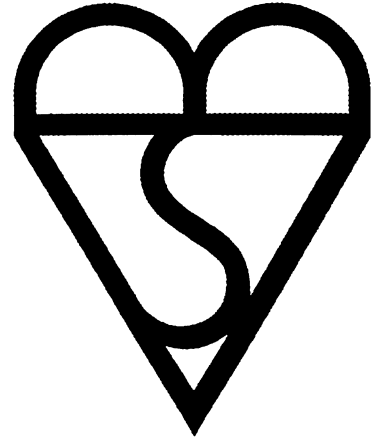


Integrated Protection Helmets



PAS 016 : 1995 ISSUE 1

**P**RODUCT  
**A**PPROVAL  
**S**PECIFICATION

(c) BSI Product Certification





Users of this document are reminded that copyright subsists. No part of this publication may be reproduced in any form without prior permission in writing of BSI PC

© BSI PC October 1995. All rights reserved



---

## Contents

|     |                                                                                 |
|-----|---------------------------------------------------------------------------------|
|     | Foreword                                                                        |
|     | Specification                                                                   |
| 1   | SCOPE                                                                           |
| 2   | GENERAL REQUIREMENTS                                                            |
| 3   | HEAD PROTECTION                                                                 |
| 3.1 | Definitions                                                                     |
| 3.2 | Construction                                                                    |
| 3.3 | Performance                                                                     |
| 4   | EYE PROTECTION                                                                  |
| 4.1 | Definitions                                                                     |
| 4.2 | Materials                                                                       |
| 4.3 | Construction                                                                    |
| 4.4 | Optical properties                                                              |
| 4.5 | Performance                                                                     |
| 5   | HEARING PROTECTION                                                              |
| 5.1 | Definitions                                                                     |
| 5.2 | Materials                                                                       |
| 5.3 | Construction                                                                    |
| 5.4 | Fit and size                                                                    |
| 5.5 | Comfort                                                                         |
| 5.6 | Performance                                                                     |
| 6   | RESPIRATORY PROTECTION                                                          |
| 6.1 | Definition and description                                                      |
| 6.2 | Classification and designation                                                  |
| 6.3 | Performance                                                                     |
| 7   | MARKING                                                                         |
| 8   | INFORMATION TO USERS AND LABELLING                                              |
|     | Appendices                                                                      |
| A   | HEAD PROTECTION                                                                 |
| A1  | Method for measuring wearing height, vertical distance and horizontal clearance |
| A2  | Method of test for shock absorption                                             |
| A3  | Conditioning procedures                                                         |
| A4  | Method of test for resistance to penetration                                    |
| A5  | Method of test for electrical insulation                                        |
| A6  | Method of test for lateral rigidity                                             |
| A7  | Method of test for chin strap anchorage                                         |



|    |                                                                                                         |
|----|---------------------------------------------------------------------------------------------------------|
| B  | EYE PROTECTION                                                                                          |
| B1 | Description of faults sometimes found in plastics used for visors                                       |
| B2 | Method of test for optical properties                                                                   |
| B3 | Conditioning procedures                                                                                 |
| B4 | Method of test for robustness and for impact strength of visors                                         |
| B5 | Method of test for non-adherence of molten metals                                                       |
| B6 | Method of test for assessment of protection against splashes                                            |
| B7 | Method of test for resistance to penetration by hot solids                                              |
| B8 | Method of test for proof against liquid droplets                                                        |
| B9 | Method of measuring field of vision                                                                     |
| C  | HEARING PROTECTION                                                                                      |
| C1 | Samples and conditioning                                                                                |
| C2 | Method for measuring rotation of cups                                                                   |
| C3 | Method of test for cushion force                                                                        |
| C4 | Method of test for cushion pressure                                                                     |
| C5 | Method of test for durability                                                                           |
| C6 | Method of measuring insertion loss                                                                      |
| C7 | Method of test for cushion leakage                                                                      |
| C8 | Method of test for adjustability                                                                        |
| D  | RESPIRATORY PROTECTION                                                                                  |
| D1 | Method for measuring total inward leakage                                                               |
| D2 | Method for measuring carbon dioxide content of inhalation air                                           |
| D3 | Method for measuring breathing resistance                                                               |
| D4 | Method for measuring air supply flow rate                                                               |
| D5 | Method for test for clogging                                                                            |
| D6 | Method of test for flammability                                                                         |
| D7 | Method of measuring noise level                                                                         |
| E  | GENERAL REQUIREMENTS                                                                                    |
| E1 | Method of test for resistance to corrosion of metal parts where not made from corrosion resistant alloy |
| F  | RECOMMENDED ORDER OF TESTING                                                                            |

