BRITISH STANDARD

BS 7971-8:2003

Protective clothing and equipment for use in violent situations and in training —

Part 8: Blunt trauma torso, shoulder, abdomen and genital protectors — Requirements and test methods

ICS 13.340.10

BSI
British Standards

Committees responsible for this British Standard

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APSS — Association of Police and Public Security Suppliers

Association of Chief Police Officers in Scotland

BSIF Test and Certification Association

British Association for Chemical Specialities

British Association of Women Police

British Clothing Industry Association

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British Textile Technology Group

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Contents

Foreword

This part of BS 7971 has been prepared by Subcommittee PH/3/12.

The following parts of BS 7971 are currently published or in preparation:

— *Part 1: General requirements*;

— *Part 2: Guidance on risk assessment and on the selection, use, cleaning and maintenance of protective clothing and equipment*;

— *Part 3: Personal defence shields — Requirements and test methods*;

— *Part 4: Limb protectors — Requirements and test methods*;

— *Part 5: Footwear — Requirements and test methods*;

— *Part 6: Gloves for protection against mechanical, thermal and chemical hazards — Requirements and test methods*;

— *Part 7: Slash-resistant gloves — Requirements and test methods*;

— *Part 8: Blunt trauma torso, shoulder, abdomen and genital protectors — Requirements and test methods*;

— *Part 9: Training suits and equipment — Requirements and test methods*;

— *Part 10: Coveralls — Requirements and test methods*.

It has been assumed in the drafting of this standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

WARNING. This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 39 and a back cover.

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Introduction

Torso, shoulder, abdomen and genital protectors are items of protective clothing which are generally, but not exclusively, worn by serving police officers and prison officers whilst they are engaged in operational duties and in training. They are also used by civilians engaged in activities where the risks of attack and assault are similar e.g. private security personnel, bullion handlers, escorts and couriers.

These protectors are intended to reduce the severity of, or prevent, soft tissue injuries resulting from blunt trauma to the areas covered. Such blunt trauma can arise as the result of impact from airborne missiles (house bricks, assorted types of bottle, metal bars, pieces of timber, fragments of wood, broken glass and slates, etc.), or can be due to assault by individuals using weapons such as bars, baseball bats and pieces of timber, or caused by individuals kicking or making violent physical contact with the wearer's body

These protectors are not intended to provide ballistic protection or protection against blows from sharp or pointed instruments (e.g. axes, spikes and knives).

For certain user groups, including police and prison officers, the protectors constitute a second line of defence, with a personal defence shield providing a degree of primary protection (see BS 7971-3). Whilst shields do not always prevent impacts with the wearer's body by missiles or weapons, they can reduce the energy of impacts to levels at which protectors can have a significant effect in the reduction of soft tissue or skeletal injuries. At times, however, circumstances can dictate that the shield is dispensed with or placed in a position which leaves the user exposed to a direct impact or assault. In these circumstances, and in the event of an unanticipated assault from behind, a torso protector and shoulder protectors can provide a level of protection from injury which the user would otherwise not have.

Experience has shown that many areas of the body are at risk of impact in the attack scenarios described above. This standard specifies requirements and test methods for torso, shoulder, abdomen and genital protectors. However, other areas of the body can also be at risk of impact in these attack scenarios, so protective clothing and/or equipment to protect these areas is also necessary.

The test methods specified in this part of BS 7971 have been designed to measure the performance of torso, shoulder, abdomen and genital protectors with respect to the protection they can be expected to provide against the commonly-faced hazards listed above. The severity of these tests cannot compare directly with the conditions to which police officers, prison officers and other users can be exposed in real life situations, but experience has shown that protectors which pass such tests can significantly reduce the incidence and/or severity of injuries.

The requirements for torso protectors for equestrian use specified in this part of BS 7971 are more stringent than those specified for protectors for horse riders in BS EN 13158:2000.

1 Scope

This part of BS 7971 specifies performance requirements and test methods for blunt trauma torso, shoulder, abdomen and genital protectors for use by police and prison officers and others who might be exposed to attack and assault in the course of their duties, for use in operational situations and in training. It specifies requirements for torso protectors for pedestrian use and for torso protectors for equestrian use.

NOTE 1 Information and guidance on the use of these protectors is given in Annex A.

NOTE 2 Guidance on risk assessment and the selection, care and maintenance of protective clothing and equipment for use in violent situations and in training is given in BS 7971-2.

This standard is not applicable to protectors intended to provide protection against ballistic or penetrating trauma (e.g. stabbing).

NOTE 3 Such body armour is specified in Police Scientific Development Branch publications [1], [2] and [3].

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including amendments) applies.

BS 7971-1, *Protective clothing and equipment for use in violent situations and in training — Part 1: General requirements.*

BS 7971-4:2002, *Protective clothing and equipment for use in violent situations and in training — Part 4: Limb protectors — Requirements and test methods.*

3 Terms and definitions

For the purposes of this part of BS 7971 the terms and definitions given in BS 7971-1 and the following apply.

3.1
torso protector
sleeveless protector covering specific areas of the front and back of the torso

3.2
pedestrian torso protector
torso protector designed for use on foot

3.3
equestrian torso protector
torso protector designed for use on horse-back

NOTE Equestrian torso protectors are generally shorter at the front and longer at the back compared to pedestrian torso protectors.

3.4
shoulder protector
protector for addition to a torso protector covering the shoulder joint (the acromioclavicular joint and the glenohumeral joint) at the distal end of the collar bone, or for restraint to the body by a harness of straps or other system independent of a torso protector

NOTE Shoulder protectors can be permanently affixed to a torso protector or can be detachable.

3.5
abdomen protector
protector covering the front of the abdomen

3.6
genital protector
protector covering the genitalia

NOTE A genital protector can be permanently attached to an abdomen protector or can be completely independent.

4 Performance levels

Pedestrian and equestrian torso protectors and shoulder protectors shall be performance level 3 as specified in BS 7971-1.

Abdomen protectors and genital protectors shall be performance level 2 as specified in BS 7971-1.

5 Construction and performance requirements

5.1 General

Pedestrian torso protectors, equestrian torso protectors, shoulder protectors, abdomen protectors and genital protectors shall conform to the general requirements for protective clothing and equipment for use in violent situations and in training specified in BS 7971-1, as applicable.

5.2 Sizing of protectors, and dimensions of zones of protection and test areas

5.2.1 *General*

5.2.1.1 All protectors shall be marked with a size designation. The size shall be related to the body dimensions of the intended user, using the relevant control body dimensions, as specified in **5.2.2**, **5.2.3**, **5.2.4** or **5.2.5**, as applicable, and the relationship shall be explained in the information supplied by the manufacturer as specified in BS 7971-1. Sizing shall be verified in accordance with **6.3**, **6.4**, **6.5** or **6.6**, as applicable. For protectors that are stated to fit a range of differently sized people, the values of the control body dimensions of the largest size of user that the protector is stated to fit shall be used for sizing.

5.2.1.2 All protectors shall have a zone of protection which shall have the dimensions required for the largest size of user for whom the protector is designated by the manufacturer. The dimensions of the zone of protection shall be determined in accordance with **6.3**, **6.4**, **6.5** or **6.6**, as applicable, and shall conform to **5.2.2**, **5.2.3**, **5.2.4** or **5.2.5**, as applicable. The positions and dimensions of the zones of protection, relative to the coverage provided by the entire protector, shall be stated in the information supplied by the manufacturer as specified in BS 7971-1.

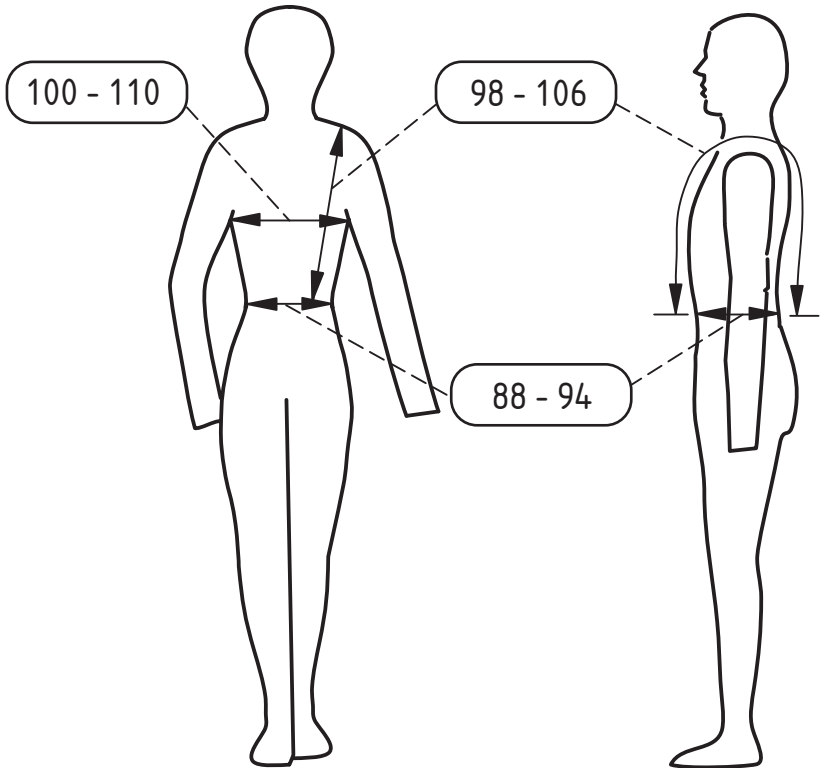
5.2.1.3 Unless otherwise specified for a particular protector or a particular test, test areas shall have the same dimensions as the zone of protection.

