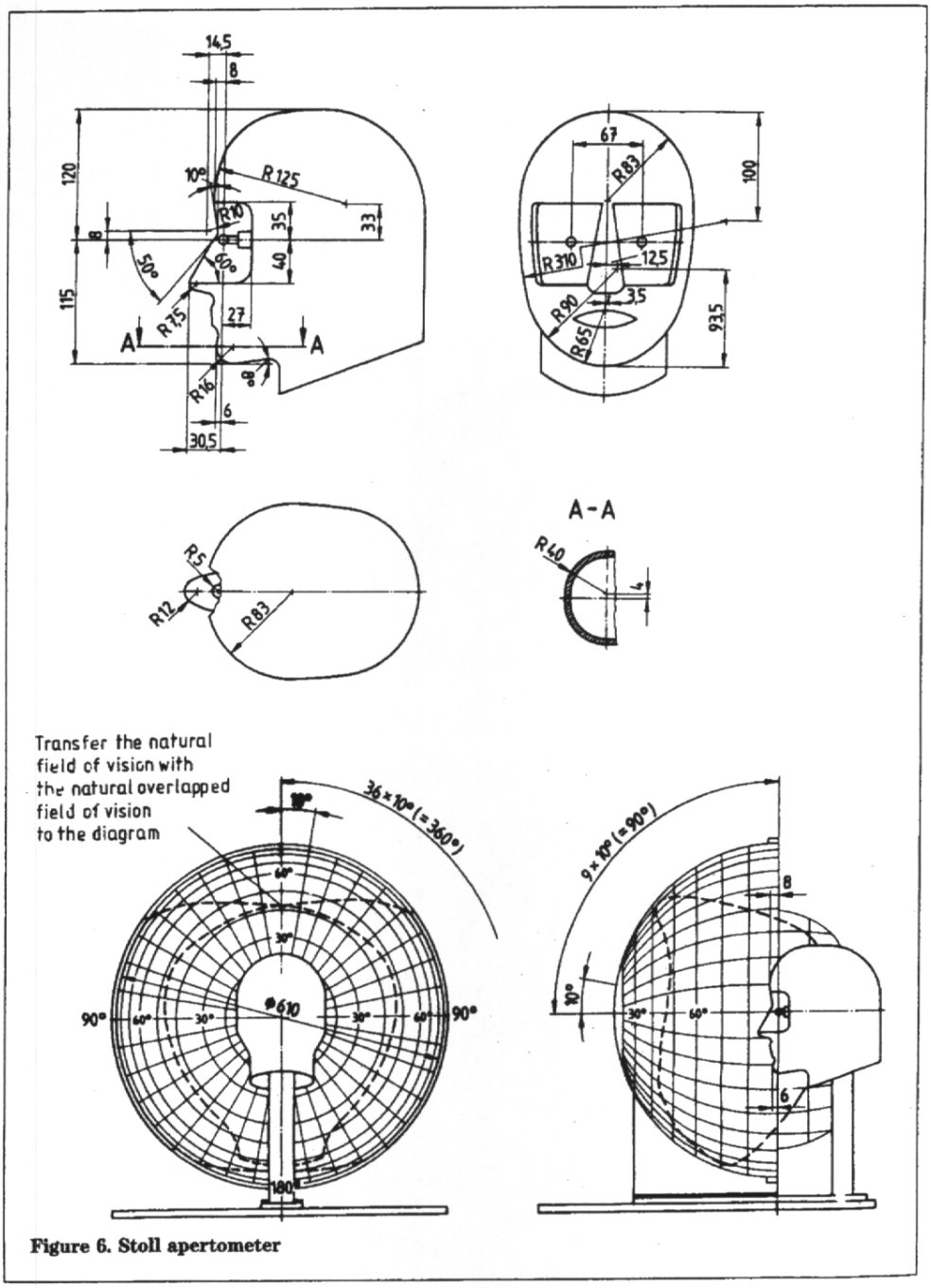
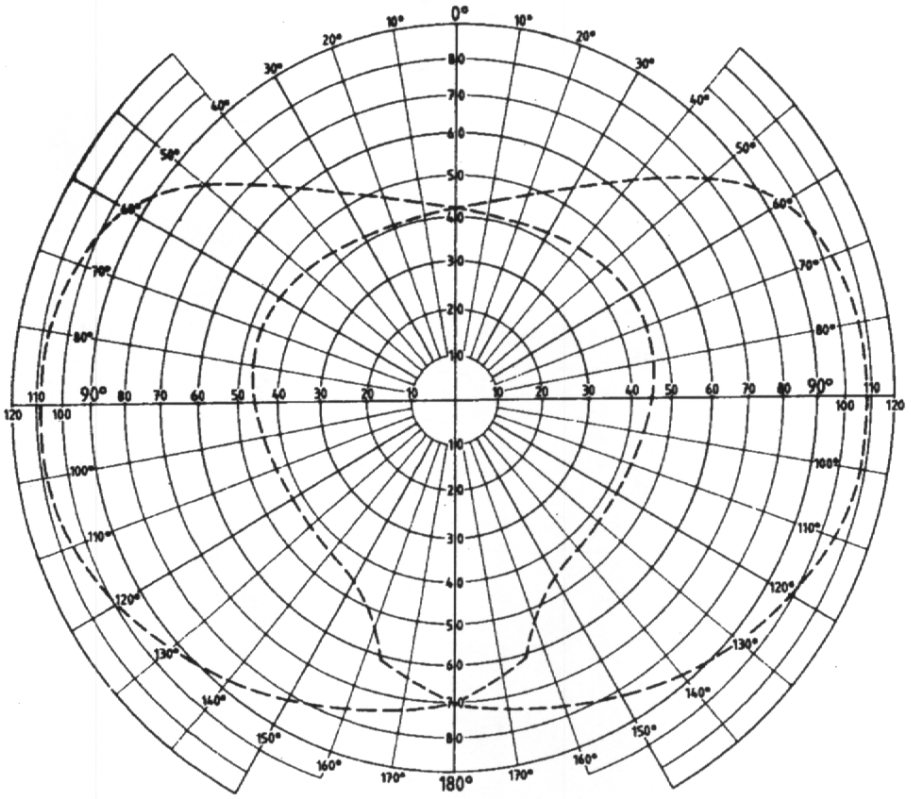