#### Tables

|   |                                                                                          |
|---|------------------------------------------------------------------------------------------|
| 1 | Tolerances for eye protectors (refractive, astigmatic and prismatic powers)              |
| 2 | Head dimensions                                                                          |
| 3 | Attenuation requirements for ear-muffs                                                   |
| 4 | Ear-muff setting for the measurement of cup rotation, cushion force and cushion pressure |
| 5 | Classification of devices (respiratory protection)                                       |
| 6 | Maximum initial penetration                                                              |
| 7 | Sensitivity index and allowable field variations (hearing protection)                    |
| 8 | Experimental plan for total inward leakage exercises                                     |



---

## Figures

- 1 Test block for testing penetration resistance
- 2 Target for use when testing refractive properties
- 3 Ocular area to be protected against splashes
- 4 Example of apparatus for testing for non-adherence of molten metals (section view)
- 5 Example of apparatus for assessment of protection against splashes
- 6 Apparatus for testing resistance to penetration by hot solids
- 7 Head dimensions
- 8 Apparatus for measurement of rotation of cups and for tests of cushion force and cushion pressure and for adjustability.
- 9 Flexing machine for assessment of durability
- 10 Example of an acoustic test fixture
- 11 Outline of test enclosure, acoustic tunnel
- 12 Schematic diagram of apparatus used in the determination of total inward leakage
- 13 Schematic diagram of test rig for carbon dioxide content of the inhalation air
- 14 Measurement of air supply flow rate (example 1)
- 15 Measurement of air supply flow rate (example 2)
- 16 Measurement of air supply flow rate (example 3)
- 17 Stoll apertometer
- 18 Diagram of apertometer chart
- 19 Schematic diagram of apparatus for assessment of flammability
- 20 Assembly of atomiser



---

## **FOREWORD**

This Product Approval Specification, PAS, has been published to provide the Specification reference for BSI certification using the well known BSI Certification Trade Mark, the Kitemark, which is registered under the Trade Marks Act : 1938 and can only be used under licence from BSI.

This Product Approval Specification is not a British Standard and will be withdrawn on publication of its content in or as a British Standard.

This PAS has been developed by BSI Product Certification in the absence of a single British Standard covering all component elements of an Integrated Protection Helmet, using relevant technical requirements and criteria derived from related British and European Standards and from other technical data and criteria validated by BSI Testing.

The PAS has been prepared and published by BSI Product Certification who retain its ownership and copyright.

Acknowledgement is given to the following organisations who were consulted in the preparation of this specification:

British Coal  
Union of Democratic Miners  
Centurion Safety Products  
BSI Testing

The Director of BSI Product Certification reserves the right to withdraw or amend this PAS on advice from the BSI Product Certification Advisory Council. It will be reviewed at intervals not exceeding two years, and any amendments arising from that review shall be published in an amended PAS and notified to Kitemark licensees.



---

## Section 1: SCOPE

This Product Approval Specification (PAS) specifies the requirements for all-in-one integrated safety helmets with eye protection, hearing protection and build-in powered air filtering for respiratory protection.

In preparing this specification it was recognised that products coming within the scope are at the forefront of design development and therefore in performing particular evaluations in respect of eye and ear protection the exercise of some expert technical judgement is necessary until methods of test can be developed.

With regard to flammability, consideration was given to options for flammability and ignitability tasks, but for the typical applications and uses of the helmet that were foreseen, flammability was considered more appropriate.

It should be noted that helmets conforming with this specification are designed and manufactured to provide adequate protection under the environmental conditions specified, subject to adherence to the instructions and care stated by the manufacturer. Where the conditions are exceeded and/or the instructions for use and care are not followed, the efficiency of the helmet may be impaired.

**NOTE:** The titles of the publications referred to in this Specification are listed at the back of this document.



---

## Section 2: GENERAL

### 2.1 Materials

2.1.1 The materials used in the manufacture of Integrated Protection Helmets should be of durable quality, i.e. their characteristics should not undergo significant alteration under the influence of ageing or of the circumstances of normal use, e.g. exposure to sun, rain, cold, dust, vibration, contact with the skin, effects of sweat or of products applied to the skin or hair. For materials not in general use, advice as to suitability should be sought before use.