5.2.2 *Torso protectors*

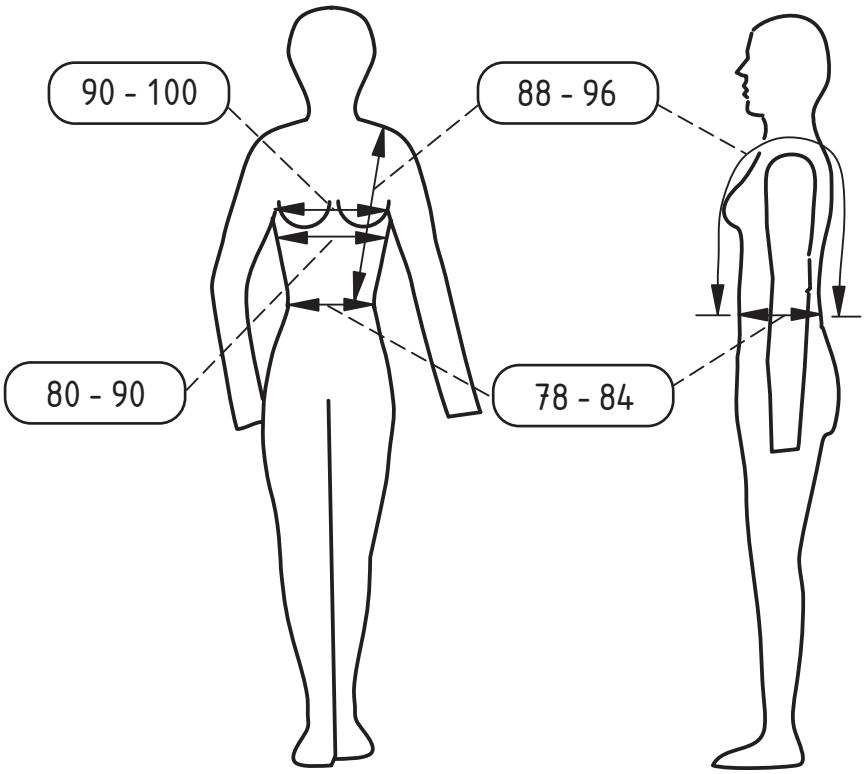
5.2.2.1 *Sizing of pedestrian torso protectors and equestrian torso protectors*

Torso protectors for men shall be sized using chest girth, waist girth and waist-to-waist over shoulder length as control dimensions. Torso protectors for women shall be sized using bust girth, under bust girth, waist girth and waist-to-waist over shoulder length as control dimensions. Sizing shall be verified in accordance with **6.3.1**.

For each protector, the size range of the intended users shall be indicated on a pair of sizing pictograms as shown in Figure 1. The sizing pictograms shall be printed on a label attached to the protector or given in the information supplied by the manufacturer (see Clause **7**).



a) Pictograms for protectors for men



b) Pictograms for protectors for women

Figure 1 — Sizing pictograms for pedestrian and equestrian torso protectors, including examples of size ranges

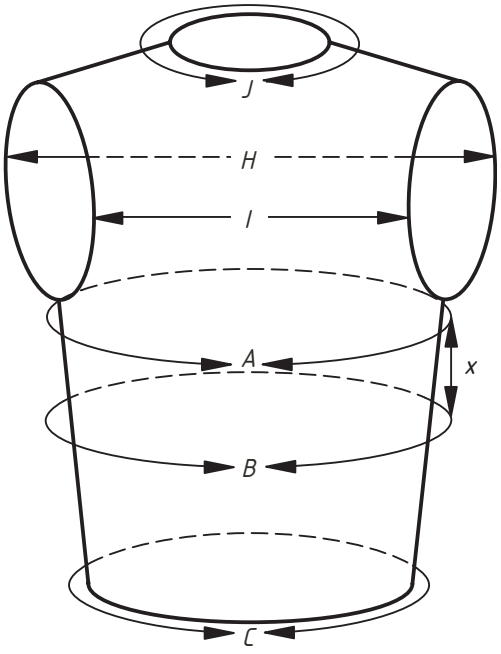
5.2.2.2 *Dimensions of the zone of protection of pedestrian torso protectors*

The dimensions of the zone of protection of pedestrian torso protectors measured on the inside of the protector shall be as given in Table 1 and illustrated in Figure 2.

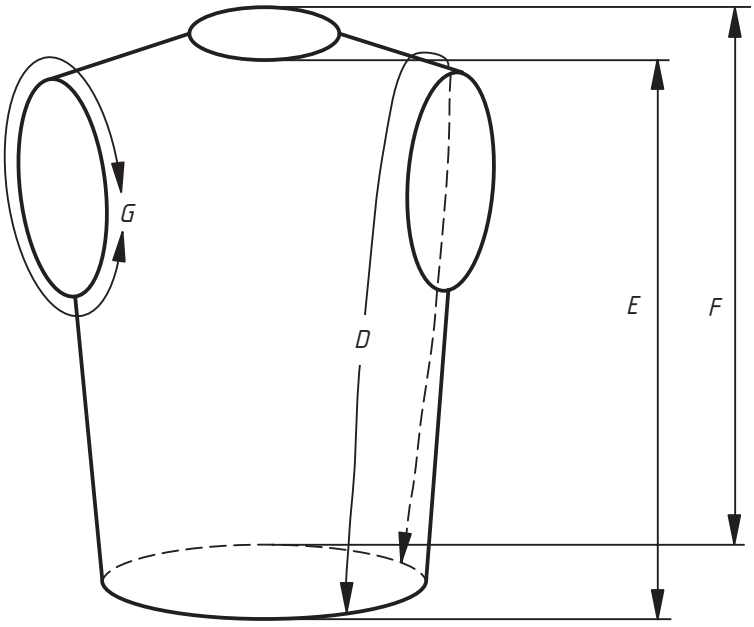
Table 1 — Dimensions of zone of protection of pedestrian torso protectors

Dimension of zone of protection		Letter identifying dimension in Figure 2	Control dimension	Dimension of zone of protection as a percentage of control dimension
Protectors for men	Protectors for women			
Girth around chest of protector	Girth around bust of protector	*A*	Chest girth or bust girth	105 to 110
—	Under bust girth of protector	*B*	Under bust girth	105 to 110
Girth around waist of protector	Girth around waist of protector	*C*	Waist girth	105 to 110
Front lower edge to back lower edge over shoulder distance[a]	Front lower edge to back lower edge over shoulder distance[a]	*D*	Waist-to-waist over shoulder length	>105
Centre front length	Centre front length	*E*	Waist-to-waist over shoulder length	>38
Centre back length	Centre back length	*F*	Waist-to-waist over shoulder length	>50
Armhole circumference	Armhole circumference	*G*	Chest girth or under bust girth	<72
Minimum width between armholes across the back[b]	Minimum width between armholes across the back[b]	*H*	Chest girth or under bust girth	>28
Minimum width between armholes across the front[b]	Minimum width between armholes across the front[b]	*I*	Chest girth or bust girth	>22
Neck opening circumference	Neck opening circumference	*J*	Chest girth or under bust girth	<65

[a] Measured in same way as waist-to-waist over shoulder length.
[b] Measured at a level halfway down the armhole opening.