Figure 6. Stoll apertometer



- - - natural field of vision with natural overlapped field of vision

The areas enclosed by circular lines of the diagram are proportional to the corresponding areas marked on the spherical shell of the apertometer

Semi-circular surface represented inside of the 90° circle ..... = 126,9 cm^2

Natural field of vision inside of the 90° circle (78,8 %) ..... = 100,0 cm^2

Natural field of vision outside of the 90° circle ..... = 12,0 cm^2

Natural field of vision totally ..... = 112,0 $cm^2 \cong$ 100 %

Natural overlapped field of vision ..... = 38,0 $cm^2 \cong$ 100 %

Shape of lenses: _____ facepiece model: _____
(dimensions) _____ _____

Where measurements of the field of vision are taken, the effective field of vision as observed by the apertometer shall be transferred to the diagram. Only the effective field of vision within the natural field of vision respectively the effective overlapped field of vision shall be planimetered and noted in cm^2.

Planimetered area of effective field of vision (totally) ..... cm^2

Planimetered area of effective overlapped field of vision ..... cm^2

Effective field of vision (totally) ..... %

Effective overlapped field of vision ..... %

NOTE. Further details are given in EN 136.

Figure 7. Diagram of apertometer chart (not to scale)

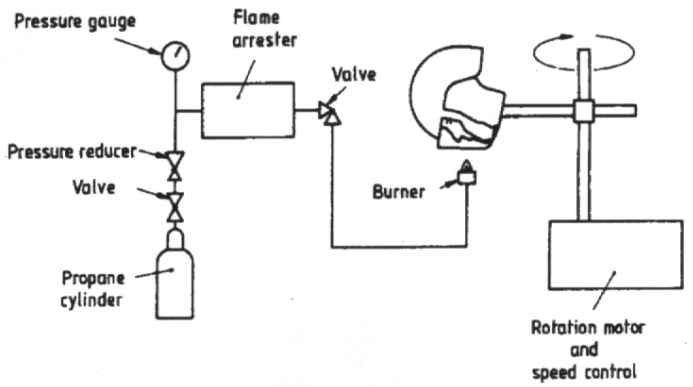
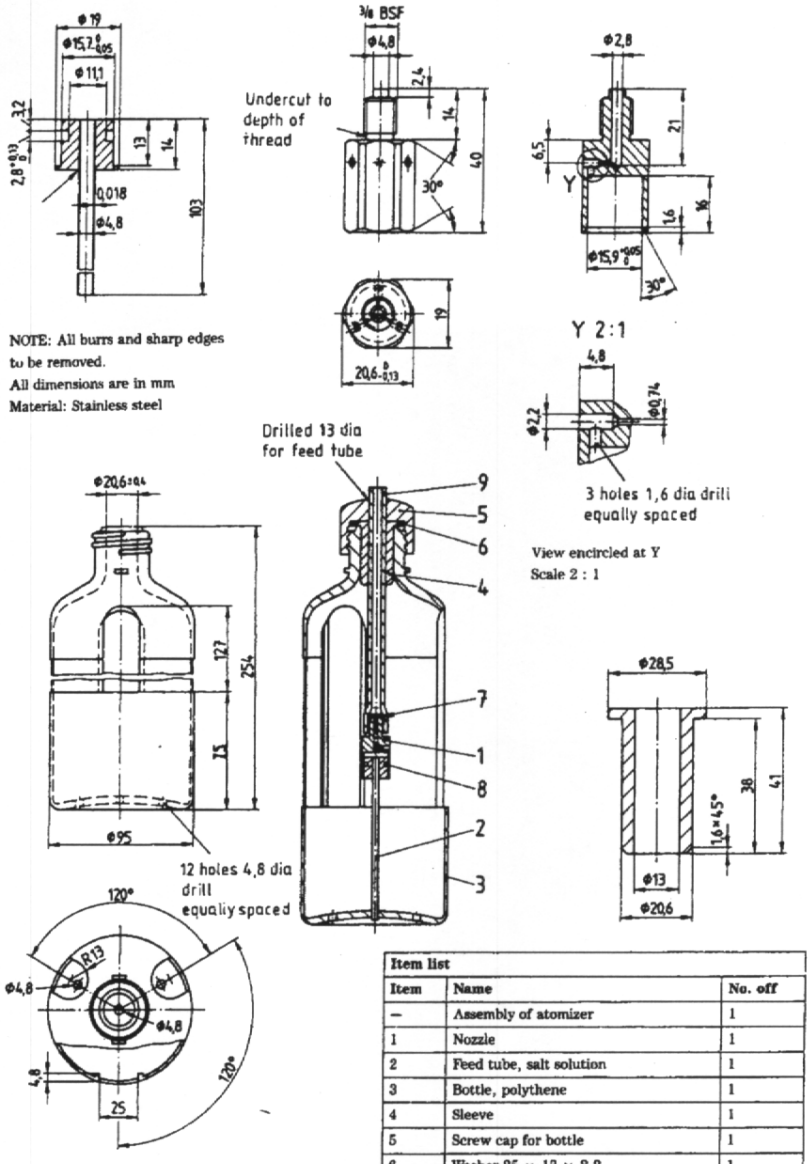


Figure 8. Schematic diagram of apparatus for assessment of flammability



Item list		
Item	**Name**	**No. off**
–	Assembly of atomizer	1
1	Nozzle	1
2	Feed tube, salt solution	1
3	Bottle, polythene	1
4	Sleeve	1
5	Screw cap for bottle	1
6	Washer 25 × 13 × 3,2	1
7	Washer 9,5 × 4,8 × 2,4	1
8	O-seal	1
9	Air tube outside 13 dia inside 6,5 dia	as reqd

Figure 9. Assembly of atomizer

