PSDB Protective Headwear Standard for UK Police (2004)

Public Order Helmet

Chris Malbon
John Croft

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CHRIS MALBON
JOHN CROFT

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Home Office
Police Scientific Development Branch
Sandridge
St Albans
Hertfordshire AL4 9HQ
United Kingdom

Email: psdb.sand.enquiries@homeoffice.gsi.gov.uk

Tel: 01727 865051 Fax: 01727 816233

FOREWORD

The PSDB Minimum Performance Specification for Riot Helmets (1994) was produced by the Home Office Police Scientific Development Branch at the request of the Tactics, Training and Equipment Working Group of the Association of Chief Police Officers (ACPO).

The following year an agreement between PSDB and the British Standards Institution (BSI) was reached to administer the specification in the form of a Product Approval Specification (PAS017).

This standard was a major step towards providing greater protection for police officers against the threats faced during public order situations and where an increased level of head protection was required. It provided a level of protection against the threats posed to a police officer, including hand thrown missiles (such as sections of bricks) and fire.

The PSDB Protective Headwear Standard for UK Police (2004) introduces new tests for visor impact protection, solvent resistance of visors and anti-mist visors. Additionally new test methods have been introduced for testing the impact attenuation of the helmet. These tests have been designed to represent the typical threat that police officers face from both hand thrown and hand wielded non-edge weapons.

The revisions made to this standard will allow forces to issue guidance on the selection of protective headwear that will assist Chief Officers when carrying out risk assessments that are required to comply with the Police (Health and Safety) Act.

Paul Acres QPM
Chief Constable Hertfordshire Constabulary
ACPO Conflict Management
Portfolio Holder

Brian R Coleman OBE
Director
Home Office
Police Scientific Development Branch

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MANAGEMENT SUMMARY

In 1994 PSDB published a Minimum Performance Specification for Riot Helmets which was later administered by the British Standards Institution (BSI) in the form of a Product Approval Specification (PAS017). This document set out the minimum level of protection required for helmets that were designed for Public Order situations.

PSDB has now revised PAS017 and produced this new PSDB/ACPO standard.

The main changes are:

- The introduction of two new test anvils for testing impact attenuation of the helmet shell. A corner brick shaped anvil (FPE2/001) and a non-edged hand wielded weapon (FPE2/002);
- The testing of impact attenuation of the helmet body is tested at fixed energies;
- The maximum measured acceleration of the brain for impact attenuation is reduced to 250'g' for the upper level;
- The inclusion of a test for the impact protection of the visor;
- The inclusion of a test for the solvent resistance of the visor;
- The inclusion of a test for the anti-mist properties of the visor.

1 INTRODUCTION

Protective headwear for situations of public disorder has been available to UK police for many years. Since 1995 this headwear has been tested to a Minimum Performance Specification developed by PSDB and administered by the British Standards Institution (BSI) in the form of a Product Approval Specification (PAS017).

PSDB addresses the constantly changing threats that are faced by UK police by regularly reviewing its standards as and when new information becomes available. This standard specifies the minimum requirements for protective headwear for situations where additional protection from hand thrown missiles and manual attack weapons is required, such as situations of public disorder.

1.1 Scope

This standard applies to protective headwear principally intended for use in situations of public disorder and other duties where an increased level of head protection is required. It does not address protection against ballistic threats.

Headwear meeting this standard is intended to prevent or minimise injury to the wearer from impacts caused by hand thrown and hand wielded non-edged weapons. Additionally, the headwear provides resistance to penetration, burning and chemical attack.

1.2 Testing

Compliance testing of headwear to this standard shall only be performed at PSDB approved test facilities. Development testing of headwear by manufacturers to this standard may be performed using any test facility they wish.

1.3 Publication of Results

The results of compliance testing to this standard will be held by PSDB and treated as RESTRICTED – COMMERCIAL, and as such, the information will not be made available to competing manufacturers and suppliers.

A non-restricted listing of headwear that is certified to this standard will be published on the Home Office website. Full details are available on request from PSDB (see page ii).

2 DEFINITIONS

2.1 Basic Plane

Human Head: a plane at the level of the external ear opening (external auditory meatus) and the lower edge of the eye socket (inferior margin of the orbit).

Headform: a plane relative to the headform that corresponds to the basic plane of the human head that the headform represents (Figure 1).

2.2 Batch

A quantity of helmet bodies or visors produced in a single production run using materials produced in any one production run.

2.3 Batch Identifier

A unique identifier allocated to a single batch which enables the manufacturer to identify a product made in a single production run. A separate production run consisting of helmet bodies or visors, or the use of any material from a new material batch would be classed as a new batch and would require a new batch identifier.

2.4 Batch Test

Consistency testing of a model of helmet or visor in production that has already passed compliance testing to this standard.

2.5 Chin Cup

Device that passes round the point of the wearer's chin to aid in the retention of the helmet to the wearer's head and forming part of the retention system.

2.6 Chin Strap

Strap that passes under the wearer's chin or lower jaw, forming part of the retention system.

2.7 Comfort Padding

Soft material within the helmet designed to ensure a close and comfortable fit for the wearer.

2.8 Full Compliance Test

Compliance testing of a new model of helmet body with a visor. The visor may be an existing model or a new model.

2.9 Helmet

Headwear consisting of a helmet body, visor and neck guard, which is intended to minimise injury to the wearer's head arising from impact, penetrative, chemical and fire attacks, without unduly restricting the movement of the user.

2.10 Helmet Body

The part of the helmet that protects the majority of the wearer's head, excluding visor mounts, visor and neck guard.

2.11 Helmet Shell

Smooth surface that forms the outer layer of the helmet body.

2.12 Manual Attack Weapons

Common objects capable of inflicting injury when either thrown by hand or wielded with either one or two hands in the manner of a bat, club or other weapon.

2.13 Mid-Coronal Plane

Human Head: Vertical plane passing through the head along its central vertical axis dividing the head into its anterior and posterior sections.

Headform: a plane relative to the headform that corresponds to the mid-coronal plane of the human head that the headform represents (Figure 1).

2.14 Mid-Sagital Plane

Human Head: Vertical plane passing through the head along its central vertical axis that separates the left and right sections of the head.

Headform: a plane relative to the headform that corresponds to the mid-sagital plane of the human head that the headform represents (Figure 1).

2.15 Model

A manufacturer's designation (name, number or other description) that serves to uniquely identify a specific helmet body or visor design. ***Each sample type submitted for testing shall carry this unique identification.***

2.16 Neck Guard

An item, when securely attached to the helmet offers additional protection to the rear of the neck without unduly restricting the movement of the wearer (The additional protection provided should be clearly stated by the manufacturer.)

2.17 Protective Padding

The lining material within the helmet body, which is designed to absorb the energy of an impact.

2.18 Quick-Release Mechanism

System attached to or incorporated in the helmet that enables the rapid fastening or unfastening of the retention system.

2.19 Reference Plane

A plane relative to the headform, parallel to the basic plane and at a distance above it specified in BS EN 960:1994.

2.20 Retention System

The assembly, which when closed or fastened, prevents the removal, with reasonable force, of the helmet from the wearer's head.

2.21 Size

The human head size that a particular helmet is designed to fit.

2.22 Test Sample

The helmet or visor supplied by the manufacturer or purchasing authority for testing.

2.23 Visor

Transparent protective screen attached to the helmet body by a mounting system covering the wearer's face.

2.24 Visor Mounting System

Mechanism for securely attaching the visor to the helmet body, which enables the visor to be moved through a range of positions (see Section 3.15).

2.25 Visor Compliance Test (separate)

Compliance testing of a new model of visor for use with a previously certified model of helmet body.

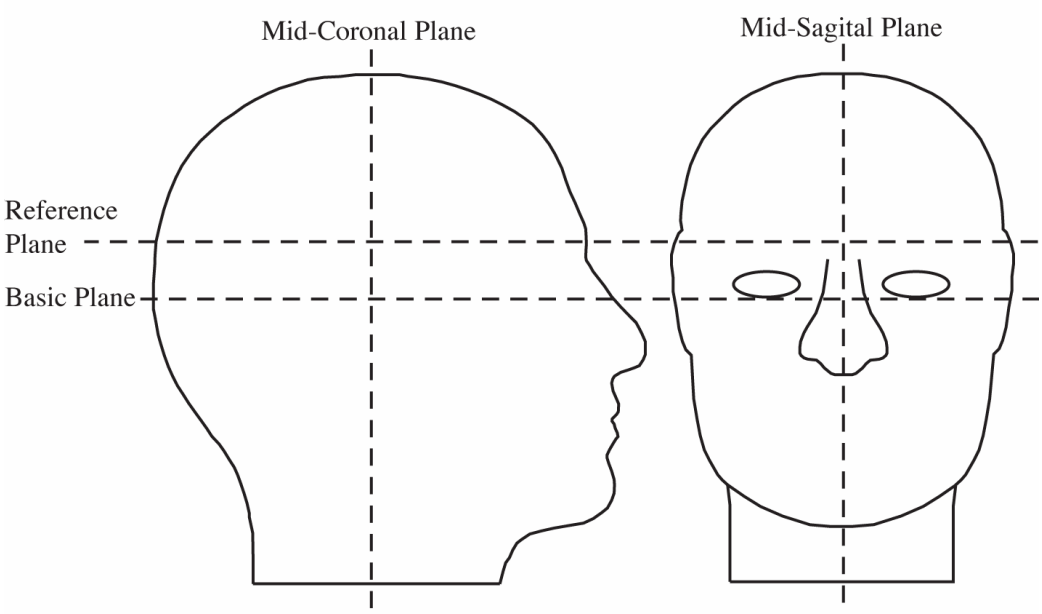

FIGURE 1 *Reference Planes*

3 GENERAL REQUIREMENTS

3.1 Labelling – Helmet Body

Each helmet body supplied shall have a clearly visible label permanently attached to the inside of the helmet.

The following information shall be included:

i The manufacturer's and suppliers name (if not the same);

ii The model designation;

iii The date of manufacture (mm/yyyy) and batch number;

iv The size range that the helmet is designed to fit quoted in mm;

v A label with the following statement "This helmet is intended for Police use only for Public Order Duties";

vi Warning that the helmet will only provide protection if securely fastened and used with an appropriate certified visor;

vii Warning against the inappropriate use of solvents, paints and the use of unsuitable adhesive labels (if applicable);

viii A label with the following statement; "Any helmet subjected to severe impact, exposure to chemicals or fire should be replaced even if no damage is apparent externally".

In addition each helmet should be supplied with an information document including the following details:

i A description of its intended application;

ii A description of the extent and limitations of the protection that the model provides;

iii The expected lifespan of the helmet assuming no damage;

iv Recommended storage conditions for the helmet;

v Care and cleaning instructions;

vi Any factors other than impacts that may reduce the effectiveness of the helmet;

vii Details on how to change the visor, and when the visor should be replaced (e.g. scratched, contact with solvents);

viii Warning about inappropriate modifications;

ix Advice on how to ensure the helmet fits properly, including instruction on any adjustments that can be made if applicable;

x Instructions on the correct usage of the retention system;

xi The material used in the construction of the helmet body;

xii The respirator(s) that the helmet is compatible for use with.

3.2 Labelling - Visor

Each visor supplied shall have the following information marked onto the visor in an area that will not interfere with the vision of the user:

i Manufacturer's and suppliers name (if not the same);

ii The model designation;

iii The date of manufacture (mm/yyyy) and batch number;

iv The thickness of the visor;

v Details of any treatment applied to the visor (e.g. anti-mist).

In addition, each visor shall be supplied with an information document including the following:

i Details of which models of helmet body the visor is certified for use with;

ii Fitting instructions;

iii Details of any treatments that have been applied to the visor (e.g. anti-mist);

iv Care and cleaning instructions;

v The materials used in the construction of the visor.

3.3 Sizing

Helmets shall either be adjustable or supplied in a range of sizes to fit a minimum range of head sizes from 520mm to 620mm without the need for modification.

3.4 Comfort

Helmets may be supplied with additional comfort padding to enable a more appropriate fit for various head shapes. The lining of the helmet shall be made from materials which are known not to undergo any appreciable alteration through the effects of perspiration or toilet products or cause any adverse reaction to the user (e.g. skin allergy).

3.5 Quality of Manufacture and Traceability

Each helmet body and visor shall be free from manufacturing flaws or evidence of inferior workmanship. Manufacturers submitting helmets and visors for compliance testing must be able to demonstrate consistency of manufacture through membership of a nationally recognised quality assurance scheme, e.g. ISO9001:2000, etc.

3.6 Colour

Helmets should be available in a range of colours suitable for their intended application.

3.7 Construction

The helmet shall be designed and fabricated with due regard to the properties and limitations of the materials used. All methods of shaping, moulding and attachment shall not produce any localised areas of stress concentrations that may reduce the level of protection provided. Any internal rigid projections shall be covered with protective padding so that any forces transmitted to the head is not concentrated.

3.8 Fire

The materials used for the external surfaces of the helmet, visor, neck guard (if fitted) and any other accessory that is mounted on the external surface of the helmet must be self-extinguishing.

3.9 Environment

The environment in which the protective equipment is used can alter the physical properties of materials, including exposure to UV light, solvents, caustic or corrosive chemicals and temperature variations. The helmet shall be constructed from materials, which when exposed to these elements at levels that would be expected over the lifespan of the helmet, do not undergo any alteration that may make it unfit for its intended application.

3.10 Compatibility with Respirators

When correctly sized and fastened, the helmet shall be compatible[1] for use with at least one of the following styles of respirator: Scott™ N95; Avon™ FM12; Avon™ S10.

3.11 Weight

The weight of the helmet body, visor and neck guard shall not exceed 1.75kg.