a) Horizontal dimensions



b) Vertical dimensions

Key

x 15 % of waist-to-waist over shoulder length

Figure 2 — Pedestrian torso protectors zone of protection

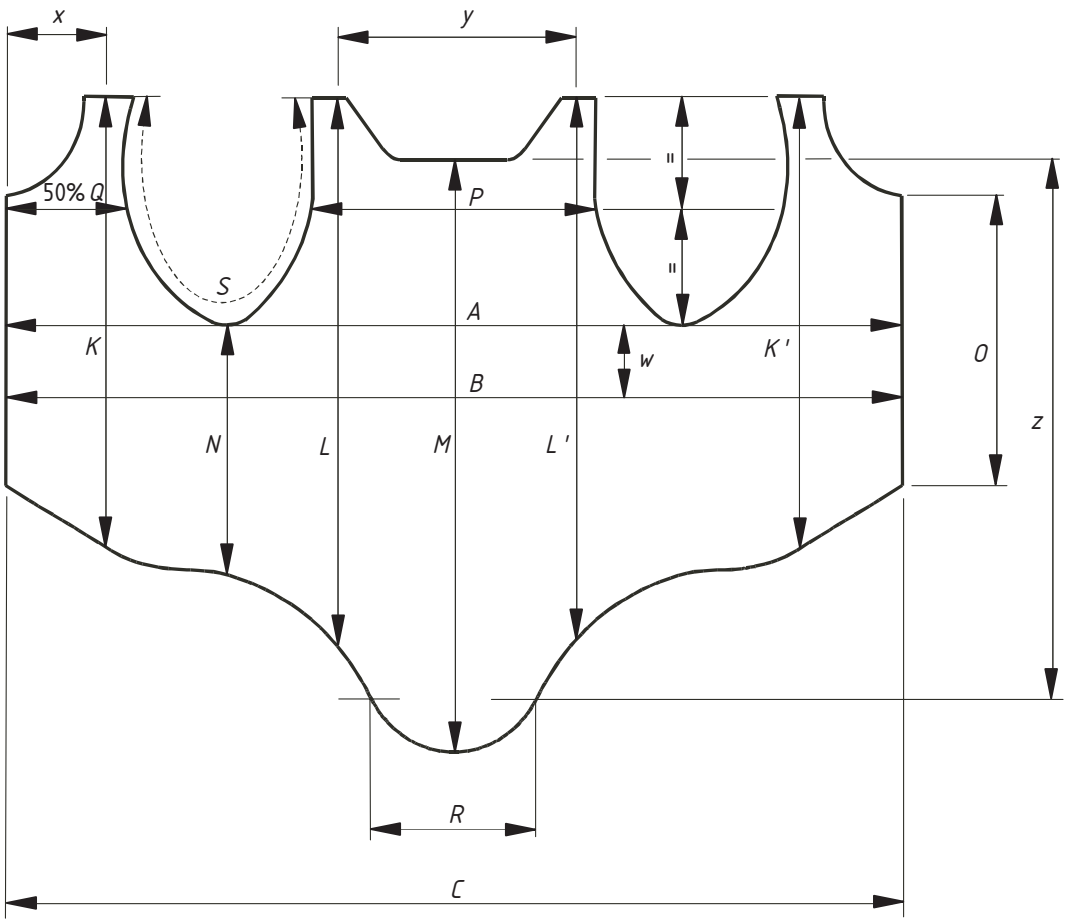
5.2.2.3 *Dimensions of the zone of protection of equestrian torso protectors*

The dimensions of the zone of protection of equestrian torso protectors shall be as given in Table 2 and illustrated in Figure 3. Dimensions *A* to *C* shall be measured on the inside of the protector and dimensions *K* to *R* shall be measured on the outside of the protector.

Table 2 — Dimensions of zone of protection of equestrian torso protectors

Dimension of zone of protection		Letter identifying dimension in Figure 3	Control dimension	Dimension of zone of protection as a percentage of control dimension
Protectors for men	Protectors for women			
Girth around chest of protector	Girth around bust of protector	*A*	Chest girth or bust girth	105 to 110
—	Under bust girth of protector	*B*	Under bust girth	105 to 110
Girth around waist of protector	Girth around waist of protector	*C*	Waist girth	105 to 110
Distance from top of shoulder to lower edge of protector at the front[a]	Distance from top of shoulder to lower edge of protector at the front[a]	*K* and *K′*	Waist-to-waist over shoulder length	>47
Distance from top of shoulder to lower edge of protector at the back[b]	Distance from top of shoulder to lower edge of protector at the back[b]	*L* and *L′*	Waist-to-waist over shoulder length	>63
Centre back length	Centre back length	*M*	Waist-to-waist over shoulder length	>57
Distance from bottom of armhole to lower edge of protector	Distance from bottom of armhole to lower edge of protector	*N*	Waist-to-waist over shoulder length	>17
Centre front length	Centre front length	*O*	Waist-to-waist over shoulder length	>33
Minimum width between armholes across the back[c]	Minimum width between armholes across the back[c]	*P*	Chest girth or under bust girth	>30
Minimum width between armholes across the front[c]	Minimum width between armholes across the front[c]	*Q*	Chest girth or bust girth	>23
Width of the back at a distance from the lower edge of the neck opening equal to 50 % of the waist-to-waist over the shoulder length	Width of the back at a distance from the lower edge of the neck opening equal to 50 % of the waist-to-waist over the shoulder length	*R*	Chest girth or under bust girth	>25
Armhole circumference	Armhole circumference	*S*	Chest girth or under bust girth	<72

[a] Measured at a distance from the centre of the chest equal to 12.5 % of the chest girth or bust girth (i.e. distance *KK′* in Figure 3 is 25 % of the chest girth or bust girth.)
[b] Measured at a distance from the centre of the back equal to 12.5 % of the chest girth or bust girth (i.e. distance *LL′* in Figure 3 is 25 % of the chest girth or bust girth.)
[c] Measured at a level halfway down the armhole opening.



Key

w 15 % of waist-to-waist over shoulder length
x 12.5 % of chest girth or bust girth
y 25 % of chest girth or bust girth
z 50 % of waist-to-waist over shoulder length

Figure 3 — Equestrian torso protectors zone of protection

5.2.3 *Shoulder protectors*

The sizing and the dimensions of the zone of protection of shoulder protectors shall be as specified in BS 7971-4.

5.2.4 *Abdomen protectors*

5.2.4.1 *Sizing*

Abdomen protectors shall be sized using waist girth and total crotch length as control dimensions.

5.2.4.2 *Minimum dimensions of the zone of protection*

The minimum dimensions of the zone of protection of abdomen protectors shall be as given in Table 3 and illustrated in Figure 4.

NOTE For an abdomen protector with an attached hard genital protector the minimum dimensions of the zone of protection of the abdomen protector are reduced by an amount corresponding to the area of overlap, as shown in Figure 4.

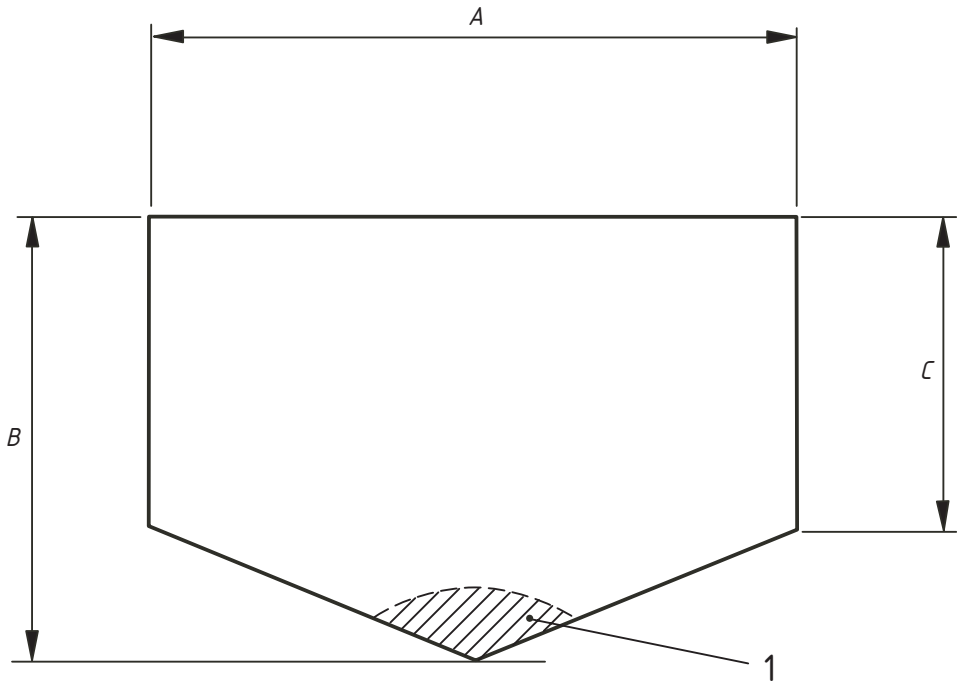
The abdomen protector shall have a zone of protection which either:

a) has dimensions calculated using the user's waist girth as the control dimension, as indicated in Table 3 column 5; or

b) is one of the nominal sizes given in Table 3 columns 6, 7, 8, 9 and 10.

Table 3 — Dimensions of zone of protection of abdomen protectors

1	2	3	4	5	6	7	8	9	10
Dimension of zone of protection	**Letter identifying dimension in Figure 4**	**Sex of users**	**Nominal length of protector**	**Dimension of zone of protection as a percentage of control dimension**	**Dimension of zone of protection for each nominal size** mm				
					Size 1	**Size 2**	**Size 3**	**Size 4**	**Size 5**
Minimum waist girth	*A*	Women	Short	28.0	224	258	291	325	358
			Regular						
			Long						
		Men	Short	28.0	224	258	291	325	358
			Regular						
			Long						
Minimum centre length	*B*	Women	Short	18.4	147	169	191	213	236
			Regular	20.8	166	190	215	240	265
			Long	23.0	184	212	239	267	294
		Men	Short	16.1	129	148	167	187	206
			Regular	18.4	147	169	191	213	236
			Long	20.7	166	190	215	240	294
Minimum side length	*C*	Women	Short	14.4	115	132	150	167	184
			Regular	16.3	130	149	168	188	207
			Long	18.0	144	166	187	209	230
		Men	Short	11.9	95	109	124	138	152
			Regular	13.6	109	125	141	158	174
			Long	15.3	122	141	159	177	196