2.1.2 For those parts of the Integrated Protection Helmet coming into contact with the wearer's skin, materials which are known to be likely to cause irritation or any other adverse effect to health should not be used.

2.1.3 Materials shall not be cleaned with substances that are known to be harmful to health shall not be used.

2.1.4 All materials shall be visibly unimpaired after cleaning or disinfecting by the methods specified by the manufacturer.

2.1.5 Samples of all exposed metal parts on the internal and external surfaces of the Integrated Protection Helmet, unless manufactured from corrosive resistant materials shall show no sign of corrosion when viewed by the unaided eye of a trained observer and shall be in a serviceable condition when tested as described in appendix E.1. 'Method of Test for Resistance to Corrosion of Metal Parts where not made from Corrosion Resistant Alloy'.

### 2.2 Construction

2.2.1 The Integrated Protection Helmet shall have no sharp edges and shall be free of projections or other features likely to cause discomfort during wear.

2.2.2 Parts which are not intended to last the lifetime of the helmet or which become damaged during use and are intended by the manufacturer to be replaceable, shall be replaceable without the use of special tools.

2.2.3 Helmets shall be of a sufficiently robust construction to facilitate their being picked up, by hand, by any part without that part, or any other part becoming detached, no matter how temporarily or easy to reattach. An element of technical judgement may be applied to confirm the helmet and any detachable parts are of robust construction.

### 2.3 Testing

2.3.1 The Integrated Protection Helmets shall be submitted for testing in the condition in which they are offered for sale.

2.3.2 No Integrated Protection Helmet that has been subjected to testing shall be offered for sale.



---

## Section 3: HEAD PROTECTION

### 3.1 Definitions

For the purposes of this PAS the following definitions relating to head protection apply:

#### 3.1.1 Safety helmet

Headgear intended to protect primarily the upper part of a wearer's head against the blow from above.

#### 3.1.2 Shell

The hard, smooth material that provides the general outer form of the helmet.

#### 3.1.3 Peak

An extension of the shell above the eyes.

#### 3.1.4 Brim

A rim surrounding the shell, which may form a gutter.

#### 3.1.5 Harness

The complete assembly that provides a means (a) of maintaining the helmet in position on the head and (b) of absorbing kinetic energy during an impact.

**NOTE:** It may consist, for example, of the items defined in 3.1.5.1 to 3.1.5.5.

##### 3.1.5.1 Headband

A part of the harness surrounding the head in the region of the base of the skull.

##### 3.1.5.2 Cradle

The fixed or adjustable assembly of the parts of the harness in contact with the head, excluding the headband and nape strap.

##### 3.1.5.3 Anti-concussion tapes

Supporting straps that absorb kinetic energy.

##### 3.1.5.4 Comfort band or sweat band

An accessory to cover the inner front surface of the headband to improve wearer comfort.

##### 3.1.5.5 Nape strap

An adjustable strap that fits behind the head below the plane of the headband and that may be an integral part of the headband.

#### 3.1.6 Chin strap

An adjustable strap that fits under the chin to secure the helmet on the head.



---

#### 3.1.7 Headform

A headform in accordance with BS 6489 above the reference plane.

#### 3.1.8 Wearing height

The vertical measurement from the lower edge of the headband to the highest point of the headform on which the helmet is mounted measured either at the front (midway between the sides of the headform) or at the side (midway between the front and back of the headform), whichever gives the greater distance.

#### 3.1.9 Vertical distance

The vertical measurement between the top of the headform on which the helmet is mounted and the highest point on the outside surface of the shell.

#### 3.1.10 Horizontal clearance

The horizontal distance between the headform on which the helmet is mounted and the inside of the shell measured at the level of the headband.

### 3.2 Construction

The construction of the helmet shall be in the form of a hard shell having a smooth outer surface and fitted with a harness.

The outer surface shall be smoothly finished. The shell may be shaped to form a brim and/or peak.

If the shell is pierced with holes for any purpose other than for the attachment of the means of energy absorption, no internal chord of any such hole shall exceed 4mm, and the total area of such holes on either side of the helmet shall not exceed 160 mm<sup>2</sup>, making a total on both sides not exceeding 320 mm<sup>2</sup>.

Any devices fitted to the helmet shall be so designed that they are unlikely to cause any injury to the wearer in the event of an accident. In particular there should not be metallic or other rigid projections on the inside of the helmet.

Where stitching is used to secure the harness to the shell, it should be protected if it may be subject to abrasion or may cause discomfort to the user during use.