3.12 Helmet Surface

The helmet shell shall have a smooth continuous external surface and be free from sudden changes in cross section. Any external projections should not protrude from the shell by more than 18mm when the visor is in its lowest position. Where possible, protrusions should be tapered into the adjacent shell.

3.13 Apertures

Apertures in the shell to improve hearing are allowed below the lower edge of impact protection, however the total area of all apertures must be less than 1500mm^2. The apertures must be covered in a manner that protects the wearer from liquids, flames and hot air. The maximum size of any single hole in the aperture covering must not exceed 3.0mm^2.

3.14 Health Consideration

Materials used in the construction shall not constitute any form of hazard to the health of the wearer or others. The helmet shall be without sharp edges or projections, which might cause injury to the wearer or other people. Trim designed to cover sharp edges shall be securely attached.

3.15 Mounting System

The visor mounting system shall allow the wearer to move the visor through a range of positions between closed (visor fully covering the wearer's face) and open (visor completely clear of the wearer's face). Moving the visor shall not cause abrasion of the

[1] PSDB defines compatibility on this occasion as: the fit of the helmet body shall not be affected; the seal of the respirator shall not be compromised when worn with the helmet.

visor within the field of vision. The mounting system shall maintain the visor position when the helmet is subjected to a full range of motion experienced by a helmet during use.

3.16 Visor

The visor shall be constructed from a transparent material, with a form that does not prejudice clear vision or induce eyestrain. Removal of the visor from the mounting system, or the mounting system from the helmet shall require the use of one or more tools.

3.17 Visor Liquid Seal

When fully closed the visor shall form a complete liquid tight seal along the top edge of the visor to the shell of the helmet.

4 TEST PROCEDURE

4.1 Calibration of Test Equipment

Test equipment used for compliance testing to this standard must be calibrated. Test calibration records shall be maintained and traceable to the requirements of a nationally recognised quality assurance standard e.g. UKAS, ISO17025 etc.

4.2 Submission for testing

Before submitting any test samples to a PSDB accredited test house for compliance testing, manufacturers and suppliers are required to inform PSDB, in writing, of their intention to submit the samples for testing. Documentation describing the construction of the test sample shall be included. This documentation shall be in the form of a declaration stating that "Any product produced as model number **** as a result of successful compliance testing to PSDB standards, will be of the same construction, using the same materials, from the same manufacturer as the test sample".

The materials used in the construction of the helmet body and/or visor shall also be listed starting from the outside, giving manufacturer's references, trade names, thickness, etc. Also, any accessories that are supplied as standard with the model under test shall be declared.

The information supplied on this declaration will be treated as "RESTRICTED COMMERICIAL" by PSDB.

A sample declaration form showing the information required, which may be photocopied, is shown in Appendix A. An electronic version of this form may be obtained from PSDB, and the declaration submitted to PSDB by email.

Submission of samples for batch testing shall be arranged directly with a PSDB approved test facility by the manufacturer or supplier. PSDB only needs to be informed if a failure occurs during batch testing.

4.2.1 Test Sample submission

Once the declaration has been approved by PSDB, the test house will be informed of the manufacturer or supplier's intention to submit the model number/s agreed with PSDB for testing.

The manufacturer or supplier will then be invited to contact the test facility directly to arrange a test date and submit the required number of samples to the test house for compliance testing.

4.3 Full Compliance Test

This test is for a new model of helmet body with a particular model of visor, which may also be a new model. Seventeen complete helmet bodies and visors of the same model shall be submitted for testing. The sizes are specified in Table 1.

Each submitted helmet sample shall be supplied for compliance testing to this standard in its fully finished condition. Neck guards and visors shall be supplied fitted to the helmet body sample.

Helmets produced outside of the required size range must still be tested for compliance with this standard. The manufacturer or supplier shall supply one of each size of helmet that is not within the required size range (Section 3.3) for compliance testing.

Helmets outside of the required size range shall be tested for compliance for coverage and peripheral vision. Additionally, impact protection shall be deemed to be suitable if the construction and material properties of the impact liner and helmet shell are the same as for that of a helmet suitable for a 600mm head. This shall be confirmed by measurement performed by the test facility.

Helmet	Size (mm)	Primary Test	Secondary Test
1	570	Vision Test (Spherical, Astigmatism and Prismatic)	Visor Mist (optional)
2	570	Visor Impact	N/A
3	570	Visor Pellet	Helmet Retention Strength
4	570	Flammable Liquid Trap	N/A
5	570	Flammable Liquid Trap	N/A
6	570	Flame Test	N/A
7	520	Hearing Attenuation	Visor Solvent
8	620	Hearing Attenuation	Helmet Retention Stability
9	520	Coverage and Peripheral Vision	Impact Attenuation[2]
10	620	Coverage and Peripheral Vision	Impact Attenuation
11	540	Impact Attenuation	N/A
12	540	Impact Attenuation	N/A
13	570	Impact Attenuation	N/A
14	600	Impact Attenuation	N/A
15	600	Impact Attenuation	N/A
16	620	Impact Attenuation	N/A
17	540	Helmet Penetration	N/A

TABLE 1 *Helmet Sizes for Full Test*

4.4 Visor Compliance Test (separate)

This test is for a new model of visor for use with a previously certified model of helmet body. Five helmets of the specified model and seven visors of the new model shall be submitted for testing. The sizes are specified in Table 2.

Each submitted helmet body and visor shall be supplied for compliance testing to this standard in its fully finished condition.

[2] tested on a 500mm headform

Helmet	Size (mm)	Primary Test	Secondary Test
1	570	Vision Test (Spherical, Astigmatism and Prismatic)	Visor Solvent
2	520	Coverage and Peripheral Vision	Flame Test
3	620	Coverage and Peripheral Vision	Visor Pellet
4	570	Visor Mist (Optional)	Flammable Liquid Trap
5	570	Visor Impact	N/A

TABLE 2 *Visor and Helmet Body Sizes for Visor Test*

4.5 Batch Testing

4.5.1 Helmet Bodies

Helmet bodies submitted for batch testing shall be supplied with the certified visor being offered with the helmet body. The number of complete helmets to be batch tested shall be dependent upon the batch size (Table 3).

Each helmet body submitted for batch testing shall be supplied in its fully finished condition. Neck guards and visors shall be supplied fitted to the helmet body. Helmet samples shall be stored for a minimum period of 24 hours at temperature and humidity between 15 to 24^{o}C and 40 to 70% relative humidity prior to batch testing. The helmets shall be tested at ambient condition without any preconditioning.

Set	Number of Helmets in Batch	Sample Size	Tests
1	5 to 300	3	Helmet Penetration Impact Attenuation, high energy, FPE2/001 and FPE2/002 anvils
2	301 – 600	6	As set 1 plus Helmet Retention Strength Helmet Retention Stability Additional Impact attenuation test, high energy, FPE2/002 anvil
3	601 – 900	9	As set 2 plus 3 Additional sets of Impact Attenuation test
4	901+	1% of batch	As set 3 plus Additional Impact attenuation tests on remaining helmets

TABLE 3 *Helmet Batch Testing*

The required tests shall be performed on the helmet size deemed appropriate by the test facility

4.5.2 Visor Batch Test

Each visor submitted for batch testing shall be supplied in its fully finished condition with a helmet body certified for use with the visor.

Visor samples shall be stored for a minimum period of 24 hours at temperature and humidity between 15 to 24^{o}C and 40 to 70% relative humidity prior to batch testing. The visors shall be tested at ambient condition without any preconditioning. The number of visors required for testing is dependent upon the batch size (Table 4).

Number of Visors in Batch	Number to test	Tests
2 to 300	3 Visors	Vision Test (Spherical, Astigmatism and Prismatic) Visor Impact
301 – 600	6 Visors	Vision Test (Spherical, Astigmatism and Prismatic) Visor Impact Visor Pellet Solvent Test
601 +	1% of batch size	Vision Test (Spherical, Astigmatism and Prismatic) Visor Impact Visor Pellet Solvent Test Repeat of above tests for remaining samples

TABLE 4 *Visor Batch Testing*

4.5.3 Batch Test Pass/Fail

A batch test is successful if the results are within the limits defined for the appropriate compliance tests. Batch testing shall fail if the results fall outside these limits. A failed batch test can be repeated by submission of 2% sample size of the batch up to a maximum of 34 helmet bodies or 14 visors. If the results of this second batch test are recorded as a failure, the batch must not be supplied to the police and remedial action must be taken to resolve the batch failure. The batch must then be resubmitted for batch testing at 2% sample size. In all cases of failure of a batch test, the test facility shall inform PSDB in writing with a copy of the test results.

4.6 Preparation of the Test Samples

On receipt of the required test samples, the test facility shall carry out an examination to determine that they are all of the same model number specified in the declaration and of the specified sizes required for testing if the samples are not adjustable.

The helmets and visors shall be labelled in accordance with the numbers specified in Table 1 (full test) or Table 2 (visor test).

4.7 Marking of Helmets

Helmets 9 to 17 shall have lines marked on their external surface relative to the following planes of the headform:

1. Mid-Coronal plane;
2. Mid-Sagital plane.

The headforms used for marking the helmets shall be of the correct size for the helmet being marked.

In addition, helmet numbers 9 to 16 shall be marked on their external surface with a line relative to the horizontal plane that intersects the point H1 (Table 7).

These lines shall be applied with a marker that has no known detrimental effects to the material properties of the helmet shell.

Helmets numbered 9 to 16 shall be weighed in the condition that they are to be tested and the result recorded.

4.8 Test Process

The submitted test samples shall be inspected for compliance with the applicable general requirements (Section 3) of this standard. Once this has been confirmed, testing can commence.

Where helmets submitted for testing include an adjustment mechanism for size, they shall be tested at a size that is deemed to be worst case by the test house.

4.9 Presentation of Results

On completion of testing to this standard, all results shall be sent to PSDB for evaluation.

Upon successful compliance testing a compliance document will be issued by PSDB to the manufacturer or supplier stating that the model submitted has successfully met this standard.

In all circumstances a copy of the test report will be made available to the manufacturer or supplier.

Once a compliance document has been issued it is the responsibility of the manufacturer or supplier to ensure that continuous batch testing is performed in accordance with this standard. Results of batch testing shall be made available for inspection by PSDB upon request.

PSDB reserves the right to suspend certification of a particular model of helmet or visor if the manufacturer or supplier is unable to provide evidence of batch testing in the previous 12 months.

5 ENVIRONMENTAL CONDITIONING OF HELMETS

Helmet bodies subjected for impact attenuation and penetration tests, and visors subjected for impact and pellet protection tests, shall be conditioned immediately prior to testing.

5.1 Helmet Body Conditioning

Helmet bodies shall be conditioned with the visor and neck guard attached. They shall be conditioned in the sequence indicated in the Table 5, except for helmet bodies used for impact attenuation testing where the cold and hot conditioning are exchanged depending upon condition specified in Table 8.

Condition	Description	Time
Solvent	Using 25ml of Iso-octane/toluene mixture (50/50), soak a cotton cloth approximately 150x150mm and wipe the mixture over the complete helmet body surface keeping the surface wet for a minimum of 10 seconds.	
Ambient	15 to 24^{o}C at 40 to 70% humidity	Minimum 30 Min
Water	Place the helmet with the crown upwards and spray with water at a temperature of 15 ± 5^{o}C with a flow rate of 1 ± 0.1 lmin^{-1}	2 hrs +15/-0min
Ambient	15 to 24^{o}C at 40 to 70% humidity Place helmet on moisture absorbing material	Minimum 30 Min
UV	Expose the outer surface of the helmet to ultra-violet radiation from a 150W Xenon filled quartz lamp at a range of 150mm.	90 hrs +8/-0hrs
Ambient	15 to 24^{o}C at 40 to 70% humidity	Minimum 30 Min
Cold	Place the helmet in a conditioning chamber at –20 ± 2^{o}C	2 hrs +22/-0hrs
Ambient	15 to 24^{o}C at 40 to 70% humidity	Minimum 30 Min
Hot	Place the helmet in a conditioning chamber at +50 ± 2^{o}C	2 hrs +22/-0hrs

TABLE 5 *Conditioning of Helmet Bodies*

After completion of the last conditioning process the first test must be carried out within 5 minutes of removal from the conditioning chamber.

5.2 Visor Conditioning

Visors shall be conditioned attached to the helmet body they are to be tested with (Table 6).

Condition	Description	Time
Water	Place the visor under a water spray at ambient temperature with a flow rate of 1 ± 0.1 lmin^{-1}	2 hrs +15/-0min
Ambient	Place visor on moisture absorbing material 15 to 24°C at 40 to 70% humidity	Minimum 30 Min
UV	Expose the outer surface of the visor to ultra-violet radiation from a 150W Xenon filled quartz lamp at a range of 150mm.	90 hrs +8/-0hrs
Ambient	15 to 24°C at 40 to 70% humidity	Minimum 30 Min
Cold	Place the visor in a conditioning chamber at -20 ± 2°C	2 hrs +22/-0hrs
Ambient	15 to 24°C at 40 to 70% humidity	Minimum 30 Min
Hot	Place the visor in a conditioning chamber at $+50 \pm 2$°C	2 hrs +22/-0hrs

TABLE 6 *Conditioning of Visors*

After completion of the last conditioning process the first test must be carried out within 5 minutes of removal from the conditioning chamber.

6 COVERAGE AND PERIPHERAL VISION

6.1 Procedure

Place the helmet on the correct size headform[3] as described in the manufacturer's instructions, ensuring that the front horizontal edge of the helmet shell is parallel to the basic plane of the headform.

6.1.1 Helmet body coverage

Assess the coverage of the helmet shell to ensure that it forms a single continuous surface extending downwards covering the area defined by the boundary H1, H2, H3 and H4, (Table 7 and Figure 2). This is the minimum area that must be covered by the helmet shell.