Key
1 Area of overlap with a hard genital protector

Figure 4 — Abdomen protectors zone of protection

5.2.5 *Genital protectors*

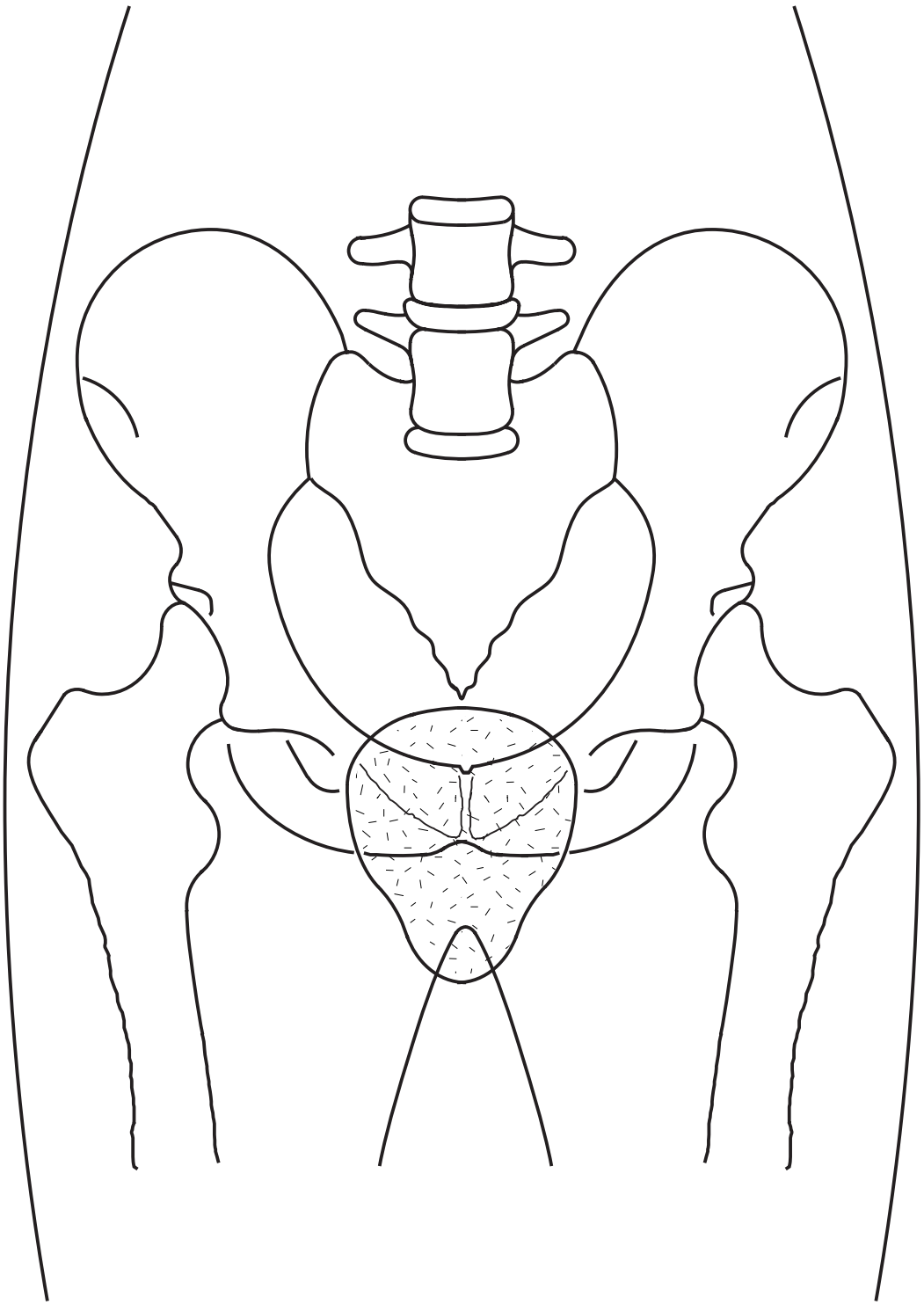
5.2.5.1 *Sizing and dimensions of hard genital protectors*

Sizes and dimensions of hard genital protectors shall be as specified in Table 4 and illustrated in Figure 5 and Figure 6. Dimensions of hard genital protectors shall be measured as specified in **6.6.1**.

Table 4 — Size designations and dimensions for hard genital protectors

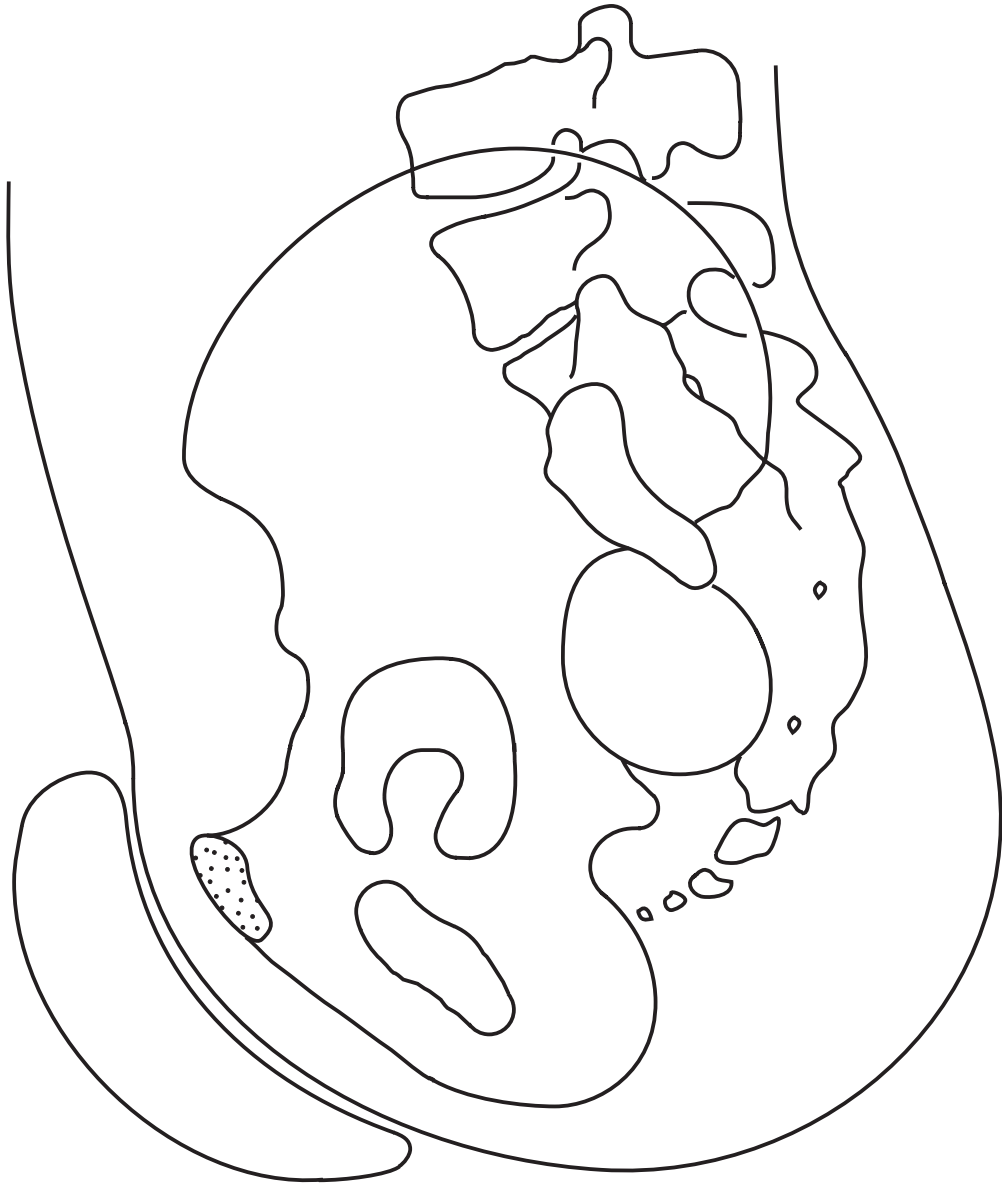
Size designation	Minimum internal depth, A[a] mm	Minimum internal length, B[a] mm	Minimum internal width at widest part, C[b] mm	Minimum protected volume, D[b] cm^3
Female size 1	20	100	55	70
Female size 2	25	110	65	110
Female size 3	30	120	75	150
Male size 1	40	120	85	170
Male size 2	45	130	95	225
Male size 3	50	140	105	300

[a] See Figure 6b).
[b] See Figure 6c).