#### 3.2.1 Vertical Distance

When measured under the conditions described in Appendix A.1., the vertical distance shall be not greater than 80mm.

#### 3.2.2 Horizontal clearance

When measured under the conditions described in Appendix A.1., the horizontal clearance at the front and sides of the helmet shall be not less than 5mm.



### 3.2.3 Wearing height

When measured under the conditions described in Appendix A.1. and all the settings of the height and angle adjustments of the headband, the wearing height shall be not less than the following dimensions for the appropriate sizes of headform in accordance with BS 6489:

77mm for headform B,  
80mm for headform D,  
83mm for headform F,  
88mm for headform J,  
91mm for headform L,  
95mm for headform N.

### 3.2.4 Retention system

Either the helmet shell or the harness shall be fitted with a chin strap or with means of attaching one. A nape strap shall be provided and it shall be adjustable both in length and in the angle which it makes with the edge of the shell.

### 3.2.5 Chin strap

Any chin strap supplied with the helmet shall be not less than 10mm wide when untensioned and shall be attached either to the shell or to the harness.

### 3.2.6 Chin strap anchorage

Any chin strap supplied with the helmet, when tested in accordance with Appendix A.7., the artificial jaw shall be released at a force of not less than 150 N and not more than 250 N.

### 3.2.7 Headband

The length of the headband shall be adjustable in increments of not more than 5mm.

### 3.2.8 Comfort band or sweatband

Where fitted, a sweatband shall be not less than 25mm wide. The sweatband shall cover the inner front surface of the headband for a length of not less than 100mm each side of the centre of the forehead. The length shall be measured with a flexible measure along a line  $10 \pm 1$ mm above the lower edge of the headband. If the sweatband is not detachable, it shall be of such materials and design that it may be cleaned in situ.

### 3.2.9 Cradle

The cradle of a helmet shall incorporate textile tapes not less than 15mm wide, and the total of the widths of the tapes radiating from the crown shall be not less than 72mm.

## 3.3 Performance

### 3.3.1 Shock absorption

3.3.1.1 General. When the helmet is tested by the method given in Appendix A.2., using the appropriate conditioning procedure described in appendix A.3., the deceleration of the striker shall not exceed 100g\*.



3.3.1.2 At extra-low temperature (optional). Where the helmet is required to have shock absorption properties at extra low temperature (-20°C), when tested by the method given in appendix A.2. after conditioning at the appropriate temperature as described in A.3., the deceleration of the striker shall not exceed 100g\*.

**\* The symbol g signifies a unit of deceleration equal to 9.81m.s<sup>-2</sup>**

### 3.3.2 Resistance to penetration

3.3.2.1 In a wet condition. When the helmet is tested by the method given in Appendix A.4. after conditioning with water as described in A.3.3, the striker shall not make electrical contact with the test block.

3.3.2.2 At low or high temperature (optional). Where the helmet is required to resist penetration at extra low temperature (-20°C) or at high temperature, then when tested by the method given in Appendix A.4. after conditioning at the appropriate temperature as described in appendix A.3.2, the striker shall not make electrical contact with the test block.

### 3.3.3 Electrical insulation (optional)

Where the helmet is required to comply with the optional requirement for electrical insulation, the leakage current shall not exceed 1.2 mA when the helmet is tested by the method described in Appendix A.5.

**NOTE: This requirement is intended to provide protection against voltages up to 440V.**

### 3.3.4 Lateral rigidity (optional)

Where it is required that the helmet meets requirements for lateral rigidity, then the maximum lateral deformation of the shell shall not exceed 40mm, and the residual deformation shall not exceed 15mm when tested by the method given in Appendix A.6.



---

## Section 4: EYE PROTECTION

### 4.1 Definitions

For the purposes of this PAS the following definitions relating to eye protection apply:

#### 4.1.1 Eye protector

Any form of eye-protective equipment covering at least the region of the eyes.

#### 4.1.2 Ocular

The transparent part of the eye-protector that permits vision.

#### 4.1.3 Orbital cavities

The apertures in the skull in which the eyes and their appendages sit.

#### 4.1.4 Visor/face screen

An eye-protector covering all or a substantial part of the face.

#### 4.1.5 Housing

The part of the integrated protection helmet that retains the visor.

### 4.2 Materials

#### 4.2.1 Visors shall be made of plastics materials

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

### 4.3 Construction

4.3.1 Eye-protectors shall be free from the obvious defects and in particular the ocular area shall be free of defects likely to be detrimental to the overall performance of the visor.