[3] The headforms used by the current PSDB test facility conform to BS EN 960:1994

6.1.2 Visor Coverage

Assess the coverage of the visor to ensure that it forms a single continuous surface covering the area defined by the boundary V1, V2, V3, V4 and V4` (Table 7 and Figure 2). This is the minimum area that must be covered by the visor.

When fully closed, the visor shall form a complete liquid tight seal along the top edge of the visor to the shell of the helmet body, extending back as far as the vertical plane that intersect point H3 on both sides of the helmet.

Visors may be supplied for specific purposes that may not comply with the above criteria. Any such design must be referred to PSDB for approval prior to testing. Visors shall also be supplied with an additional warning printed on the visor in an area outside of the visual field of the user stating its intended application.

The area defined by H1, H2, H3, V1, V2 and V3 must be covered by either the visor, helmet shell or a combination of both.

Head Circumference	V1	V2	V3	V3	V4	H1	H2	H3
	BP	MCP	BP	MCP	BP	BP	MCP	MCP
500	36.7	16.9	20.5	10	96.3	48.7	6.9	0
510	37.2	15.4	20	10.5	102.3	48.7	5.4	0.5
520	37.7	19.4	19.5	11.5	104	49	9.4	1.5
530	38.2	19.4	19	12	108	49	9.4	2
540	38.7	19.9	18.5	12.5	111	49	9.9	2.5
550	39.2	19.9	18	13	115	50	9.9	3
560	39.7	20.9	17.5	13.5	117	50	10.9	3.5
570	40.2	23.4	17	16	118	53	13.4	6
580	40.7	23.9	16.5	16.5	121	53	13.9	6.5
590	41.2	23.9	16	17	121	53.9	13.9	7
600	41.7	24.9	15.5	18	126	54	14.9	8
610	42.4	24.9	15	18	128	53.2	14.9	8
620	42.7	25.9	14.5	18.5	130	54	15.9	8.5

TABLE 7 *Location of Reference Points on Headform*

Notes:

- All measurements in millimetres (mm);
- MCP: Mid Coronal Plane;
- BP: Basic Plane as defined in BS EN960:1994;
- V2 is in the same horizontal plane as V1;
- V4 is in the same vertical plane as V3
- V4' is in the same horizontal plane as V4;
- H2 is in the same horizontal plane as H1;
- H3 and H4 are in the same horizontal plane as V3.

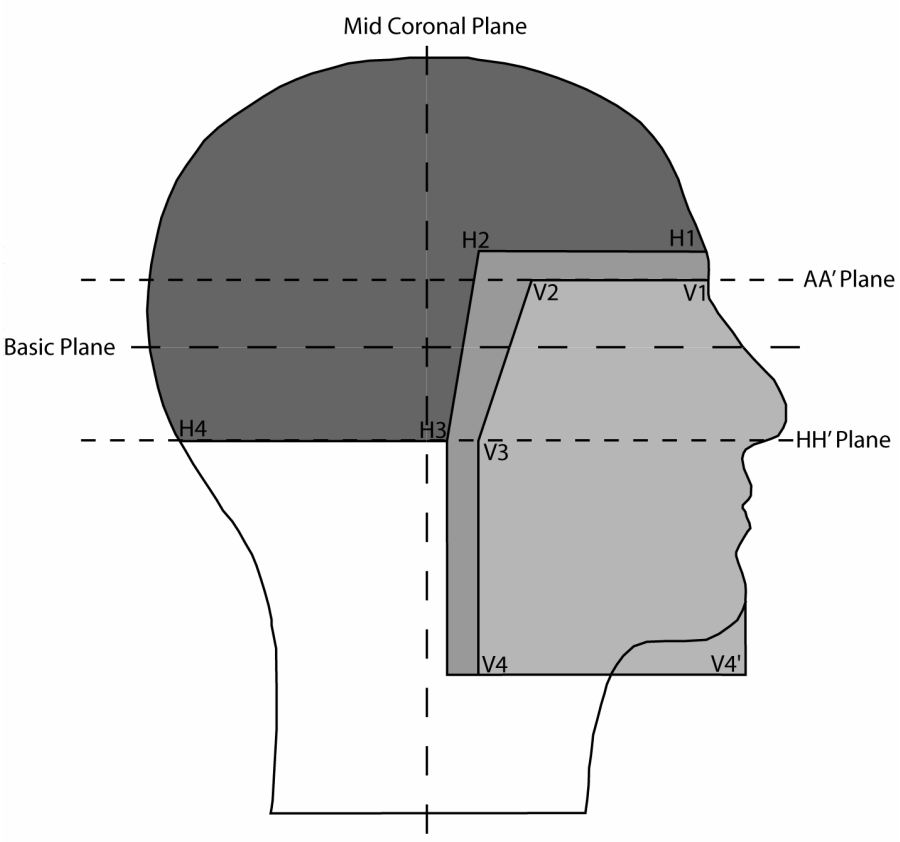

FIGURE 2 Coverage of Helmet Body and Visor

6.1.3 Peripheral Vision

The helmet and visor shall be assessed to ensure that the peripheral vision of the user is not affected by any part of the helmet body or visor mounting system. The vision of the user shall not be obstructed:

- Upwards at a minimum angle of 25^{o} from the horizontal plane that intersects point V1, where it intersects the front of the headform (Figure 3);
- Downwards at a minimum angle of 45^{o} from the horizontal basic plane at the front of the headform (Figure 3);
- Sideways at a minimum angle of 105^{o} outwards from the mid sagital plane where it intersects the basic plane at the front of the headform (Figure 4).

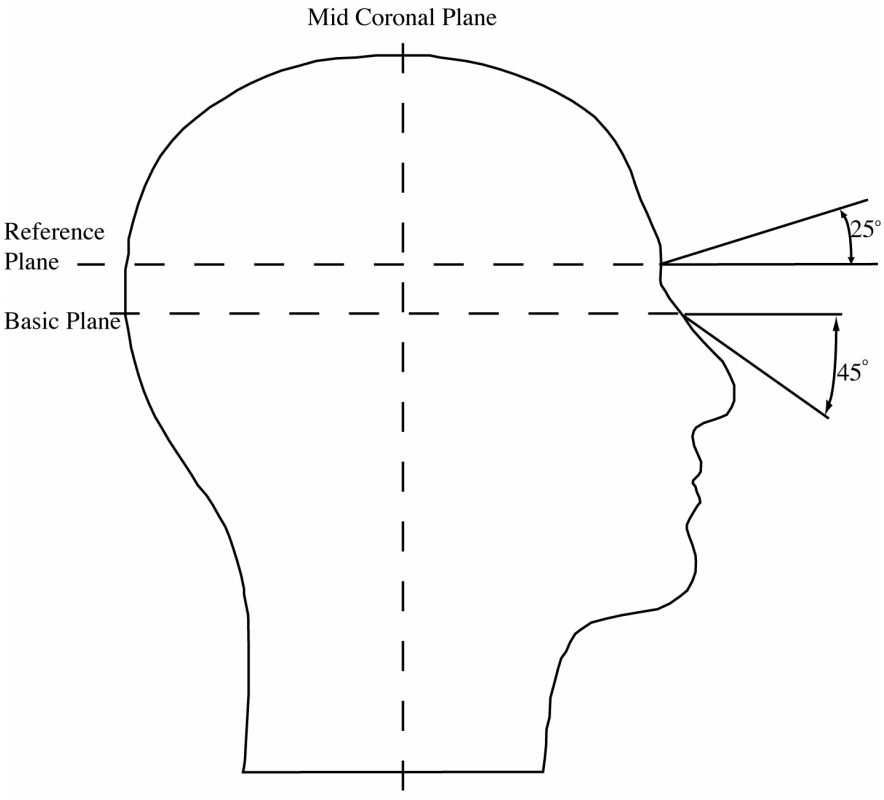

FIGURE 3 *Peripheral Vision - Forwards*

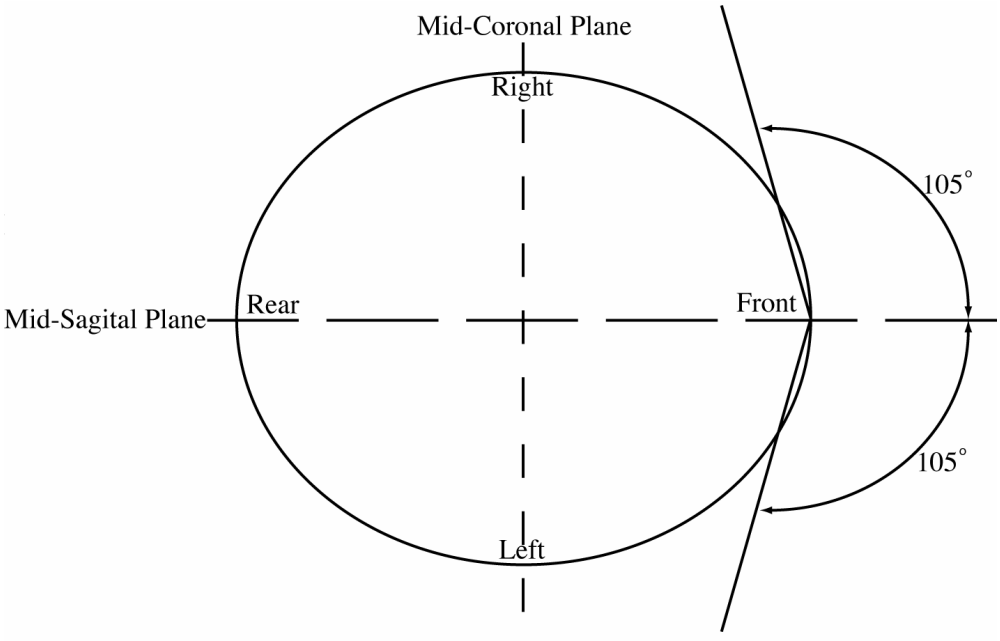

FIGURE 4 *Peripheral Vision - Sidewards*

7 HEARING ATTENUATION

7.1 Purpose

This test is performed to ensure that a helmet design does not attenuate the level of sound reaching the wearer above the defined limits stated in Section 7.5.

7.2 Apparatus

- 2 miniature omnidirectional microphones e.g. Knowles Acoustic EK3132;
- 2 test headforms[4], made from cast epoxy, hollow with wooden bases, of sizes 520mm and 620mm;
- Suitable acoustic test apparatus to perform test.

7.3 Preparation of Test Equipment

7.3.1 Headform

The headform shall be securely mounted on a monopole support incorporating acoustic padding (Figure 5). The two miniature microphones shall be attached to the headform using a suitable method and located at the intersection of the basic plane and the mid-coronal plane with the microphone diaphragm facing outwards. Care must be taken to ensure the cables for the microphone are run in such a manner that they do not interfere with the fit of the helmet or cause movement of the microphones when the helmet is fitted or removed.

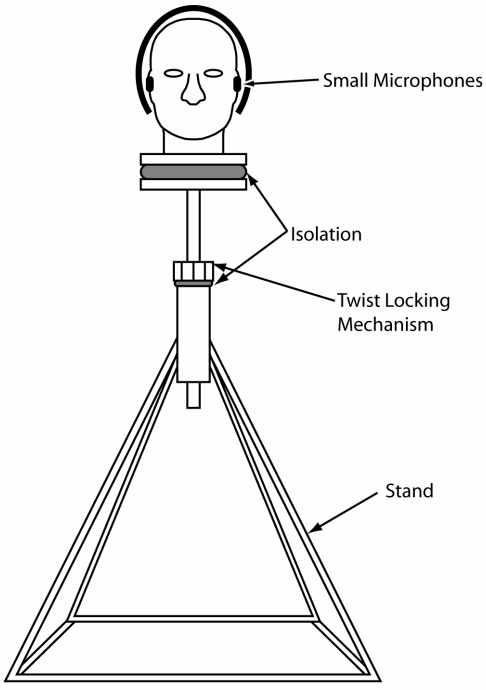

FIGURE 5 *Test Mount for Acoustic Test*

[4] The headforms used by the current PSDB test facility conform to BS EN 960:1994

7.3.2 Test chamber

An anechoic chamber equipped to produce a pseudo random sound field with a sound pressure level at the headform of 70dB (±5dB) shall be used.

7.3.3 Sound Generation

The test equipment shall be capable of producing a nominal pink noise spectrum in one third octave bands centred on frequencies of 1.00, 1.25, 1.60, 2.00, 2.50, 3.15, 4.00 and 5.00KHz.

7.3.4 Helmet

Helmets of the sizes specified in Table 1 shall be supplied in their fully finished condition with the visor and neck guard fitted to the helmet and all packaging material removed.

7.4 Test procedure

1. Mount the 520mm headform on the stand and ensure that the sound field around the headform is constant.
2. Measure the sound pressure level at each of the frequencies (without helmet) and record the values.
3. Mount the helmet on the headform and secure as described in the manufacturers instructions.
4. Measure the sound pressure levels at each of the frequencies and record the values.
5. Remove the helmet from the headform.
6. Repeat steps 2 to 5 a further two times to give three groups of measurements (1 set).
7. Repeat steps 2 to 6 a further two times to give three sets of measurements.
8. Mount the 620mm headform on the stand and ensure that the sound field around the headform is constant.
9. Measure the sound pressure level at each of the frequencies (without helmet) and record the values.
10. Mount the helmet on the headform and secure as described in the manufacturers instructions.
11. Measure the sound pressure levels at each of the frequencies and record the values
12. Remove the helmet from the headform.
13. Repeat steps 8 to 12 a further two times to give three groups of measurements (1 set).
14. Repeat steps 8 to 13 a further two times to give three sets of measurements.