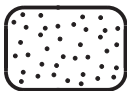


a) Anterior view of internal dimensions of a hard genital protector against a male pelvis

Figure 5 — Position of hard genital protector relative to pelvic bones



Key

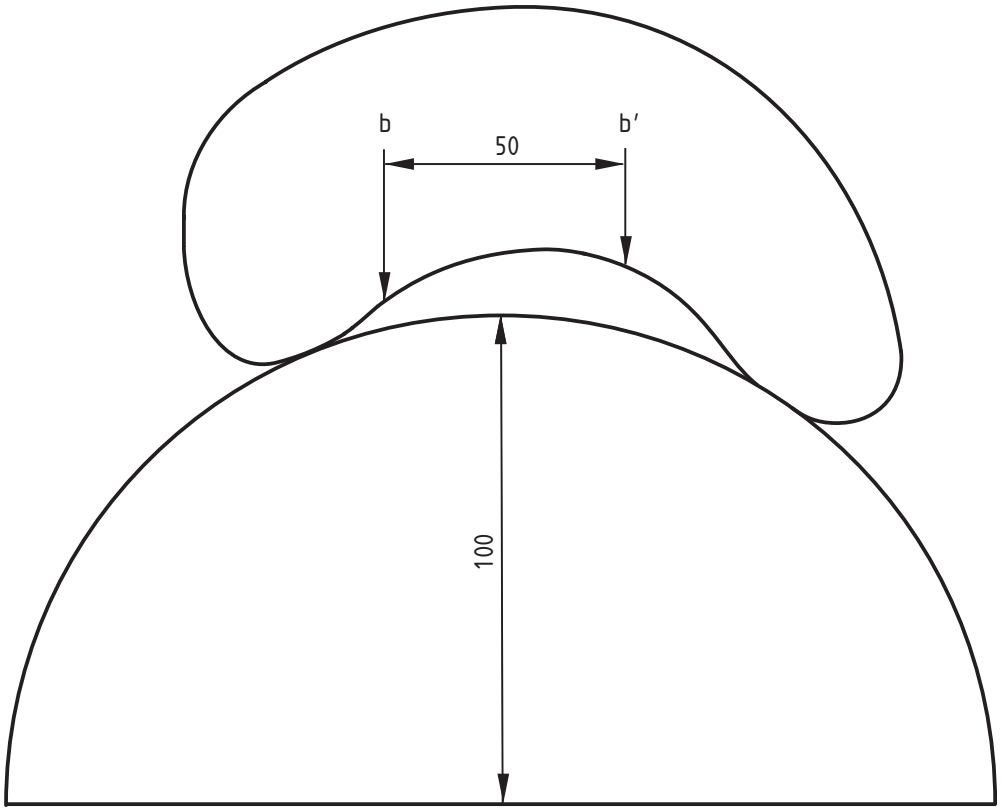


Symphysis pubis

b) Side view of position of hard genital protector against pelvis

Figure 5 — Position of hard genital protector relative to pelvic bones (*continued*)

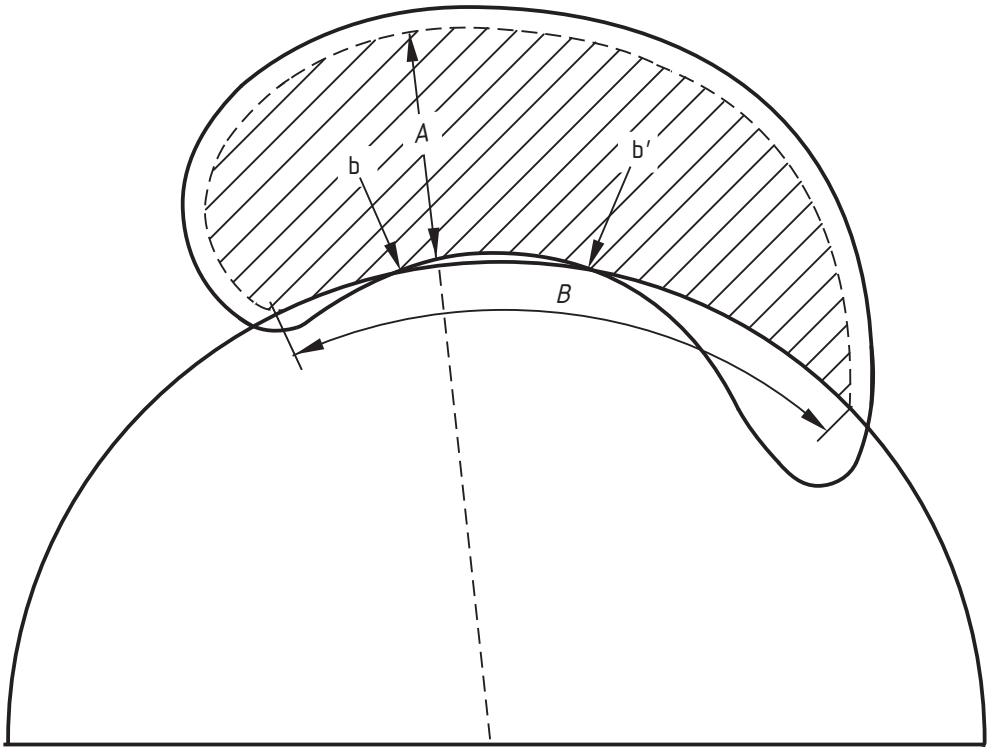
Dimensions in millimetres



NOTE Bearing area indicator marks are shown 50 mm apart (b, b′).

a) Side view of genital protector on 100 mm radius half cylinder

Figure 6 — Dimensions of hard genital protector



Key

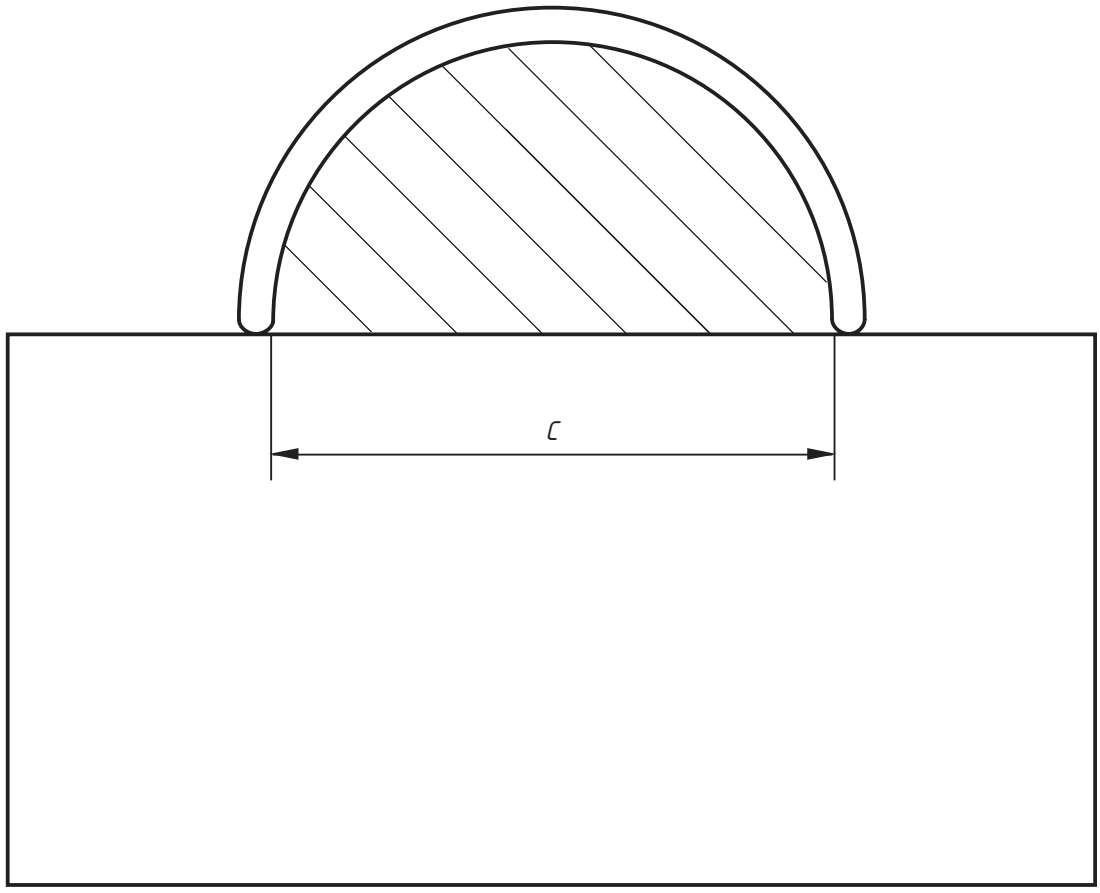
A Minimum internal depth

B Minimum internal length

Volume

b) Side view of genital protector trimmed to fit 100 mm radius half cylinder

Figure 6 — Dimensions of hard genital protector (*continued*)



Key

C Minimum internal width at widest part

Volume

c) Cross section of genital protector on 100 mm radius half cylinder

Figure 6 — Dimensions of hard genital protector (*continued*)

5.2.5.2 *Soft genital protectors for women*

NOTE Soft genital protectors for women should be designed to conform to body shapes. They should be soft and flexible and should extend into a narrow tail designed to pass backwards between the wearer's legs.

The sizes and the minimum dimensions of the zone of protection of soft genital protectors for women shall be as specified in Table 5 and illustrated in Figure 7.

The genital protector shall have a zone of protection which either:

a) has dimensions calculated using the user's waist girth as the control dimension, as indicated in Table 5 column 3; or

b) is one of the nominal sizes given in Table 5 columns 4, 5, 6, 7 and 8.