4.3.2 Adjustable parts or components incorporated in eye-protectors shall be easily adjustable.

4.3.3 Ventilation features shall be designed to prevent the direct access of any particle to the eye from any angle forward from the frontal plane of the eye-protector.

4.3.4 When moved to the raised position the visor shall remain in place, requiring deliberate action by the wearer to return to the lowered position

#### 4.3.5 Dimensions

The visible aperture of the visor shall be such that a rectangle with minimum dimensions of 32mm (horizontal length) and 25mm (vertical depth) can be described in full for each eye (pupilar distance = 64mm).



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 Appendix B9.

#### 4.4 Optical properties

4.4.1 The visors shall be conditioned in accordance with appendix B.3.

4.4.2 Visors curved along one axis shall conform with the requirements of 4.4.2, 4.4.3 and 4.4.4.

Visors curved along two axis at 90° shall substantially conform with 4.4.2, 3 and 4. However, it is recognised that products coming within the scope of this specification are at the forefront of design development and in performing the evaluation of visor characteristics, an element of technical judgement may be applied by the laboratory to establish the visor meets the principles for providing protection. Visors shall transmit not less than 80% of the light energy within the spectrum unless they are in the impact resisting group and are double layered, in which case the transmission shall not be less than 70%. These limits shall not apply to visors claimed to be tinted.

**NOTE: Tinted visors include those with metal coatings applied.**

4.4.3 Visors shall be free to within 3mm of their edges from inherent faults such as those listed in Appendix B.1, that can be observed by the wearer when the visor is worn. The inspection for faults shall be made by the wearer with his eyes focused at a variety of focal distances likely to be encountered at work, i.e., the wearer shall not attempt to focus on the visor itself.

Where mould or crease lines are a design feature of the visor they shall not occur within the minimum dimensions given in 4.3.5.

**TABLE 1**

**TOLERANCES FOR EYE-PROTECTORS**

| Type of eye-protector    | Spherical effect | Astigmatism | Prismatic effect |
|--------------------------|------------------|-------------|------------------|
|                          | D                | D           | $\Delta$         |
| Impact                   | $\pm 0.12$       | $\pm 0.12$  | 0.25             |
| All other eye-protectors | $\pm 0.06$       | $\pm 0.06$  | 0.15             |

**NOTE: The unit of power is the dioptre (symbol D). The unit of prism power is the prism dioptre (symbol  $\Delta$ ). (See BS 3521 : Parts 1 and 2).**

4.4.4 When measured as described in Appendix B.2, refractive, astigmatic and prismatic powers for afocal visors shall comply with the tolerances given in Table 1.

The spherical and astigmatic powers shall be within the specified limits at all points on the ocular lying within 25 mm of the test point.

For impact resistant visors, the combined prismatic imbalance in the vertical direction shall not exceed  $0.30\Delta$ .



---

#### 4.5 Performance

##### 4.5.1 Visor

Visors shall not distort vision, nor shall misting occur as subjectively determined in the course of testing as in appendix D.1.

##### 4.5.2 Conditioning

Prior to testing visors shall be conditioned as described in Appendix B.3.

##### 4.5.3 Robustness of construction

When tested as described in Appendix B.4.3.1 visors shall not show any of the following defects:

###### a) FRACTURE

A visor shall be considered to have fractured when it cracks through its entire thickness into two or more separate pieces or when more than 30 mg of the visor material becomes detached from the surface remote from that receiving the test impact.

###### b) DEFORMATION

A visor shall be considered to have deformed when a mark appears on the white paper or an indentation appears in the plasticine appropriate to the striking face of the ball.

###### c) HOUSING FAILURE

A visor housing shall be considered to have failed if it is fractured, if its parts separate or if it allows a visor to be knocked from its housing.

###### d) LATERAL PROTECTION FAILURE

Lateral protection, where provided, shall be considered to have failed if it:

- 1) fracture through its entire thickness into two or more separate pieces or if one or more particles becomes detached from the surface remote from that receiving the test blow;
- 2) allows the ball to penetrate completely;
- 3) partially or totally detaches from the visor, or if separation of the component parts of the lateral protection occurs.