7.5 Results

1. For each group of measurements for the 520mm headform, calculate the mean sound pressure level at each frequency for the unhelmeted and helmeted headform.
2. For each group calculate the Helmet Insertion Loss (HIL) at each frequency for the 520mm helmet. (HIL = mean value without helmet - mean value with helmet)
3. For each group of measurements for the 620mm headform, calculate the mean sound pressure level at each frequency for the unhelmeted and helmeted headform.

4. For each group calculate the Helmet Insertion Loss (HIL) at each frequency for the 620mm helmet. (HIL = mean value without helmet - mean value with helmet)
5. For both helmet sizes and each frequency, calculate:
   - Mean Helmet Insertion Loss (S_M) of the sets;
   - Standard Deviation (S_{SD}) of the sets.
6. Calculate the statistical measure of insertion loss (HIL_{SM}) for both helmets using:

$$HIL_{SM} = S_M + (3 \times S_{SD}).$$

A helmet model passes if for both sizes of helmet:

1. HIL_{SM} is less than 15dB for frequencies up to 3.15Khz inclusive and less than 17dB for frequencies above this;
2. S_{SD} is less than 2.

If the S_{SD} is greater than 2, the measurements shall be checked to determine if there was an error during testing. If a test error can be determined the test can be repeated and the new measurement used to determine compliance with the standard. In this circumstance PSDB shall be informed prior to repeating the test.

8 FLAMMABLE LIQUID TRAP

8.1 Purpose

This test is performed to ensure there are no liquid traps on the exterior of the helmet and that the helmet is self-extinguishing within the defined period of time.

8.2 Apparatus

- Non-flammable headform;
- Suitable fireproof test chamber;
- Video camera.

8.3 Preparation of Test Equipment

8.3.1 Helmet

Helmets of the size specified in Table 1 shall be supplied in their fully finished condition with the visor and neck guard fitted to the helmet and all packaging material removed.

8.3.2 Headform

The headform shall be of an appropriate size and style mounted so that the lowest part of the helmet being tested is 200mm above the surface. The headform, stand and surrounding area shall be manufactured from non-flammable materials and placed in a draught free fireproof enclosure for the purpose of this test.

8.3.3 Video Camera

The flammable liquid trap test shall be recorded using either analogue or digital video process to provide evidence should PSDB arbitration be required. Multiple video cameras or mirrors may be required to enable a complete view of the helmet being tested.

8.3.4 Flammable liquid

A mixture of 5ml Iso-Octane and 5ml Toluene.

8.4 Test Procedure

1. Place the helmet onto the test headform positioned as described in the manufacturer's instructions. Fasten the helmet to the headform using the supplied chinstrap and tuck any excess strapping into the helmet. If this is not feasible, either tuck all of the strapping into the helmet or cut away the strapping, being careful not to affect the properties of the helmet.

The following section of the test shall be recorded on video

2. Lay absorbent material or a suitable tray under the helmeted headform.

Points 3 to 6 shall be completed within 15 seconds

3. Pour the flammable liquid over the crown of the helmet ensuring an even coverage over the helmet.

4. Wait 10 seconds.

5. Remove the absorbent material or tray.

6. Ignite the solvent by applying a flame briefly to the crown of the helmet.

7. Record the time taken for the flames on the helmet to extinguish.

8. Examine the exterior and interior of the helmet for evidence of damage and record any evidence.

8.5 Results

The test sample has passed if the flames extinguished within 15 seconds of the fluid being ignited.

The test sample has failed if the helmet continues to burn for more than 15 seconds or there are visual signs of fire damage on the inside liner of the helmet.

In the event of a borderline result, the video, tested helmet and test report shall be sent to PSDB for arbitration.

In all cases, a copy of the video and test report shall be sent to PSDB.

9 FLAME TEST

9.1 Purpose

This test is performed to determine the flame retardance properties of the helmet.

9.2 Apparatus

- Gas burner with a 10mm (± 1mm) bore mounted at an angle of 45 degrees;
- Gas supply consisting of minimum 95% propane;
- Pressure control valve with meter.

9.3 Preparation of Test Equipment

9.3.1 Burner

Light the burner and adjust the gas pressure to 3.5kPa.

9.3.2 Flame

Adjust the air supply to give a blue flame with no visible yellow and an inner blue cone of 15mm length.

9.3.3 Video camera

The flame test shall be recorded using either analogue or digital video process to provide evidence should PSDB arbitration be required. Multiple video cameras or mirrors may be required to enable a complete view of the helmet being tested.

9.4 Test Procedure

1. Select a suitable area of the outer shell of the helmet, but not within 25mm radius of visor mounting points.

The following section of the test shall be recorded on video

2. Support the helmet at an angle so the surface to be tested is at an angle of 90^{o} to the tip of the flame (Figure 6).

3. Apply the flame for a period of 30 seconds (± 3 seconds).

4. Remove from the flame and record the time for any flames on the helmet to extinguish.

5. Record any evidence of damage to the helmet shell and interior.

Stop the video

6. Allow the helmet to cool to room temperature.

The following section of test shall be recorded on video

7. Repeat steps 2 to 5 on another section of the helmet, but not within 50mm radius of the previous test.

Stop the video

8. Allow the helmet to cool to room temperature.

9. Select an area of the visor to be tested, but not within 25mm of the visor mounting points.

The following section of test shall be recorded on video

10. With the visor mounted on an appropriate helmet, support the helmet at an angle so the surface to be tested is at an angle of 90^{o} to the tip of the flame.

11. Apply the flame for a period of 10 seconds (± 2 seconds).

12. Remove from the flame and record the time for any flames on the visor to extinguish.

13. Record any evidence of damage to the visor.

Stop the video

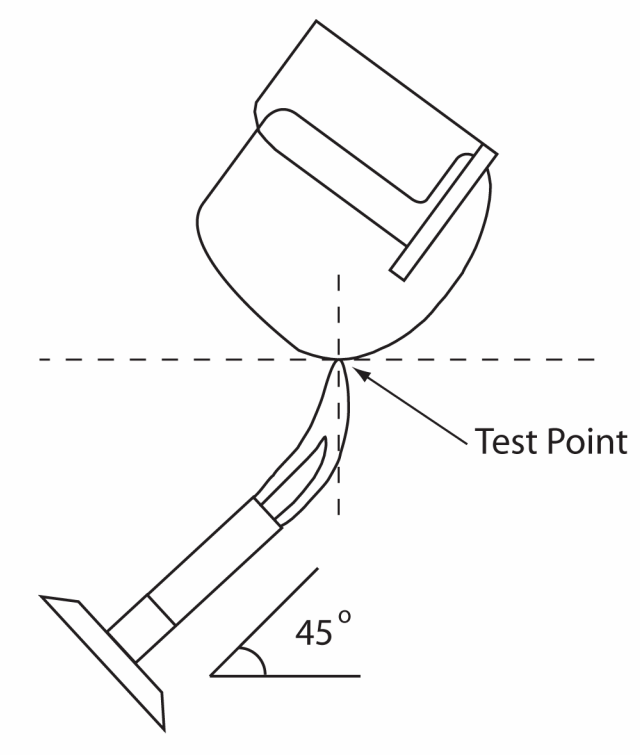

***FIGURE 6** Flame Test*

9.5 Results

The test sample has passed if no area of the helmet and visor continues burning for more than 15 seconds after removal from the flame.

The test sample has failed if any area of the helmet or visor continues burning for more than 15 seconds after removal from the flame or the inner lining of the helmet shows visual signs of burning or melting.

In the event of a borderline result, the video, tested helmet and test report shall be sent to PSDB for arbitration.

In all cases a copy of the video and test report shall be sent to PSDB.

10 HELMET RETENTION STABILITY TEST

10.1 Purpose

This test is performed to ensure the helmet does not roll forward over the wearer's face as a result of an applied force.

10.2 Apparatus

This test is performed using the procedure and test apparatus set out in BS EN 13087-4:2000, Protective Helmets- Test methods - Part 4: Retention system effectiveness. The test is performed on the helmet size specified in Table 1

10.3 Prerequisites

10.3.1 Performance Requirements

The helmet shall remain on the headform and have a rotation of less than 90 degrees.

10.3.2 Number of Samples

The test shall be performed three times on one sample of helmet. The helmet shall be repositioned and secured between each test

10.3.3 Preparation of Samples

The helmet shall be removed from all packing materials and stored at ambient temperature for a period of not less than 4 hours prior to testing. The neck guard should be removed for the purpose of this test.

10.3.4 Direction of Application of Force

The tensile force shall be applied from the rear of the helmet.

10.3.5 Headform

The helmet shall be mounted on the appropriate sized headform[5].

10.3.6 Impact Energy

The helmet shall be tested with an impact of 40 ± 2J.

10.3.7 Fitting Instructions

The helmet shall be mounted onto the test headform, positioned as described in the manufacturer's instructions and securely fastened using its normal retention system.

11 HELMET RETENTION STRENGTH TEST

11.1 Purpose

This test is performed to ensure the retention system does not separate or extend above defined limits as a result of a dynamic load.

11.2 Apparatus

- Rigidly mounted half headform[5] on a system allowing straps to hang freely below it;
- A bar guided drop weight;
- A device to measure the extension in the chin strap.

[5] The headforms used by the current PSDB test facility conform to BS EN 960:1994

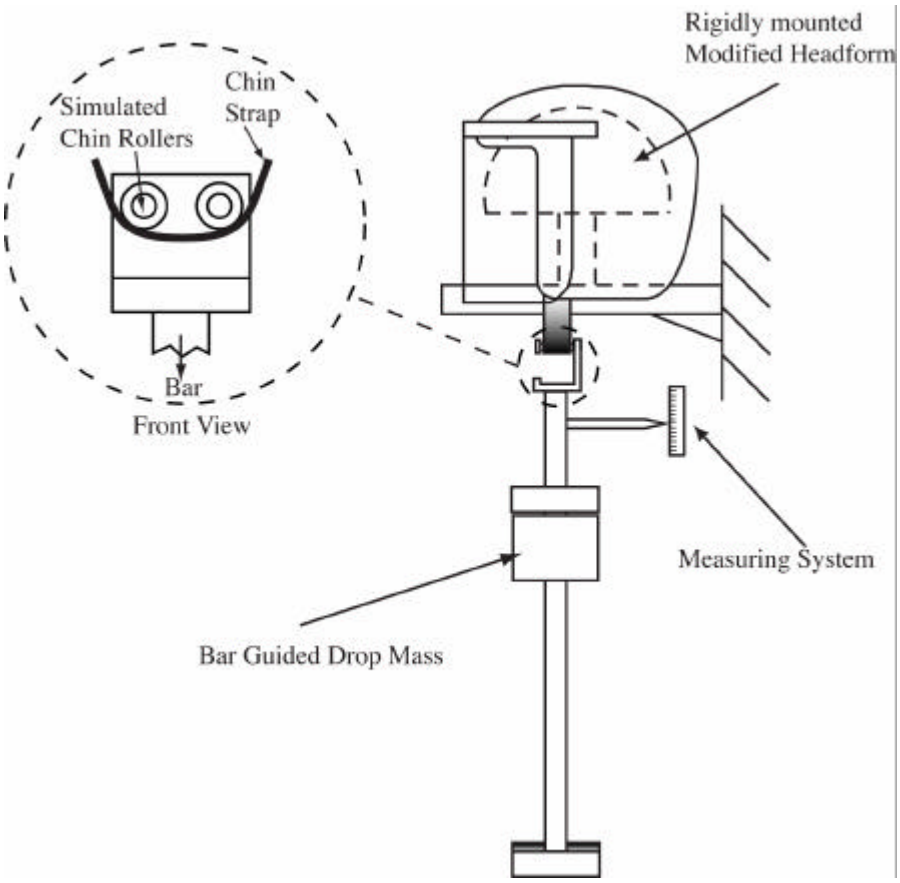

FIGURE 7 *Retention Strength Test*

11.3 Preparation of Test Equipment

11.3.1 Headform

The half headform shall be securely mounted on a structure restricting it from movement in the vertical and horizontal direction. This is to ensure the retention system alone bears the weight of the test. The straps must hang freely below the headform to connect to the weight system. The weight system shall hang in the same vertical plane as the vertical axis of the helmet (Figure 7).

11.3.2 Helmet Mounting

The helmet shall be positioned on the test headform as described in the manufacturer's instructions, but it shall not be securely fastened to the headform. If the test sample is supplied with a chin cup on the strap it must be removed carefully so as not to alter the properties of the strap. The strap shall be fastened to allow it to hang loosely below the test sample.

11.3.3 Bar Guided Drop Weight

The mass of the guide bar assembly, including all attachments, but not the drop weight is 7 -0 +0.25kg and the mass of the drop weight is 10 -0 +0.25kg.

11.3.4 Simulated Chin

A simulated chin consisting of a stirup carrying 2 metal rollers, 12.7 ±0.5mm in diameter with their centres 76 ± 0.5mm apart.

11.3.5 Measuring System

The system, which the tester can set to zero, shall be capable of measuring any extension of the strap as a result of a load being applied to an accuracy of ±0.1mm.

11.4 Test Procedure

1. Align the test helmet on the headform.
2. Fasten the retention system and attach the bar guided drop weight and simulated chin.
3. Adjust the strap to position the simulated chin 130mm below the reference plane of the half headform.
4. Adjust the measuring device to zero in this statically equilibrium position.
5. Raise the drop mass to a height to give an energy of 30 ± 2J and lock in place.
6. Release the drop mass.
7. Record the dynamic extension of the retention system.
8. With the drop mass still resting on the base plate, record the residual extension of the strap.
9. Repeat steps 1-6 (excluding step 4) a further three times to test the robustness of the quick release mechanism repositioning the helmet between tests.