Table 5 — Dimensions of zone of protection of soft genital protectors for women

1	2	3	4	5	6	7	8
Dimension of zone of protection	**Letter identifying dimension in Figure 7**	**Dimension of zone of protection as a percentage of control dimension**	**Dimension of zone of protection for each nominal size** mm				
			Size 1	**Size 2**	**Size 3**	**Size 4**	**Size 5**
Minimum width at the top	*A*	15	111	129	147	165	183
Minimum length	*B*	20	148	172	196	220	244
Minimum width at the base	*C*	5	37	43	49	55	61

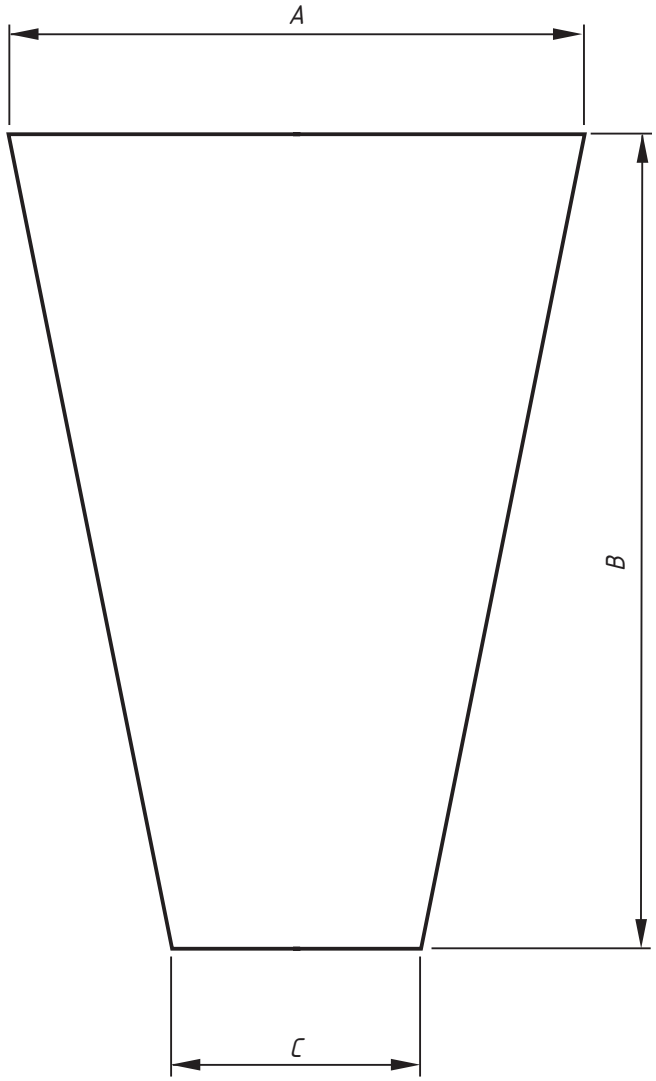


Figure 7 — Dimensions of zone of protection of soft genital protectors for women

5.3 Restraint

5.3.1 *Pedestrian torso protectors, equestrian torso protectors and shoulder protectors*

Torso protectors shall be provided with closures and adjusters and restraining straps or other means of restraint. Shoulder protectors shall be provided with means for attachment to the torso protector and/or restraining straps or other means of attachment to the body of the wearer.

NOTE Adjusters and adjustable closures of pedestrian torso protectors and equestrian torso protectors that are part of the restraint system should be so designed that the protector cannot readily be worn unrestrained.

When each adjuster, adjustable closure or closure is tested in accordance with **6.7.1** and **6.7.2**, closures shall not open and there shall be no gap of more than 15 mm between areas of protective material, when a force of 50 N is applied.

When adjusters or adjustable closures are at their maximally open setting, and each is tested in accordance with **6.7.1** and **6.7.2**, there shall be no gap of more than 15 mm between areas of protective material, when a force of 10 N is applied.

When restraint testing of torso protectors is carried out in accordance with **6.7.1** and **6.7.2**, the protector shall not be displaced by more than a distance equal to 20 % of the chest girth or bust girth of the protector when forces of 50 N are applied.

When shoulder protectors are subjected to restraint testing in accordance with **6.7.1** and **6.7.2**, each shoulder protector shall not be displaced by more than 10 % of its longitudinal dimension or more than 20 % of its lateral dimension when a force of 20 N is applied in any direction in the plane of the surface of the protector away from the point of the shoulder and backwards over the point of the shoulder.

For multi-component shoulder protectors, in addition to testing of the whole protector, each component shall be tested individually. When a force of 20 N is applied to each component in turn in any direction in the plane of the surface of the protector away from the point of the shoulder and backwards over the point of the shoulder, the component shall not be displaced by more than 10 % of its longitudinal dimension or more than 20 % of its lateral dimension.

5.3.2 *Abdomen protectors and genital protectors*

Abdomen protectors and genital protectors either shall be provided with means of restraint, which shall be integral straps with buckles, touch and close fasteners, or a separate “harness”, or shall be such that restraint can be achieved by other items of protective clothing or equipment. Details of how restraint of the protector is to be achieved shall be given in the information supplied by the manufacturer (see Clause **7**).

When restraint testing is carried out in accordance with **6.7.1** and **6.7.3** using the test force specified in Table 6, with the load in place, and after the load has been removed, displacement of the protector in the plane of application of the test force shall be not more than the relevant value given in Table 6.

Table 6 — Test forces and maximum displacement for restraint testing of abdomen protectors and genital protectors

Protector type	Test force N	Maximum displacement percentage of the linear dimension of the zone of protection measured along the line of the force applied	
		With load in place	After load has been removed
Abdomen protectors	15	15	5
Hard genital protectors	5	50	25
Soft genital protectors	5	50	25

5.4 Blunt impact resistance

5.4.1 *Pedestrian torso protectors and equestrian torso protectors*

When the protector is tested in accordance with **6.8.3.1**, the mean peak transmitted force shall be less than 4 kN and no single value shall exceed 6 kN.

5.4.2 *Shoulder protectors*

Shoulder protectors shall be tested as specified in BS 7971-4:2002, **6.4** and shall conform to the requirements for performance level 3 shoulder protectors specified in BS 7971-4:2002, **5.6.1**.

5.4.3 *Abdomen protectors*

When the protector is tested in accordance with **6.8.3.2**, the mean peak transmitted force shall be less than 3 kN and no single value shall exceed 4.5 kN.

5.4.4 *Hard genital protectors*

When tested in accordance with **6.8.3.3**, the protector shall not shatter or crack, the rubber membrane shall not be perforated, and the internal depth of the protector shall not fall below 80 % of the minimum value given in Table 4.

5.4.5 *Soft genital protectors*

When the protector is tested in accordance with **6.8.3.4**, the mean peak transmitted force shall be less than 3 kN and no single value shall exceed 4.5 kN.

5.5 Blade impact resistance of pedestrian torso protectors, equestrian torso protectors, shoulder protectors, abdomen protectors and hard genital protectors

When the protector is tested in accordance with **6.8.4** using the 60° blade impactor specified in BS 7971-4:2002, **6.4.2.9**, and the relevant anvil type and impact energy specified in Table 7, the blade impactor shall not cut through the inner surface of the protector at any point in the zone of protection.

Table 7 — Test conditions for blade impact testing

Protector type	Anvil type	Impact energy J
Pedestrian torso protectors	Cylindrical anvil (**6.8.2.5.1**) with guard ring level with top of anvil	20
Equestrian torso protectors	Cylindrical anvil (**6.8.2.5.1**) with guard ring level with top of anvil	20
Shoulder protectors	Cylindrical anvil with 50 mm radius of curvature domed top as specified in BS 7971-4:2002, **6.4.2.5**	30
Abdomen protectors	Cylindrical anvil (**6.8.2.5.1**) with guard ring level with top of anvil	10
Hard genital protectors	Horizontal anvil (**6.8.2.5.2**)	15

NOTE 1 The blade impactor represents the cutting action of skimmed slates and glass. It does not replicate the hazard posed by heavy blades such as machetes and Samurai swords.

NOTE 2 The blade impact resistance specified for shoulder protectors is the same as that specified for performance level 3 shoulder protectors in BS 7971-4.

5.6 Ergonomic performance and compatibility

Pedestrian torso protectors, shoulder protectors, abdomen protectors and genital protectors shall be tested in accordance with BS 7971-1.

Equestrian torso protectors shall be tested in accordance with BS 7971-1 with the inclusion of the additional test specified in Annex B. This test shall be carried out as part of the assessment of ergonomic performance and compatibility specified in BS 7971-1 and the results shall be included in the analysis specified in BS 7971-1.

Each protector shall have a test score equal to or less than the value specified in Table 8.

Table 8 — Maximum test scores

Protector type	Performance level	Maximum test score
Torso (pedestrian)	3	3
Torso (pedestrian) with shoulder protectors	3	4
Torso (equestrian)	3	3
Torso (equestrian) with shoulder protectors	3	4
Shoulder without a torso protector	3	3[a]
Abdomen	2	3
Abdomen with attached hard genital protector	2	4
Genital (hard)	2	1
Genital (soft)	2	1

[a] This is the same as the value specified for shoulder protectors in BS 7971-4.

6 Test methods

6.1 Test specimens

6.1.1 *General*

One protector of each type (or, in the case of shoulder protectors, one pair of protectors) in each size produced by the manufacturer shall be submitted for assessment and/or testing. If more than three sizes are produced, a minimum of three protectors shall be submitted, one at the small end of the size range, one at the large end of the size range and one in the middle of the size range. At least one size of each model of protector shall be assessed and tested in accordance with **6.2** to **6.8** inclusive, as applicable.

NOTE Test specimens that have been subjected to assessment in accordance with BS 7971-1 may be used if they were not damaged in any way during the process.

Protectors shall be submitted for testing as supplied by the manufacturer, complete with any labels and accompanying information.