---

#### 4.5.4 Protection against impact (optional)

4.5.4.1 Impact eye-protectors. When tested as described in Appendix B.4.3.2 using a velocity of impact of 45m/s for grade 2 and a velocity of impact of 120 m/s for grade 1, impact visors shall not show any of the following:

- a) fracture. A visor shall be considered to have fractured when it cracks through its thickness or when one or more particles become detached from the surface remote from that receiving the test impact.
- b) deformation. As described in 4.5.3 (b).
- c) housing failure. As described in 4.5.3 (c).

4.5.4.2 Lateral protection of impact visors. The lateral protection of impact visors shall comply with the requirements of either grade 1 or grade 2 as in 4.5.4, or for robustness of construction as in 4.5.3.

When the lateral protection is tested in accordance with Appendix B.4, it shall be considered to have failed to meet the particular impact grade or general robustness claimed in respect of the associated lens if it shows any of the defects listed in 4.5.3 (d).

#### 4.5.5 Protection against liquids (optional)

4.5.5.1 Liquid droplets. When tested as described in Appendix B.8, visors for protection against liquid droplets shall be deemed to comply with this Specification if there is not coloration of the paper representing the ocular areas.

4.5.5.2 Liquid splashes. When tested as described in appendix B.6, visors for protection against liquid splashes shall be deemed to comply with this Specification if they cover the ocular area as described in Appendix B.6.2.

**NOTE: Visors for protection against liquid droplets are tested for resistance to ingress. Visors for liquid splashes are assessed for coverage on a headform that does not attempt to cover all head sizes. The greatest care should be taken to ensure a proper fit or adequate coverage on the individual user.**

#### 4.5.6 Protection against molten metals and hot solids (optional)

4.5.6.1 Molten metals eye-protectors shall be non-metallic or shall be treated to prevent molten metals adhering to the visor or other parts of the eye-protector when tested as described in Appendix B.5.

4.5.6.2 The visor shall cover the ocular area defined in Appendix B.6.2. and shown in figure 3.

4.5.6.3 Hot solids penetration. Complete penetration of the visor and housing shall not occur within 5 s when tested as described in Appendix B.7.



---

## SECTION 5: HEARING PROTECTION

### 5.1 Definitions

For the purposes of this PAS the following definitions relating to hearing protection apply:

#### 5.1.1 Acoustic test fixture (ATF)

A device that approximates certain dimensions of an average adult human head and is used for measuring the insertion loss of ear-muffs. For this purpose it includes a microphone arrangement for measuring sound pressure levels.

#### 5.1.2 Attenuation

The algebraic difference in dB between the 1/3 octave band pressure level, as perceived by a real ear at threshold in a specified sound field under specified conditions, with the hearing protector absent and the sound pressure level with the hearing protector being worn, the other conditions identical.

#### 5.1.3 Attenuation enhancer

Material contained within the cup which can increase the attenuation of the ear-muffs at certain frequencies.

#### 5.1.4 Cup

A hollow, approximately hemispherically shaped component which is mounted on the helmet and to which a cushion and an attenuation enhancer are usually fitted.

#### 5.1.5 Cushion

A deformable cover, usually foam plastics or liquid filled, fitted to the rim of the cup to improve the comfort and fit of the ear-muffs on the head.

#### 5.1.6 Decibel (dB)

One-tenth of a bel, a scale unit used in comparison of the magnitude of powers. The number of bels, expressing the relative magnitudes of two powers, is the logarithm to the base of 10 of the ratio of the powers.

#### 5.1.7 Ear-muffs

A hearing protector, either fitting over and enclosing the pinna and sealing against the side of the head (circumaural) or sealing against the pinna (supra-aural).

#### 5.1.8 Insertion loss

The algebraic difference in dB between the 1/3 octave band pressure level, measured by the microphone of the acoustic test fixture in a specified sound field under specified conditions, with the hearing protector absent and the sound pressure level with the hearing protector on, with other conditions identical.



#### 5.1.9 Pink noise

Noise whose sound pressure spectral density is inversely proportional to frequency, i.e. equal energy in each 1/3 octave band.

#### 5.1.10 Head width

Maximum width of head when subject is sitting erect (see figure 7).

#### 5.1.11 Head height

Vertical distance between tragus and top of head when subject is sitting erect (see figure 7).

#### 5.1.12 Head depth

Horizontal distance between tragus and vertical line through back of head when subject is sitting erect (see figure 7).

### 5.2 Materials

5.2.1 Materials of the cushions that may come into contact with the skin shall be non-staining, soft, pliable and not known to be likely to cause skin irritation or any adverse effect on health.