11.5 Results

The test sample has passed if:

- The dynamic extension of the strap does not exceed 35mm and the residual extension does not exceed 15mm.
- The quick release mechanism does not fail or show signs of mechanical failure, e.g. cracking, stress lines, etc.

12 HELMET PENETRATION TEST

12.1 Purpose

This test is performed to ensure the wearer is protected from a penetrating attack to the helmet body.

12.2 Apparatus

- Gravity fed drop tube;
- 1kg mass impactor with a secure mounting for the test spike;
- PSDB/SP/B test spike, engineering drawing in Appendix B;
- Rigidly mounted headform with soft metal block modification to crown;

- Velocity measuring device to record velocity at point of impact.

12.3 Preparation of Test Equipment

12.3.1 Witness block

A soft metal block of minimum diameter 40mm and thickness of 20mm with a smooth surface free from flaws. The block may be reused if the strike surface can be smoothed back to its original position.

12.3.2 Headform

A headform with the witness block mounted flush with the surface at the intersection of the mid-coronal plane and the mid-sagital plane shall be used. The headform shall be securely mounted to a rigid base and in the same central axis as the drop tube (Figure 8).

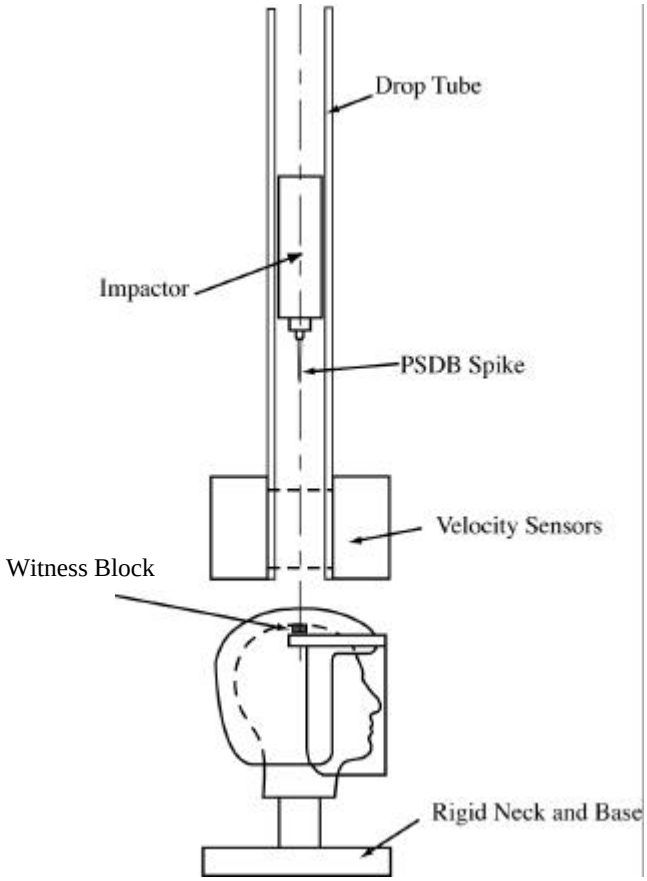

FIGURE 8 *Penetration Test*

12.3.3 Helmet Mounting

The helmet shall be mounted and securely fastened onto the test headform as described in the manufacturer's instructions.

12.3.4 Velocity Measurement

Equipment capable of measuring the velocity of the spike, within 60mm of the top of the helmet to an accuracy of $\pm$ 0.1ms^{-1} shall be used.

12.3.5 Spike Preparation

Prior to testing the spike shall be subjected to a tip-sharpness test. The test procedure used by PSDB consists of a standard Rockwell Hardness Testing Machine, Mitutoyo model ATK-F1000, with a modified indenter holder to accept the spike. The machine shall be pre-set to give minor and major loads of 3kg and 5kg respectively as detailed in Appendix B2.

The spike shall first be wiped with a clean dry cotton cloth to remove any traces of lubricant. The tip sharpness shall then be tested by applying the load at the spike tip into a small sample block of 99.997% pure aluminium that has been machined to a smooth surface finish.

A list of suggested suppliers of pure aluminium is given in Appendix C.

The test value from a new, unused spike shall lie between –100HRC and –140HRC. These values can also be expressed in terms of indentation depth in the aluminium test block, produced by the major load application, and will correspond to depths of 0.40 to 0.48mm as detailed in Appendix B3.

An alternative to using the above tip sharpness method has also been established. The PSDB/SP spike may be tested for tip sharpness at the Cutlery and Allied Trades Research Association (CATRA). The Rockwell values of –100HRC to –140HRC compare with CATRA values of 3.47N force to 0.66N force. These tip sharpness values can be converted into the values on the Rockwell scale using the Table shown in Appendix B4.

If the spike used is from a set which has been batch tested prior to supply, it is not required to individually test each spike prior to usage, providing a certificate has been obtained from CATRA certifying the sharpness of the spikes

12.4 Test Procedure

1. The helmet shall be preconditioned prior to testing (Table 5).
2. Position the helmet on the headform with the spike aligned to the intersection of the mid-sagital plane and mid-coronal plane of the helmet.
3. Raise the sabot to a height of 1.2m measured from the top of the helmet to the tip of the spike.
4. Release the sabot allowing it to free-fall.
5. Record the velocity at the impact site.
6. Remove the helmet and examine the witness block for indentations.

12.5 Results

The test sample has passed if no indentations are visible on the witness block.

13 IMPACT ATTENUATION

13.1 Purpose

This is performed to ensure the helmet is capable of attenuating an impact caused by hand thrown and hand wielded blunt weapons.

13.2 Apparatus

- Test anvils FPE2/001 and FPE2/002;
- Suitable free fall test system;
- Velocity measuring sensors;
- Tri-axial accelerometer.

13.3 Preparation of Test Equipment

13.3.1 Headform

Headforms[6] of appropriate sizes, with mountings for tri-axial accelerometers situated at the centre of gravity of the headform shall be used. The headform shall be manufactured from metal of low resonance frequency.

13.3.2 Accelerometer

A tri-axial accelerometer capable of withstanding a shock of 2000'g' with a minimum measuring range of 0 to 400'g' acceleration with a accuracy of ±1'g' shall be used. The accelerometer shall be connected to measurement equipment capable of calculating the resultant acceleration.

13.3.3 Test Anvils

The test anvils shall be manufactured as specified in drawings FPE2/001 and FPE2/002, Appendix D. The anvil FPE2/001 is designed to represent a point impact, such as a corner of a small brick or similar object. The anvil FPE2/002 is designed to represent a blunt impact, such as a hand wielded non-edged weapon. These anvils are to be mounted on a solid block with a minimum mass of 500kg.

13.3.4 Drop System

The drop systems shall consist of a free fall frictionless system with a method for supporting the headform and helmet, which does not affect the measurement of acceleration at the centre of gravity of the headform (Figure 9).

13.3.5 Velocity Measurement

Equipment capable of measuring the velocity of the helmet within 60mm of the top of the test anvil with an accuracy of $\pm 0.1 ms^{-1}$ shall be used.

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[6] The headforms used by the current PSDB test facility conform to BS EN 960:1994

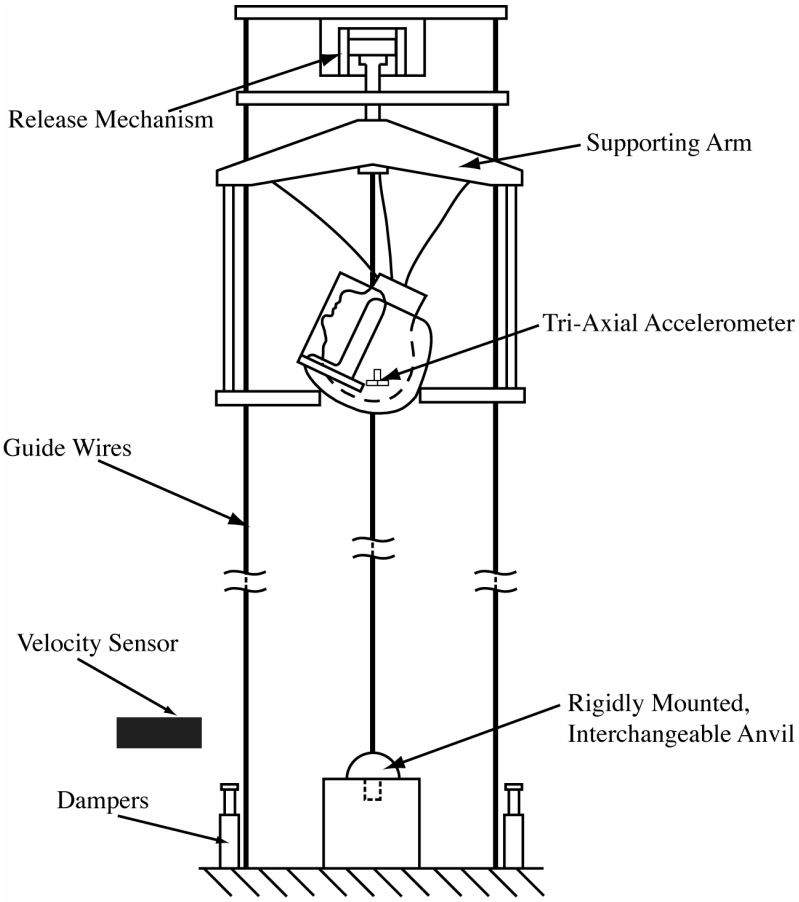


FIGURE 9 *Drop System*

13.4 Testing

13.4.1 Pre-test

Check the measuring system before commencing testing by impacting a suitable test piece with the headform, dropped from an established height known to produce a resultant acceleration of 250‘g’. This shall be repeated three times, checking that the results lie within the range of 250 ± 12 ‘g’.

Prior to testing calculate the total mass of the test sample and the appropriate size headform, and from this total mass calculate the required drop heights and velocities for the energies (Table 8).

Before any helmet is tested it shall be conditioned as described in Section 5. The helmet shall have the first impact performed within 3 minutes of removal from the final conditioning chamber. The remainder of the impacts shall be completed within 40 minutes of removal of the helmet from the chamber.

The helmets shall be tested in accordance with Table 8.

Helmet No.	Condition	Anvil	Impact Site	Energy		Limit
				Upper	Lower	

1	Hot	FPE2/001	Front, Crown, Front Left, Rear Right	120J	60J	250'g'
2	Cold		Crown, Front Right, Rear Left, Front			
3	Hot		Front Right, Front Left, Rear Right, Rear Left			
4	Cold		Front Left, Rear Right, Front, Crown	60J	30J	150'g'
5	Cold	FPE2/002	Rear Right, Front, Crown, Front Left	120J	60J	250'g'
6	Hot		Rear Left, Front, Crown, Front Right,			
7	Cold		Rear Right, Rear Left, Front Right, Front Left			
8	Hot		Front, Crown, Front Right, Rear Left	60J	30J	150'g'

TABLE 8 *Sequence and Criteria for Impact Attenuation Test*

13.4.2 Impact Site Definitions

- **Front**: the frontal area, on the vertical mid-sagital plane, within 50mm above the horizontal H1 plane (Table 7, Figure 2);
- **Crown**: the rear area, relative to the crown of the head, along the mid-sagital plane;
- **Front Left/Right**: the frontal area of the helmet body, situated from the mid-coronal plane forwards to the H1 plane, on either the left or right side of the mid-sagital plane;
- **Rear Left/Right**: the rear area of the helmet body, situated from the mid-coronal plane, rearwards to the H1 plane, on either the left or right side of the mid-sagital plane.

13.4.3 Test Procedure

1. Remove the helmet from the conditioning chamber and mount on the appropriate size test headform and securely fasten as described in the manufacturer's instructions.
2. Position the helmet on the test rig such that the area to be tested is directly in line with the test anvil.
3. Deliver two impacts on the same impact site at the upper and lower energy specified in Table 8 and record the calculated resultant acceleration from the tri-axial accelerometer and the velocity of impact. The helmet can be realigned with the anvil between impacts.
4. Repeat steps 2 and 3 for the remaining 3 impact sites, as specified in Table 8.
5. Repeat steps 1 to 4 for all remaining helmets and energy levels, as specified in Table 8.

13.5 Results

The test sample has passed the impact attenuation test if the recorded acceleration for each impact is less than the limit specified in Table 8.

14 VISION TEST (Prismatic)

14.1 Purpose

This test is performed to ensure the vision of the wearer is not distorted due to prismatic effects of the visor.

14.2 Apparatus

- Two red lasers;
- Laser target;
- Modified Headform.

14.3 Preparation of Test Equipment

14.3.1 Headform

Shall be of appropriate size with 1 ± 0.3mW, 650 ± 50nm lasers in the normal axis of the right and left eyes (Figure 10).

14.3.2 Helmet Preparation

The same helmet and set of visors that are tested in Section 15 shall be used. The helmet/visor shall be mounted on the headform as described in the manufacturer's instructions. Where possible the helmet shall be secured to the headform to limit movement during the test.

14.3.3 Target

Placed at a distance d from the headform (Figure 11), of an appropriate size with graph paper of square size of $1mm^2$. The lines of the paper must be oriented horizontally and vertically and this labelled as such on the paper.

14.3.4 Lasers

The lasers shall be focused on the target to each give a dot size of 1 ± 0.3mm diameter.

Other suitable methods for determination of prismatic effect may be used by obtaining prior approval from PSDB.