6.1.2 *Preparation of test specimens for testing*

Test specimens shall be washed or cleaned five times in accordance with the manufacturer's instructions with thorough drying between each washing or cleaning cycle, before testing, unless this was done prior to the assessment in accordance with BS 7971-1.

Test specimens for the impact testing procedure given in **6.8** shall be conditioned in accordance with **6.8.1**.

6.2 Examination of the construction of protectors

The construction of the protectors shall be examined before, or in conjunction with, the assessments and measurements specified in **6.3** to **6.6**.

NOTE Information supplied by the manufacturer in the form of a technical file or other documents may be used to assist in this examination.

If necessary, a protector shall be taken apart for this examination. The following shall be determined:

a) the number of different combinations of different materials within the zone of protection;

b) the number of areas with different quantities or layers of different materials within the zone of protection;

c) the number of different construction methods employed within the zone of protection;

d) the extent of the area occupied by each of the combinations of different materials, by each of the areas with different quantities or layers of different materials and each of the areas with different construction methods, as detailed in items a), b) and c), respectively, as a percentage of the area of the whole zone of protection, to the nearest 10 %. Areas with different constructions shall be identified by marking them with, for example, a letter (A, B, C etc.);

e) the nature and extent of tapered or thinned areas of protective material within the zone of protection;

f) the nature and extent of tapered or thinned areas in closures;

g) the extent of overlap of reduced thickness materials in overlapping closures giving full thickness;

h) whether there are any particular small areas or points where the protectors might provide less protection.

NOTE The following are examples of such potentially weak areas:

— where a hinge point has been created in a shell material;
— where two different constructions join;
— where ventilation or other holes and channels are present;
— where components of a divided shell material overlap or join.

Areas or points that might provide lower blunt impact or blade impact protection than the major part of the protector, and any test orientation that might reveal lower blade impact resistance shall be identified by a different marking to that used for item d), for example the letters D, E, F etc.

If the materials within the zone of protection taper at their edges and the tapered parts lie within the calculated minimum dimensions of the zone of protection the protector shall be deemed not to conform to the requirements for the minimum dimensions of the zone of protection. However, if the information supplied by the manufacturer (see Clause **7**) includes a claim that the tapered regions are protective and are a constituent of the zone of protection, the areas shall be included in the record of weak points [see item h)].

If a closure, or other overlapping area, lies within a zone of protection, and the overlap of the protective material is less than 60 mm the area shall be included in the record of weak points [see item h)].

The information supplied by the manufacturer shall be examined to assess whether the dimensions of the zone of protection given therein correspond to the construction of the protector.

The results of the examination shall be recorded in the test report.

6.3 Assessment and measurement of torso protectors

6.3.1 *Verification of sizing and adjustability of pedestrian torso protectors and equestrian torso protectors*

The stated size of a pedestrian or equestrian torso protector shall be checked in one of the following ways.

a) The protector shall be donned by a test subject with body dimensions close to the midpoint of the range of body dimensions that the manufacturer states the protector will fit, the adjustment range of the closures shall be checked against the manufacturer's stated range of user sizes, and the fit of the protector on the test subject shall be assessed by the subject and by an assessor. The fit shall be deemed to be acceptable if it is not uncomfortably tight or excessively loose.

NOTE As a guide, a torso protector is the correct shape and fit if it is just firm against the chest, shoulders and abdomen when a maximum in-breath is taken. If the maximum intake of breath is restricted, or if a hand can be placed inside the protector when a maximum in-breath is taken, the shape or fit are not correct. If the test subject can readily raise the torso protector by more than 80 mm by upwards pressure with their fingers under the lower edge, the protector is probably too loose.

b) If no suitable test subjects are available, the torso protector closures shall be adjusted to their mid-points, and the inside dimensions of the torso protector corresponding to the chest girth or bust girth, and to the waist girth, shall be measured. The protector shall be deemed to be the correct size if these values exceed the manufacturer's stated mid-range dimensions of users by 30 mm to 60 mm depending on the ordinary clothing that is to be worn under the protector as stated in the information supplied by the manufacturer (see Clause **7**). The adjustment range of the closures shall be checked against the manufacturer's stated range of user sizes.

The results of the examination shall be recorded in the test report.

6.3.2 *Dimensions of zone of protection in pedestrian torso protectors*

6.3.2.1 *General*

The required minimum and maximum dimensions of the zone of protection of the protector shall be calculated for the size of the largest intended user as stated by the manufacturer, using the values specified in Table 1. Before comparisons or measurements are made the closures of the protector shall be closed and the adjusters set at their widest setting. If closures or adjusters are elastic, comparisons and measurements shall be made while the protector is worn by a test subject, or is on mannequin, of a size equivalent to the largest size of user the protector is intended to fit. The dimensions of the zone of protection shall be determined by means of one of the two methods given in **6.3.2.2** and **6.3.2.3**, respectively.

6.3.2.2 *Method 1. Examination of the structure of the protector relative to a marked outline of the required zone of protection*

The perimeter of the required minimum zone of protection, calculated in accordance with **6.3.2.1**, shall be marked on the inside of the protector with a suitable marking pen. The markings with respect to dimensions of under 1 000 mm shall be to an accuracy of ±5 mm, and those with respect to dimensions over 1 000 mm, to an accuracy of ±10 mm. An examination of the protector relative to the location of this line and the results of the examination specified in **6.2** shall be used to determine whether the zone of protection is provided with full thickness materials throughout its area and in all the different construction types present.

NOTE Over the shoulder lengths should be marked while the protector is worn by a test subject, or is on a mannequin, of a size equivalent to the largest size of user the protector is intended to fit, in order to achieve realistic three dimensional shaping of the protector.

The results of the examination of the structure of the protector relative to the marked outline of the minimum zone of protection shall be recorded in the test report.

6.3.2.3 *Method 2. Direct measurement of the dimensions of the relevant areas of the protector*

6.3.2.3.1 The dimensions of the areas of full thickness materials and combinations of materials comprising the zone of protection, as located in the examination specified in **6.2**, shall be measured on the inside of the protector in accordance with **6.3.2.3.2** and the results compared to the required dimensions of the zone of protection calculated in accordance with **6.3.2.1**. Measurements of lengths shall be made to an accuracy of ±2 %.

NOTE Over the shoulder lengths should be marked while the protector is worn by a test subject, or is on a mannequin, of a size equivalent to the largest size of user the protector is intended to fit, in order to achieve realistic three dimensional shaping of the protector.

6.3.2.3.2 The girth around the chest or bust, the under bust girth (if applicable), the girth around the waist, and the front lower edge to back lower edge over shoulder distance of the protector (dimensions *A*, *B*, *C* and *D*, respectively, as given in Table 1 and Figure 2) shall be measured on the inside of the protector or determined by fitting the protector on a test subject or a mannequin with the relevant body dimensions.

The centre front length, centre back length, minimum width between the armholes across the back and minimum width between the armholes across the front (dimensions *E*, *F*, *H* and *I*, respectively, as given in Table 1 and Figure 2) shall be measured on the inside of the protector with a tape measure or a ruler.

The armhole circumference and the neck opening circumference (dimensions *G* and *J*, respectively, as given in Table 1 and Figure 2) shall be measured with the aid of a cone. The cone shall be constructed of cardboard or plastics sheet material and shall have a length of 500 mm, with a diameter of 120 mm at the narrow end and a diameter of 250 mm at the wide end. The cone shall be marked with horizontal lines denoting its outside circumference at 10 mm circumference intervals between a circumference of 380 mm and a circumference of 780 mm.

NOTE 1 Where protectors in a particular size range are being examined a cone with dimensions corresponding to a more limited size range may be used.

NOTE 2 The cone should be stiff along its long axis but be easily distorted out of a circular shape transversely.

The adjustable closures on the torso protector shall be adjusted to their mid points. The narrow end of the cone shall be inserted from the inside of the protector through one of the armholes and through the neck opening, in turn, so that the narrow end protrudes through the armhole or neck opening, and the wider end is within the protector. The cone shall then be suspended by its narrow end, and the protector allowed to slide down the cone until the cone fills the armhole or neck opening.

NOTE 3 The adjusters should be checked to ensure that they have not opened beyond their maximally open position. If they have done so, the test should be repeated with the adjusters fixed in some suitable way, such as with a pin or clip, to ensure that they do not open beyond their maximally open position.

The maximum circumference of the cone that is exposed shall be determined by taking the circumference of the largest circumference line that is exposed, even if the line is only partly exposed. This maximum circumference shall be recorded.

If the materials in the zone of protection taper towards the armhole or the neck opening, or other components of the torso protector, such as the cover, restrict the movement of the torso protector on the cone, cuts shall be made in the tapered material, cover, or other components to ensure that the measurement is made on the edge of the full thickness materials.

The result of the comparison of calculated required dimensions of the zone of protection and the measurements shall be recorded in the test report.

6.3.3 *Dimensions of zone of protection in equestrian torso protectors*

6.3.3.1 The required girth around the chest or bust, the under bust girth (if applicable) and the girth around the waist of the protector (dimensions *A*, *B* and *C* respectively, as given in Table 2 and Figure 3) shall be determined from the information supplied by the manufacturer. The required minimum values of dimensions *K*, *L*, *M*, *N*, *O*, *P*, *Q* and *R* and the required maximum value of dimension *S*, of the zone of protection, as given in Table 2 and Figure 3, shall be calculated. The dimensions of the zone of protection shall be measured in accordance with **6.3.3.2** and **6.3.3.3** with all adjustable closures set at their maximally open position.