### 5.3 Construction

5.3.1 All edges that are in contact with plastics cushions shall be radiused, finished smooth and be free from sharp edges which could cause damage to the cushions.

### 5.4 Fit and size

#### 5.4.1 Adjustability and size

**NOTE: The requirements of this clause give rise to and accord with Table 4.**

5.4.1.1 General. Unless wearer information is provided in accordance with 8.2.5 (c) to indicate otherwise, the adjustability of the ear-muffs shall comply with 5.4.1.2, when tested in accordance with the appropriate procedures of Appendix C.8

5.4.1.2 Ear-muffs. For each of the combinations of head dimensions shown in Table 2 the range of adjustment of the width between the cushions shall enable the ear-muffs to be fitted to the apparatus so that:

- a) the internal apex of the helmet harness touches the headband support pad, and
- b) the contact between the surface of the cushions and the surface of the plates of the apparatus is continuous insofar as it provides an unbroken barrier between the inside and outside perimeter of the cushions.



**TABLE 2**

**HEAD DIMENSION**

| Head height | Head Width |           |           |
|-------------|------------|-----------|-----------|
|             | mm<br>130  | mm<br>150 | mm<br>160 |
| mm 115      | x          | /         | x         |
| mm 130      | /          | /         | /         |
| mm 140      | x          | /         | x         |

/ indicates ear-muffs to fit this size

x indicates no requirement for this size to be fitted

**NOTE:** The dimensions quoted in the above Table have been chosen to cover the appropriate combinations of the head width with the head height or with the head depth of the 5th, 50th and 95th percentiles of the industrial population

5.4.2 Cup rotation. Each cup shall be capable of movement through  $\pm 10^\circ$  about two orthogonal axes (one of which is horizontal) set in the plane defined by an end face of the ATF (see figure 10) against which a cup rests with the cup separation set in accordance with Table 4.

**NOTE:** A suitable test apparatus and method is described in Appendix C.2.

The contact between the cushions and the test mounting plates shall be continuous throughout this range.

5.4.3 Size of openings in cups. The maximum length (measured in the plane of, or in a plane parallel to, the face of the cup) of the opening in the cups of the ear-muffs, with the cushions fitted, shall be not less than 50 mm and the maximum width of the opening, measured along an axis that is in the plane of, or in a plane parallel to, the face of the cup and orthogonal to the line defining the length, shall not be less than 35 mm.

## 5.5 Comfort

5.5.1 The cushion force shall be not greater than 14 N when measured with the ear-muff separation set as specified in Table 4.

**NOTE:** A suitable test apparatus and method is described in Appendix C.3.

5.5.2 The cushion pressure shall be not greater than 4500 Pa when measured using the test method given in Appendix C.4 or any other method giving equivalent results, and with the ear-muff separation set as specified in Table 4.

## 5.6 Performance and Testing

### 5.6.1 Deformation of cushions

Any cushion deformation which is present on first unpacking the ear-muffs shall disappear within 30 min of the ear-muffs being worn.



#### 5.6.2 Attenuation

Values of the attenuation of the ear-muffs as measured and presented by the procedures described in BS EN 24869-1 shall be provided for the type of ear-muffs being assessed against this specification. The values of (Mf-sf) of the ear-muffs shall not be less than the data in Table 3.

**TABLE 3**                      **ATTENUATION REQUIREMENTS FOR EAR-MUFFS**

| f in Hz | (Mf-sf) in dB |
|---------|---------------|
| 125     | 5             |
| 250     | 8             |
| 500     | 10            |
| 1000    | 12            |
| 2000    | 12            |
| 4000    | 12            |
| 8000    | 12            |

**Mf are the mean attenuation data and sf the standard deviations according to BS EN 24869-1.**

#### 5.6.3 Insertion loss

Values of insertion loss obtained as specified in C.6 and using the procedures described in Appendix C.8 shall be retained by the manufacturers.

**NOTE: These results may be used to compare performance characteristics of production ear-muffs with those of the reference samples submitted for testing in accordance with BS EN 24869-1.**

#### 5.6.4 Durability

The ear-muffs and their attachments to the helmet shall not crack, rupture, or otherwise suffer damage likely to affect performance when tested in accordance with Appendix C.5.

**Note:** In the case of manipulation and the durability of movable parts the exercise of technical judgement may be required.

#### 5.6.5 Change in cushion force.

The cushion force shall not change by more than  $\pm 25\%$  from that measured in accordance with 5.5.1 after the performance of the ear-muffs has been assessed in accordance with 5.6.4.