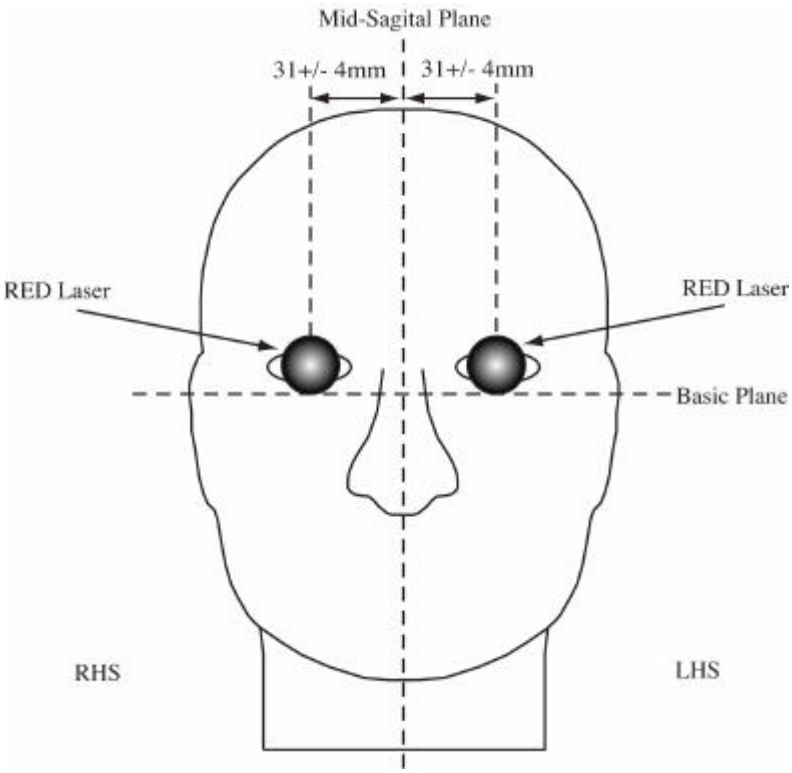


FIGURE 10 *Example Headform with Laser*

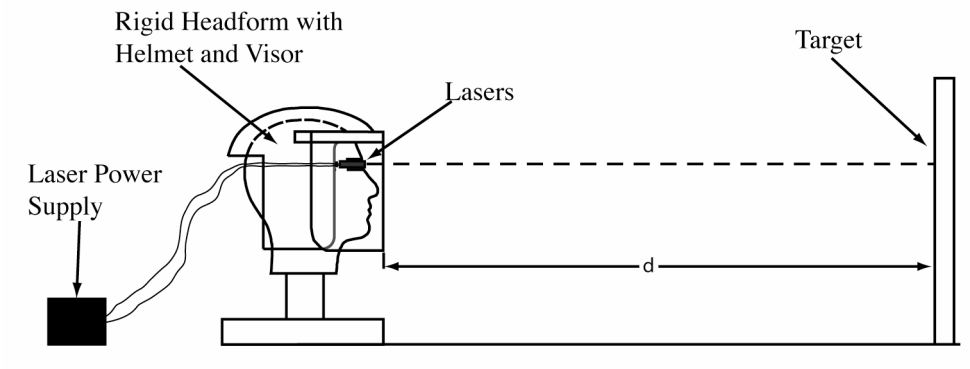


FIGURE 11 *Example Orientation of Headform and Target*

14.4 Test procedure

1. With the visor fully open mark the location of the laser dots for the left and right eye on the target.
2. Lower the visor to its fully closed position.
3. Mark the position of the laser dots for the left and right eyes on the target, noting if the beams have crossed.
4. Measure the X and Y difference for both the left and right eye and record the results (X_R, Y_R, X_L, Y_L).
5. Calculate the resultant prismatic effect and record.

Right Eye:

$$X\_plane = \frac{X_R}{d} \qquad Y\_plane = \frac{Y_R}{d}$$

Left Eye:

$$X\_plane = \frac{X_L}{d} \qquad Y\_plane = \frac{Y_L}{d}$$

6. Repeat steps 1 to 5 for the three visors.
7. Calculate the mean prismatic effect for the left and right eyes and record.

14.5 Results

The test sample has passed if both eyes conform to the following:

- Mean Prismatic Effect X_plane ≤ 5mm/m.
- Mean Prismatic Effect Y_plane ≤ 5mm/m.

15 VISION TEST (Spherical and Astigmatic Aberration)

15.1 Purpose

This test is performed to ensure the vision of the wearer is not distorted due to spherical and astigmatic aberration introduced by the visor.

15.2 Apparatus

- Telescope;
- Test pattern;
- Modified Headform.

15.3 Preparation of Test Equipment

15.3.1 Telescope

The telescope shall have a magnification between x7.5 to x20 with an aperture of 20 ± 3mm and a focusing adjustment so a minimum measure of focus of $0.01m^{-1}$ can be resolved. The telescope shall incorporate an adjustable eyepiece with a reticule.

15.3.2 Test pattern

A suitable test pattern with black background with clear horizontal and vertical lines shall be mounted 4500 ± 300mm from the telescope. The test pattern shall be back illuminated with a quasi-monochromatic light source of variable intensity and be able to rotate around its central axis as required. An example test pattern is shown in Figure 12. Other test patterns may be used with prior approval from PSDB.

15.3.3 Headform

The headform shall be of an appropriate size that allows the tester to position the telescope in the same axis as the test pattern at the plane level with the eyes.

15.3.4 Helmet Preparation

A section from the rear of the helmet shall be removed to enable a clear path through the telescope to the test pattern when the helmet is mounted on the headform. The helmet/visor shall be mounted on the headform so it is positioned as described in the manufacturer's instructions. Where possible the helmet shall be secured to the headform to limit movement during the test.

15.3.5 Visor Preparation

Three visors shall be selected at random from the helmets supplied. All packaging shall be removed from the visors and a visual inspection carried out for flaws. The visors shall be mounted to the helmet as described in the manufacturer's instructions.

The visors and modified helmet used in this test shall be used for the testing of prismatic effect as described in Section 14.

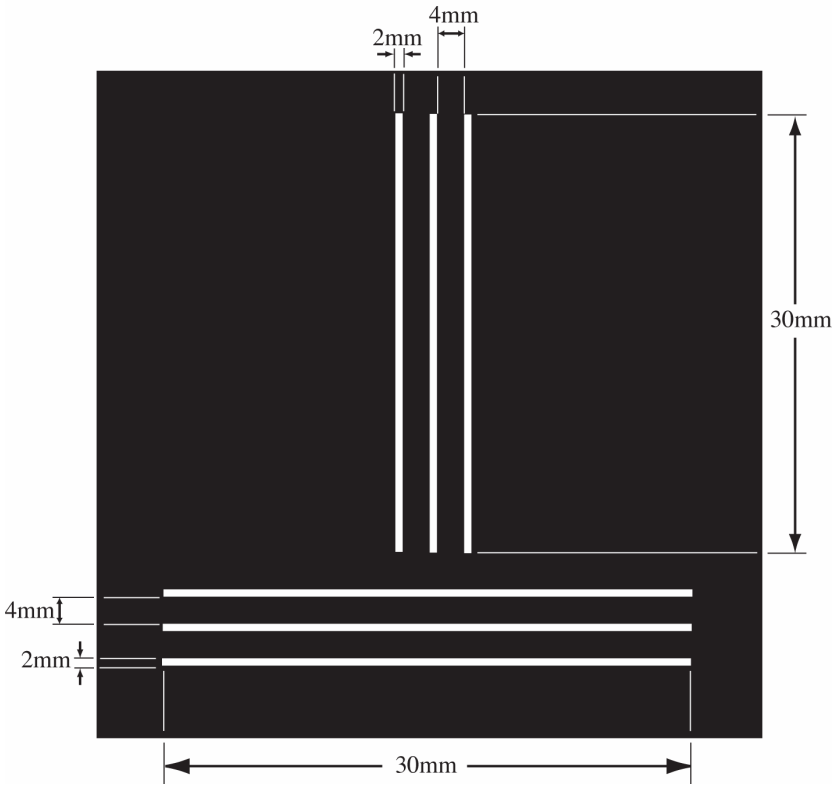


FIGURE 12 *Example Test Pattern*

15.4 Test procedure

1. With the visor in its upper most position, focus the telescope to achieve the clearest image possible. This is the zero focusing point of the telescope and all measurements are referenced from this point.
2. Position the telescope in line with the normal axis of the right eye (Figure 10).
3. Lower the visor to its fully down position and rotate the test pattern to align the horizontal and vertical lines of the test pattern with the reticular.
4. Focus the telescope on the horizontal bars of the test pattern and record the focusing point (D_{HR}).
5. Focus the telescope on the vertical bars of the test pattern and record the focusing point (D_{VR}).
6. Position the telescope in line with the normal axis of the left eye (Figure 10).
7. With the visor to its fully down position rotate the test pattern to align the horizontal and vertical lines of the test pattern with the reticular.
8. Focus the telescope on the horizontal bars of the test pattern and record the focusing point (D_{HL}).
9. Focus the telescope on the vertical bars of the test pattern and record the focusing point (D_{VL}).
10. Calculate the spherical and astigmatic aberration for each eye and record the results.

Spherical Aberration (D, [m^{-1}])

$$Right\_Eye = \frac{D_{HR} + D_{VR}}{2} \qquad Left\_Eye = \frac{D_{HL} + D_{VL}}{2}$$

Astigmatic Aberration (D, [m^{-1}])

$$Right\_Eye = \left|D_{HR} - D_{VR}\right| \qquad Left\_Eye = \left|D_{HL} - D_{VL}\right|$$

11. Repeat steps 1 to 10 for two additional visors.
12. Calculate the mean spherical and astigmatic aberration for each eye from the results obtained.

15.5 Results

The visor is deem to have passed if the mean results are:

- Spherical Aberration $\leq \pm 0.12$ m^{-1} for each eye.
- Astigmatic Aberration $\leq \pm 0.12$ m^{-1} for each eye.

16 VISOR MIST TEST (OPTIONAL)

16.1 Purpose

This test is performed to assess the anti mist properties of a visor. This test is only applicable to visors that are offered with anti-mist properties.

16.2 Apparatus

- Framework to support test equipment;
- 1.5mW laser with 20X beam expander;
- Laser power detector e.g. Lasermet Ltd, Model 8101 (calibrated at 670nm);
- Test headform (with modifications);
- Water-bath;
- 12V, 0.6W fan with volumetric flow rate of 8.3m^3/h;
- Thermocouple.

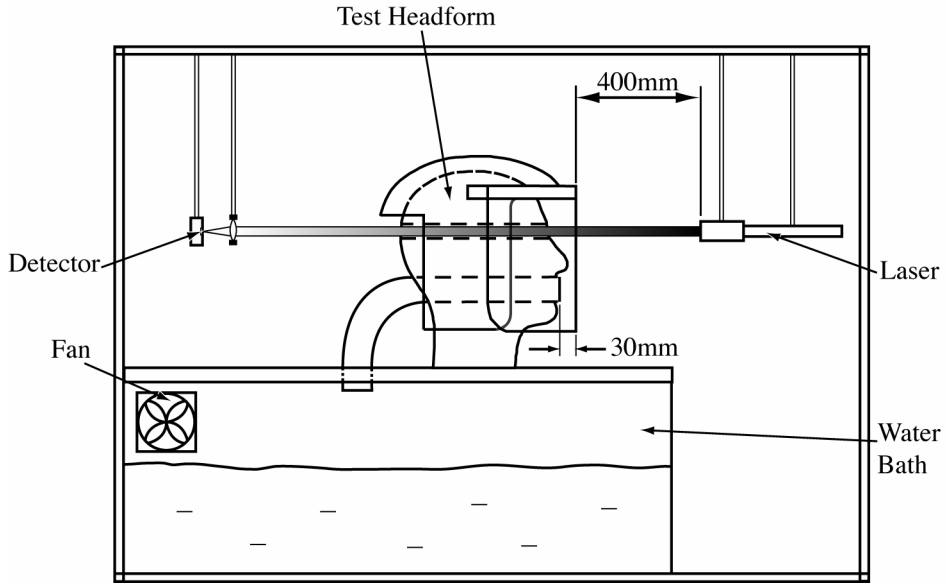


FIGURE 13 *Visor Mist Test*

16.3 Preparation of Test Equipment

16.3.1 Laser and Expander

These shall be positioned 400mm from the surface of the visor to be tested. The output beam from the expander shall be of a collimated, circular nature with a diameter of 14 ± 2mm at the surface of the visor being tested.

16.3.2 Detector

Shall be aligned in the same horizontal plane as the laser and expander with a plano-convex lens, of diameter 50mm and focal length 50mm, placed in the same horizontal plane, as shown in Figure 13. The lens shall be at a distance that focuses the whole diameter of the laser beam into the window of the detector. The detector shall be switched on for a minimum of 5 minutes prior to testing and then zeroed, with the laser off, to account for ambient light.

16.3.3 Headform

The headform should be of an appropriate design to fit the helmet being tested and of a material that does not effect the test procedure. It shall be modified with a 22mm diameter hole through the normal horizontal axis of the eye, and a 40mm diameter hole shall be made through the normal horizontal axis of the mouth. Each of these holes shall be lined with a suitable material, e.g. a polypropelene tube. It shall then be placed in position and aligned so that the laser beam passes directly through the eyehole.

16.3.4 Waterbath

The waterbath shall be filled to 66% of its volume with water, switched on and allowed to heat to a stable temperature. The temperature of the water in the bath shall be adjusted to give an output temperature, at the mouth of the headform, of $37 \pm 0.5^{o}C$, measured with the fan turned on and the airflow valve open.

16.3.5 Airflow Valve

The valve shall be able to control the flow of air to the mouth of the headform.

16.3.6 Helmet Preparation.

A Section from the rear of the helmet shall be removed to enable a clear path between the laser and detector when the helmet is mounted on the test headform. The helmet/visor shall be mounted on the test headform so it is positioned as described in the manufacturer's instructions and securely fastened with the visor down. The alignment of the system shall once again be checked to ensure there is no obstruction from the laser to the detector.