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National annex NA (informative)

Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Personal Safety Equipment Standards Policy Committee (PSM/-) to Technical Committee PSM/14 upon which the following bodies were represented:

Asbestos Removal Contractors' Association
British Agrochemicals Association Ltd.
British Coal Corporation
British Compressed Air Society
British Nuclear Fuels Limited
British Occupational Hygiene Society
British Pest Control Association
British Telecommunications plc
Chemical Industries Association
Chief and Assistant Chief Fire Officers' Association
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Health and Safety Executive
Home Office
ICE (Ergonomics) Ltd.
Industrial Safety (Protective Equipment) Manufacturers' Association
Institute of Occupational Hygienists
Institute of Occupational Medicine
Institution of Fire Engineers
Institute of Mechanical Engineers
Ministry of Defence
National Association of Fire Officers
Safety Equipment Distributors Association
Trades Union Congress
University of Aberdeen

National annex NB (informative)

The British Standards corresponding to the European Standards referred to in EN 146 are as follows:

European Standard	British Standard (content identical)
EN 143 : 1989	BS EN 143 : 1991 Specification for particle filters used in respiratory protective equipment
EN 50020 Part 7 : 1977	BS 5501 Electrical apparatus for potentially explosive atmospheres Part 7 : 1977 Intrinisic safety 'i'

The British Standard corresponding to the International Standard referred to in EN 146 is as follows:

International Standard	British Standard (content identical)
IEC 651 : 1979	BS 5969 : 1981 Specification for sound level meters

BS EN
146 : 1992

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