#### 5.6.6 Change in insertion loss

The change in insertion loss measured according to the procedures of Appendix C.6 after carrying out the performance tests specified in 5.6.4 and 5.6.5 on each cup of the designated sample shall be not greater than 4dB at more than one test frequency.

#### 5.6.7 Resistance to leakage

In the case of liquid or gas filled cushions, the cushions fitted to ear-muffs shall not leak when tested in accordance with Appendix C.7.



**TABLE 4** **EAR-MUFF SETTINGS FOR THE MEASUREMENT OF CUP ROTATION, CUSHION FORCE AND CUSHION PRESSURE**

| Classification                                                                                                               | Corresponding setting of apparatus and ear-muffs<br>(see figure 8)                                         |                              |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------|
|                                                                                                                              | Head Width                                                                                                 | Head height<br>or head depth |
| Ear-muffs which fit the head dimensions that cover those given in Table 2 when tested in accordance with Appendix C.8        | 150 mm                                                                                                     | 130 mm                       |
| Ear-muffs which do not fit the head dimensions that cover those given in Table 2 when tested in accordance with Appendix C.8 | Mid point of range of head dimensions stated by the manufacturer in accordance with the wearer information |                              |



## SECTION 6 RESPIRATORY PROTECTION

### 6.1 Definition and description

6.1.1 The respiratory protection system of the Integrated Protection Helmet is dependent on the ambient air, and provides protection against solid, or solid and liquid aerosols of negligible volatility and decomposition. The device is not designed for use where there is or might be an oxygen deficiency (oxygen less than 17% by volume) or for use for escape purposes.

The respiratory protection system includes a power-operated blower and one or more particle filters. The fan(s) 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.

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

### 6.2 Classification and designation

Powered particle filtering devices are classified and designated as a function of their total inward leakage as given in Table 5, when measured against sodium chloride at the manufacturer's minimum design flow rate.

| TABLE 5 CLASSIFICATION OF DEVICES |                                                |
|-----------------------------------|------------------------------------------------|
| Class                             | Maximum total inward leakage (%)<br>(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.

### 6.3 Performance

#### 6.3.1 Total inward leakage

When tested in accordance with Appendix D.1 and calculated according to Appendix D.1.5, the mean total inward leakage of the test aerosol for each of the exercises appendix D.1.4 (a), (c) (1), (c) (2), (c) (3) and (d) for each test subject shall be within the levels set out in clause 6.2, 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.

#### 6.3.2 Carbon dioxide content of the inhalation air

When tested in accordance with Appendix D.2 the carbon dioxide content of the inhalation air shall not exceed an average of 1% by volume.



---

#### 6.3.3 Breathing resistance

When the exhalation resistance is measured in accordance with Appendix D.3 the positive pressure under the helmet shall not exceed 7 mbar.

#### 6.3.4 Air Supply

When tested in accordance with Appendix D.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 shall not cause distress to the wearer by excessive local cooling of the head and face.

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

NOTE: Helmets conforming with this specification are designed for effective operation in conditions where the air flow does not exceed 2 meters per second and humidity up to 95%. Above these levels it should be recognised that operational efficiency may be impaired.

#### 6.3.5 Clogging

At the end of the clogging test in accordance with Appendix D.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 6.3.8.

#### 6.3.6 Electrical components.

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

#### 6.3.7 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 Appendix D.1).

#### 6.3.8 Filters

Filters other than pre-filters, shall be designed to be irreversible. Filters shall be readily replaceable without the use of tools. The performance of filters shall conform to Table 6 and shall be tested in accordance with the test methods described in EN 143 at the initial flow rate measured in Appendix D.4.5.



**TABLE 6**                      **MAXIMUM INITIAL PENETRATION**

| Class | Maximum initial penetration (%) |              |
|-------|---------------------------------|--------------|
|       | Sodium Chloride                 | Paraffin oil |
| THP1  | 10                              | 4            |
| THP2  | 5                               | 2            |
| THP3  | 0.2                             | 0.2          |

**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.

#### 6.3.9    Warning and measuring facilities

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

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

#### 6.3.10   Flammability

The Integrated Protection Helmets shall not grossly deform, decompose or continue to burn after testing in accordance with Appendix D.6.

#### 6.3.11   Noise

The noise generated by the device shall not exceed 75 dB (A) when measured using the method in D.7 and shall be measured using the complete set of filters designed to be used with the device, and without the hearing protection fitted.