16.4 Test Procedure

1. Start the fan and allow to run for 5 minutes.
2. Make sure the visor is in its fully closed position.
3. Zero the laser power detector.
4. Switch laser on and after 1 minute record the laser power reading.
5. Open the airflow valve and start the timer.
6. After 45 seconds close the valve, record the laser power reading and temperature at the mouth.

16.5 Results

$$\text{Change in Laser Power (\%)} = \left| \frac{\text{Initial Power reading - Final Power reading}}{\text{Initial Power reading}} \right| \times 100$$

The test sample has passed if the change in recorded laser power is less than 20%.

17 VISOR IMPACT TEST

17.1 Purpose

This test is performed to ensure that a known impact to the visor will not cause a deformation which may contact the wearers face.

17.2 Apparatus

- Free fall drop system with velocity sensors;
- Impactor with hemispherical steel impactor of radius 25mm and mass of 1kg;
- Rigidly mounted headform with metal nose;
- Device for measuring contact time, e.g. oscilloscope or timer module.

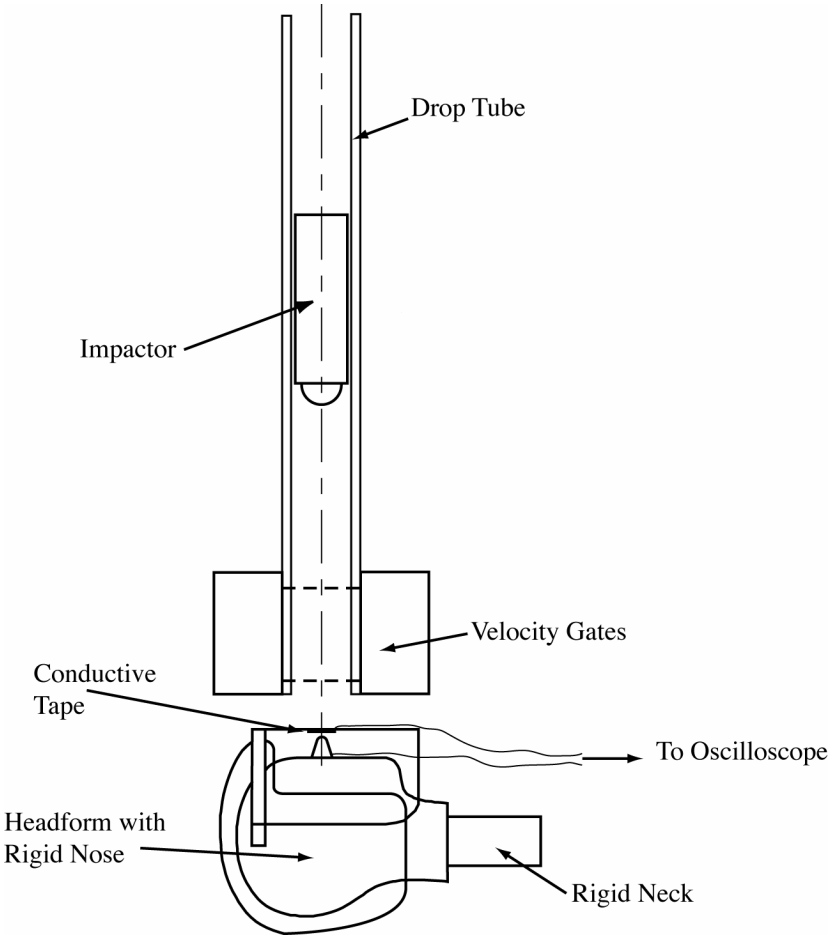


***FIGURE 14** Visor Impact Test*

17.3 Preparation of Test Equipment

17.3.1 Metal Test Nose

The test nose shall be manufactured from a suitable conductive material that will withstand an impact of 50J without deformation. It shall be of conical design and of a suitable size to give a measurement from the Mid Coronal Plane to the tip of the test

nose of 119 ± 3mm. The test nose shall be mounted 20 ± 2mm below the basic plane of the head along the mid sagital plane.

17.3.2 Headform

The headform[7] of appropriate size, shall be securely mounted to a block with a minimum mass of 250kg and with the metal test nose orientated upwards in line with the central axis of the impactor (Figure 14).

17.3.3 Visor Preparation

The visor shall be mounted on a helmet body of appropriate size for the test headform and secured as described in the manufacturer's instructions. A suitable length of 25 ± 5mm wide and 1 ± 0.5mm thick copper conductive tape shall be attached to the inside face of the visor in line with the central axis of the impactor.

17.3.4 Helmet Mounting

Mount the test sample on the headform and securely fasten as described in the manufacturer's instructions. Additional support may be provided to the underside of the helmet to ensure the helmet cannot move during the test.

17.3.5 Velocity Measurement

Equipment capable of measuring the velocity of the impactor within 60mm of the surface of the visor with an accuracy of $\pm 0.1 ms^{-1}$ shall be used..

17.3.6 Impact Time Measurement

The measuring device circuit shall be connected to the copper strip and the metal nose. The measurement device shall be able to record contact times of 0.1ms and above

17.4 Test Procedure

1. The visor shall be preconditioned prior to testing (Table 6).
2. Align the helmet and headform such that the impactor is in the same vertical axis as the rigid nose.
3. Raise the impactor in the drop system, to a height of 1m from the surface of the visor to the bottom of the impactor.
4. Release the impactor allowing it to free-fall.
5. Record the duration of any contact between the visor and test nose and the velocity of the impactor.

17.5 Results

The test sample has passed if the recorded contact time between the visor and test nose is ≤1ms in duration

[7] The headforms used by the current PSDB test facility conform to BS EN 960:1994

18 VISOR PELLET TEST

18.1 Purpose

This test is performed to ensure the visor can withstand an impact from a low mass, high velocity projectile.

18.2 Apparatus

- Propulsion system: air, gas or spring powered;
- Loading mechanism along with a barrel of sufficient length to ensure a constant velocity of the projectile at exit;
- 6mm diameter ball bearings;
- Safety enclosure around headform;
- Velocity measuring system;
- Rigidly mounted headform.

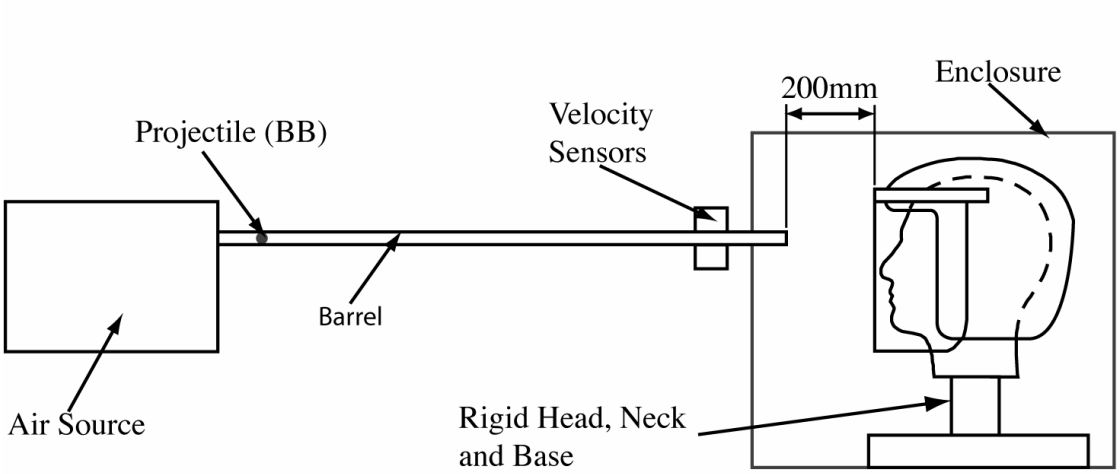


FIGURE 15 *Visor Pellet Test*

18.3 Preparation of Test Equipment

18.3.1 Propulsion System

The system shall be capable of projecting a steel ball bearing at a speed of $200 \pm 10 ms^{-1}$. The end of the barrel shall protrude into a safety enclosure to ensure any shots that ricochet off the visor are stopped (Figure 15).

18.3.2 Headform

The headform shall be mounted within a safety enclosure and be adjustable to enable alignment of the propulsion system barrel with the target areas of the visor.

18.3.3 Velocity Measurement

Equipment capable of measuring the velocity of a projectile within 60mm of the barrel end with an accuracy of $\pm 2 ms^{-1}$ shall be used.

18.3.4 Helmet

The test sample shall be mounted on the test headform so it is positioned and securely fastened as described in the manufacturer's instructions, with the visor in its fully down position, 200mm from the end of the barrel.

18.4 Test Procedure

1. The visor shall be preconditioned prior to testing (Table 6).
2. Align the test helmet and headform with the barrel to impact the left eye position.
3. Project one 6mm steel ball bearing, at a speed of $200 \pm 10 ms^{-1}$.
4. Record the velocity of the projectile.
5. Align the test helmet and headform with the barrel to impact the right eye position.
6. Repeat steps 2 & 3 for the new position.
7. Remove the test specimen from the enclosure and examine the visor.

18.5 Results and Assessment

The test sample has failed if either of the following is visible:

- Visor fracture - the visor shows signs of particle detachment or cracks >50mm;
- Visor penetration – a hole through the visor.

19 VISOR SOLVENT TEST

19.1 Purpose

This test is performed to ensure that a visor has a resistance to a specified solvent.

19.2 Apparatus

- Standard laboratory apparatus comprising stand, bosshead and clamp;
- Glass dispenser with a minimum capacity of 10ml, with glass stopcock valve;
- Drip tray;
- Rigidly mounted headform.

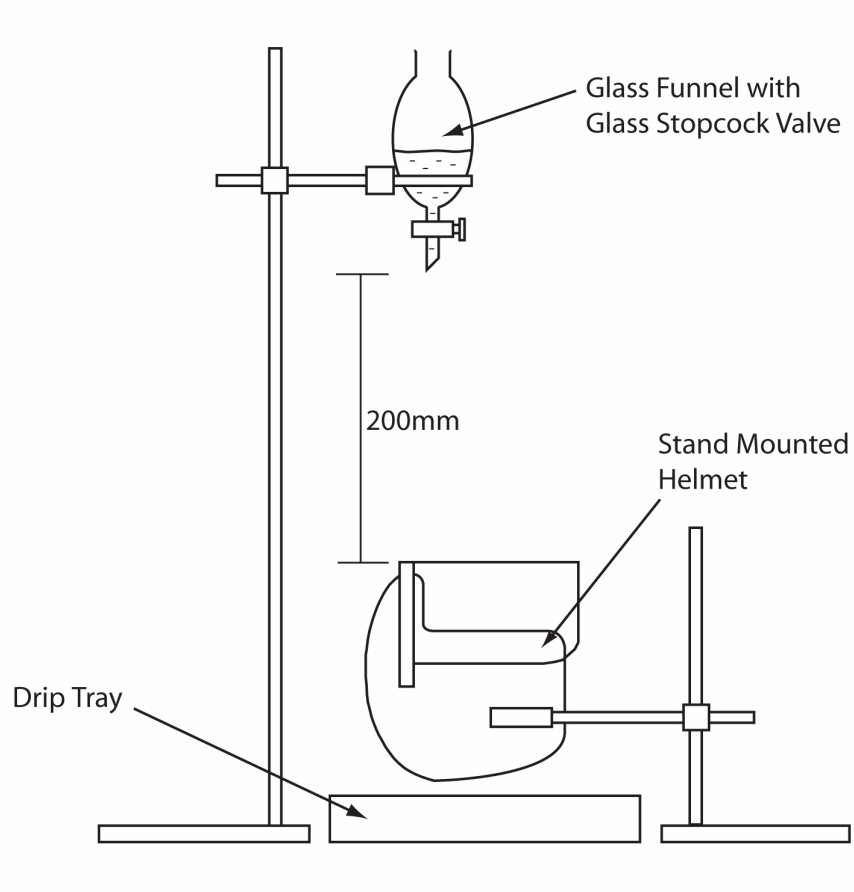


FIGURE 16 *Visor Solvent Test*

19.3 Preparation of Test Equipment

19.3.1 Headform

The headform shall be manufactured from a suitable material that does not adversely react to the solvent, or placed within a protective replaceable bag. The headform shall be rigidly mounted horizontally, face upwards (Figure 16).

19.3.2 Helmet Mounting

The helmet shall be mounted onto the test headform so it is positioned and securely fastened as described in the manufacturer's instructions with the visor in its fully down position.

19.3.3 Drip Tray

The drip tray shall be placed underneath the helmeted headform to catch any excess solvent.

19.3.4 Dispenser

The dispenser shall have a flow rate of 5 ±0.5mlsec^{-1} with a valve to enable the solvent to be released rapidly.

19.3.5 Solvent

5ml of Methyl IsoButyl Ketone (MIBK).

19.4 Test Procedure

1. Align the nozzle of the dispenser 200mm above the normal axis of either the left or right eye.
2. With the valve of the dispenser closed, add 5ml of MIBK into the dispenser.
3. Open the valve fully to release liquid.
4. Wait 30 seconds and record any damage to the visor.
5. Lift the helmet by the visor and check for cracking of the visor.

19.5 Results and Assessment

The test sample has passed if the visor remains intact and secured to the helmet body. Any minor visual impairment to the surface of the visor, which does not affect the structural characteristic of the visor and mountings, is acceptable. Significant visual impairment of the visor is not acceptable.

In the event of a borderline result, the tested visor and test report shall be sent to PSDB for arbitration.

20 ACKNOWLEDGEMENTS

Grateful thanks are given to the following people in helping produce this standard:

ACPO Working Group on Public Order;

ACPO Tactics, Training and Equipment Practitioner Group;

Mr Philip Alexander-Pye, sandwich student from Brunel University;

Mr Duncan Barrier, sandwich student from Brunel University;

Mr Chris Georgiou, sandwich student from Brunel University;

Mr Andrew Nelson and Mr Michael Vine of INSPEC International Ltd, Manchester;

Mr Danny M'Caul, School of Acoustics and Electronic Engineering, The University of Salford;

APPENDIX A: DECLARATION OF CONSTRUCTION FORM

Declaration of Content and Construction of Helmet and Visor to: PSDB Protective Headwear Standard for UK Police (2004)

When completed this document will be classified "RESTRICTED COMMERCIAL"

Helmet Body Model…… (This number must also be displayed on the Helmet body)	
	Description of Materials (from outer shell to inner surface) Include manufacturers' references, trade names, Number of layers, thickness weave e.t.c. Also include any accessories supplied with the helmet.
Outer Shell | **Inner**	
Visor Model…… (This number must also be displayed on the visor)	
	Description of Materials. Include manufacturers' references, trade names, Making sure to include material, thickness and treatment.

(*Insert Company Name here)*..... hereby declare that all Public Order Helmets and/or Visors produced as Models ..... and ..... as a result of successful <u>Compliance Testing</u> to PSDB Standards will be of the same construction, using the same materials from the same manufacturer as the test sample/s listed above in accordance with General Requirements, Section 3 of PSDB Protective Headwear Standard for UK Police (2004) Publication No 21/04. In addition, if the Public Order Helmet and/or Visor is supplied to UK police, they will be submitted to batch testing in accordance with Section 4.5 of the standard.

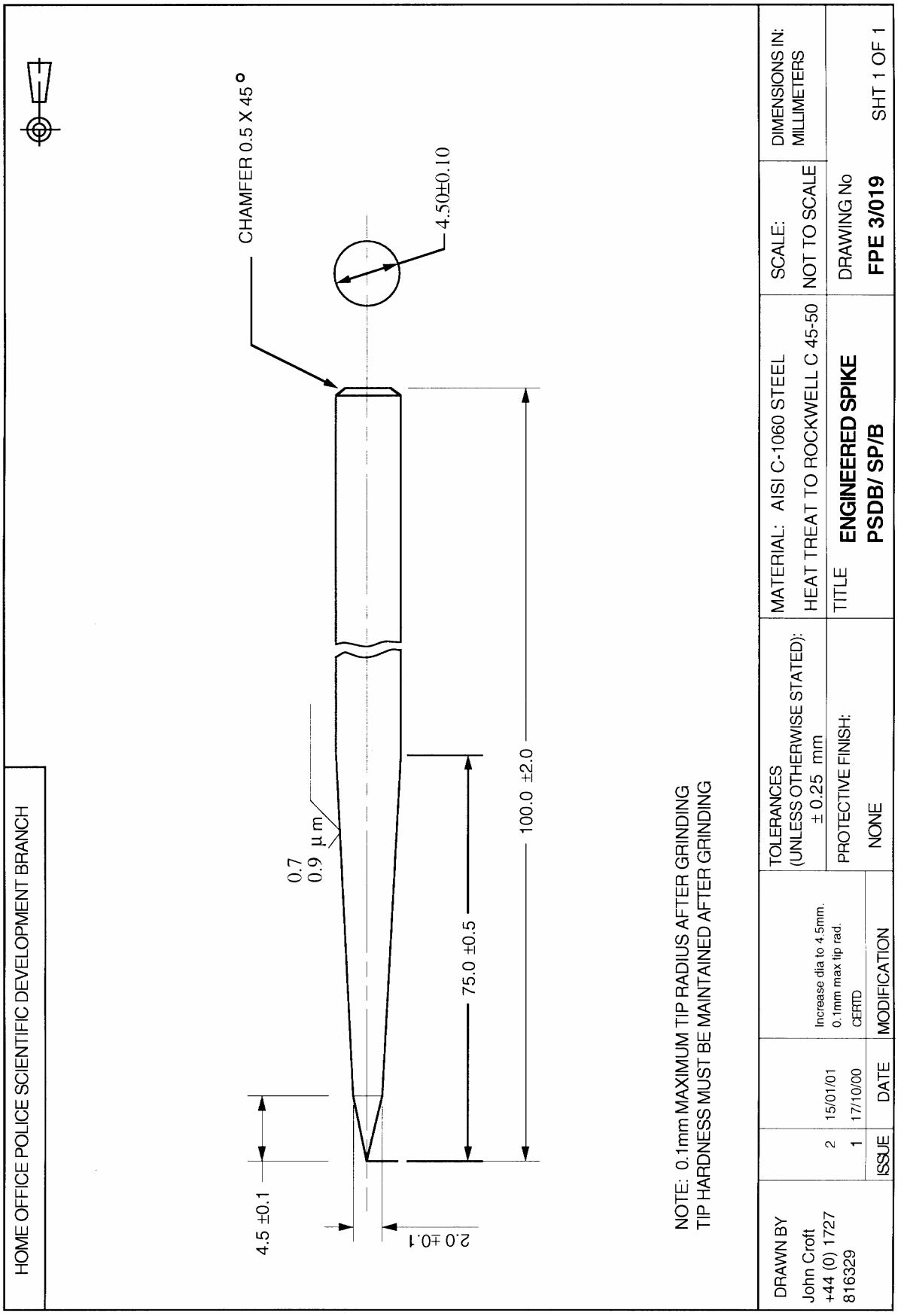
Signed..... Date.....

PSDB Use Only

Model Ref……..	Number……..	Test	House

APPENDIX B: PENETRATION

B1 PSDB/SP/B Test Spike



B2 Operation and Calibration of Mitutoyo ATK F1000 Hardness Tester

- Complete stages 1 - 4 on page 4 of the Mitutoyo Instruction Manual.
- *Do not* attach poise hanger and weight assembly (26). Instead, screw the special 10g threaded weight onto the end of the loading level (27).
- Set minor load selector ring (13) to 'S'.
- Place suitable calibrated laboratory scales with a flat surface (range 0 -10kg) on anvil (17) and set to zero.
- Insert special knife holder (without knife) into indenter (15).
- Press the mode button 5 times. You should now see *TEST MODE* flashing at the bottom of the display.
- Press 'SEL' once and check that the display reads 'SPER 100'.
- Raise the shaft (19) using handle (20) until the display reads '630', and the scales 3kg ± 50g. If the display does not give a reading between these tolerances, contact the supplier of the machine as the minor load is non user adjustable.
- Press the '▼' button to apply the major load, the display on the scales should now read 8kg ± 80g.
- *Note: The special 10g weight may give a higher than 8kg reading. If so, material should be removed from the weight until 8kg ± 80g is achieved.*
- Press the '▲' button.
- Lower table.
- When ready to begin testing, the spike to be evaluated must be wiped using a clean cotton cloth and a suitable degreasing agent. This is to ensure that all traces of lubricant are removed.
- The spike should be mounted in the special holder, and then slotted into position on the hardness tester.
- The sharpness can now be tested by applying the load of the spike tip to a small sample block of 99.997% pure aluminium.
- When put under load, the reading should be between -50 and -150 on the Mitutoyo scale. This scale can more usefully be expressed in terms of the indentation depth produced by the major load application.

B3 Conversion of HRC Values to Indentation Depths

HRC	Depth (mm)	HRC	Depth (mm)	HRC	Depth (mm)
-160	0.52	-130	0.46	-100	0.40
-150	0.50	-120	0.44	-90	0.38
-140	0.48	-110	0.42	-80	0.36

B4 Conversion Chart for Modified Rockwell Values to CATRA Force Values.

HRC Value	CATRA Value (N)	HRC Value	CATRA Value (N)	HRC Value	CATRA Value (N)	HRC Value	CATRA Value (N)
-100	3.47	-111	2.69	-122	1.92	-133	1.15
-101	3.40	-112	2.62	-123	1.85	-134	1.08
-102	3.33	-113	2.55	-124	1.78	-135	1.01
-103	3.26	-114	2.48	-125	1.71	-136	0.94
-104	3.19	-115	2.41	-126	1.64	-137	0.87
-105	3.12	-116	2.34	-127	1.57	-138	0.80
-106	3.05	-117	2.27	-128	1.50	-139	0.73
-107	2.98	-118	2.20	-129	1.43	-140	0.66
-108	2.90	-119	2.13	-130	1.36		
-109	2.84	-120	2.06	-131	1.29		
-110	2.76	-121	2.00	-132	1.22		

APPENDIX C: LIST OF MANUFACTURERS AND SUPPLIERS

PSDB Engineered Spike (PSDB/SP/B)

The PSDB engineered knife and spike were designed so that they could be manufactured by any competent engineering workshops to the drawings supplied with this standard. Two such companies are listed below for information, however, PSDB cannot guarantee quality of manufacture from any supply source.

High Speed and Carbide Ltd Clough Bank, Off Edmund Road Sheffield S2 4EL Tel: +44 (0) 1142 796197	Wardson Tools Ltd Centenary Works, Woodseats Road Sheffield S8 OPE Tel: +44 (0) 1142 552451

99.997% Pure Aluminium for Spike Sharpness Test

The aluminium is supplied as an ingot measuring 38mm x 38mm x 130mm (1.5in x 1.5in x 5in). For the test, a 38mm x 38mm x 5mm block should be cut from the ingot. Both faces of the block should then be machined (not ground) smooth.

The ingots can be purchased from:

Sigma Aldrich Chemical Company The Old Brickyard, New Road Gillingham Dorset SP8 4XT Tel: +44 (0) 1747 822211	Aldrich Chemical Company P.O. Box 355, Milwaukee Wisconsin 53201 USA Tel: 001 (414) 273-3850

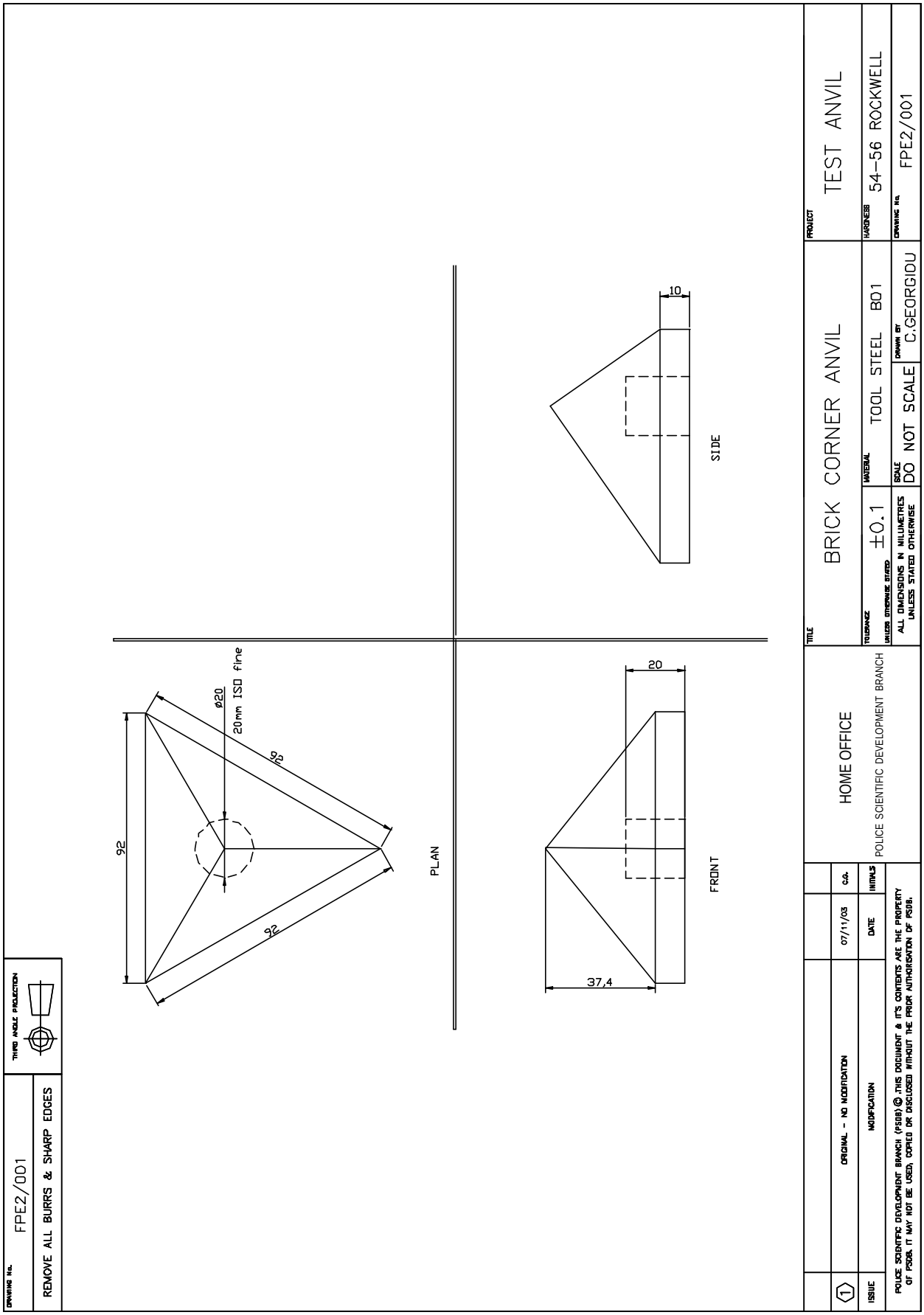
British Standards

For copyright reasons, British Standards referred to are not reproduced in this publication. They are available from:

British Standards 389 Chiswick High Road London W4 4AL Tel: +44 (0)20 8996 9000 http://www.bsi.org.uk

APPENDIX D: IMPACT ATTENUATION

D1 PSDB Engineered Test Anvil – FPE2/001



D2 PSDB Engineered Test Anvil – FPE2/002