6.3.3.2 The girth around the chest or bust, the under bust girth (if applicable) and the girth around the waist of the protector (dimensions *A*, *B* and *C*, respectively, as given in Table 2 and Figure 3) shall be measured on the inside of the protector or determined by fitting the protector on a test subject or a mannequin with the relevant body dimensions.

6.3.3.3 For measurement of dimensions *K* to *R*, the torso protector shall be worn by a test subject or put on a mannequin. The lines *K* and *K′* and *L* and *L′*, as shown in Figure 3, shall be marked on the protector, together with the centre point at the top of the shoulder where these lines meet. Dimension *z*, as shown in Figure 3, shall also be marked. Dimensions *K* to *R* shall be measured on the outside of the protector.

The armhole circumference (dimension *S* as shown in Table 2 and Figure 3) shall be measured with the aid of a cone in accordance with **6.3.2.3.2**.

The result of the comparison of required dimensions of the zone of protection and the measurements shall be recorded in the test report.

6.4 Dimensions of zone of protection in shoulder protectors

Examination and marking of the zones of protection on shoulder protectors shall be carried out in accordance with BS 7971-4:2002, **6.2**.

The results of the examination shall be recorded in the test report.

6.5 Dimensions of zone of protection in abdomen protectors

The minimum required dimensions of the zone of protection, determined in accordance with **5.2.4.2**, shall be marked on the outer surface of the protector. If necessary, the protector shall be put on a test subject so that anatomical landmarks such as the waist, hip bones and groin (inguinal groove) can be marked on it if the protector extends significantly beyond these points.

The examiner shall consider whether the three dimensional shape of the protector, the thickness of the protector or the change in its shape when strapped onto the test subject causes the positioning or size of the marked zone of protection to be inappropriate for use as the test area as specified in **5.2.1.3**. If this is the case, the examiner shall scale or modify the dimensions of the test area so as not to unreasonably reject a satisfactory protector, or to accept one with possibly inadequate performance. Details of any modifications shall be included in the test report with reasons for the modification.

The protector shall be marked with weak areas or points to be tested that were found during the examination in accordance with **6.2**.

6.6 Dimensions of genital protectors

6.6.1 *Measurement of linear dimensions and protected volume of hard genital protectors*

The protector shall be marked, on the area that bears on the pubic bones of the user in normal use, with two points b and b′ 50 mm apart as shown in Figure 6a). The protector shall be placed against a rigid cylinder, or half cylinder, with a radius of (100 ± 1) mm. If the two points marked on the bearing area do not make contact with the cylinder, the protector shall be trimmed with shears until they do, as shown in Figure 6b).

NOTE 1 The greater part of any trimming should be carried out at the smaller end of the protector, as shown in Figure 6b).

With the protector in contact with the cylinder, the internal depth, internal length (around the curvature of the cylinder) [as shown in Figure 6b)], and maximum internal width of the protector shall be measured.

NOTE 2 To measure the maximum internal width of the protector it might be convenient to trace the outline of the protector onto the cylinder and make this measurement on the outline, allowing for the wall thickness of the protector.

The protected volume of the protector shall be measured by filling the space between the protector and cylinder with soft modelling clay, or a powder (e.g. sand). The clay or powder shall then be removed from the protector, and the volume of the clay or powder shall be determined either by weighing it and calculating the volume to within ±2 cm^3, or by adding it to a measuring cylinder full of water and measuring the volume of water displaced to within ±2 cm^3.

The results shall be recorded in the test report.

6.6.2 *Measurement and marking of the zone of protection on soft genital protectors*

The minimum required dimensions of the zone of protection, determined in accordance with **5.2.5.2**, shall be marked on the outer surface of the protector.

The examiner shall consider whether the three dimensional shape of the protector, the thickness of the protector or the change in its shape when strapped onto the test subject causes the positioning or size of the marked zone of protection to be inappropriate for use as the test area as specified in **5.2.1.3**. If this is the case, the examiner shall scale or modify the dimensions of the test area so as not to unreasonably reject a satisfactory protector, or to accept one with possibly inadequate performance. Details of any modifications shall be included in the test report with reasons for the modification.

The protector shall be marked with weak areas or points to be tested that were found during the examination in accordance with **6.2**.

6.6.3 *Marking of the impact test area on genital protectors*

6.6.3.1 *Hard genital protectors*

The vertical centre line shall be marked on the outer surface of the protector. Two transverse lines shall be marked across this line, (25 ± 3) mm from the upper and lower ends of the protector, respectively. The impact test area shall be along the vertical centre line between the two transverse lines. If the genital protector is attached to an abdomen protector which overlies the genital protector, the marking shall be placed on the abdomen protector.

6.6.3.2 *Soft genital protectors*

The zone of protection and a vertical centre line shall be marked on the outer surface of the protector. Two transverse lines shall be marked across the centre line (30 ± 3) mm from the upper and lower edges of the marked zone of protection, respectively, and parallel to them. The impact test area shall be along the vertical centre line between the transverse lines. If the genital protector is attached to an abdomen protector which overlies the genital protector, the marking shall be placed on the abdomen protector.

6.7 Assessment of closures, adjusters, restraints and attachments

6.7.1 *General*

The protector or protectors shall be donned by a suitable test subject, or placed on a mannequin, and the closures and restraints securely fastened in accordance with the information supplied by the manufacturer. If a mannequin is used it shall be securely fixed to a support. If the protector is worn by a test subject, he or she shall stand upright and hold themselves steady by gripping rigid supports at or below waist level with both hands.

6.7.2 *Assessment of closures, adjusters and restraints of pedestrian torso protectors, equestrian torso protectors and shoulder protectors*

Torso protector adjusters, adjustable closures, closures and restraints, and shoulder protector attachments, shall be tested using a spring balance or a force gauge. The device shall be clamped to the surface or to a free edge of the protector, or hooked around an edge. The relevant test force as specified in **5.3.1** shall be applied gently and the result observed and measurements taken as applicable.

Each adjuster, adjustable closure and closure shall be tested at right angles to the closure or in line with the adjustment. Each adjuster or adjustable closure shall be at the mid point of its adjustment range for the closure test using a 50 N force. Each adjuster or adjustable closure shall be at its maximally open position for the adjuster test using a 10 N force.

In torso protector restraint testing the protector shall be adjusted to fit the test subject or mannequin in accordance with the manufacturer's instructions. The lower edge of the torso protector shall be pulled up the body at each of four points in turn, at the middle of the back and front, and the sides. The shoulder area shall be tested by pulling the armhole edge forwards, upwards and backwards at 90° to the edge of the armhole and at 90° to the surface of the torso protector.

Shoulder protectors shall be adjusted to fit the test subject or mannequin in accordance with the manufacturer's instructions. They shall be tested by being pulled in the plane of the protector away from their attachment if they are to be worn under clothing, and they shall also be pulled backwards over the point of the shoulder in a peeling movement, if they are designed to be worn without clothing over them. The test forces shall be applied to shoulder protectors in three directions, forwards, backwards and laterally.

The results shall be recorded in the test report.

6.7.3 *Restraint testing of abdomen and genital protectors*

6.7.3.1 *Abdomen protectors and abdomen protectors with attached genital protectors*

A spring balance or a force gauge shall be clamped to each of the attachment points shown in Figure 8a) in turn, and the relevant test force given in Table 6 shall be applied for a minimum of 30 s tangential to the surface of the protector at the point of attachment in the relevant direction as shown in Figure 8a). If it is impractical to apply the force tangential to the surface of the protector, the force shall be applied parallel to the body surface or parallel to the plane of the tangent to the body surface beneath the attachment point.

With the force still applied, and after the force has been removed, the maximum amount of displacement of the protector relative to an independently supported fixed pointer shall be measured in the direction of application of the test force. Each measurement shall be made to an accuracy of ±5 % of the maximum permitted displacement, as given in Table 6, and each measurement shall be expressed as a percentage of the size of the zone of protection, measured along a line passing through the attachment point in the direction of application of the test force. The protector shall be re-positioned and adjusted as necessary between tests.

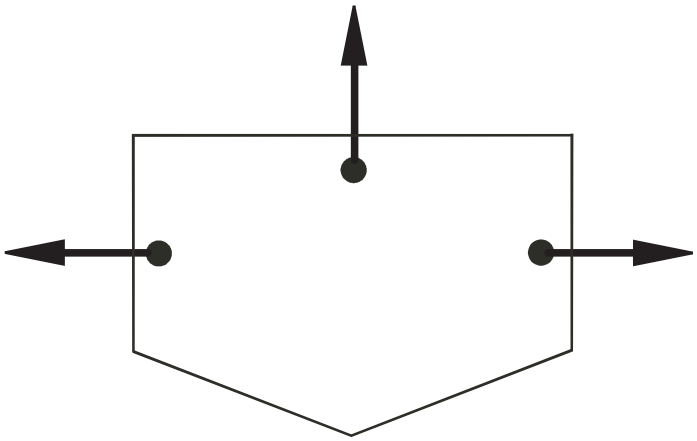
The results shall be recorded in the test report.

6.7.3.2 *Genital protectors not attached to abdomen protectors*

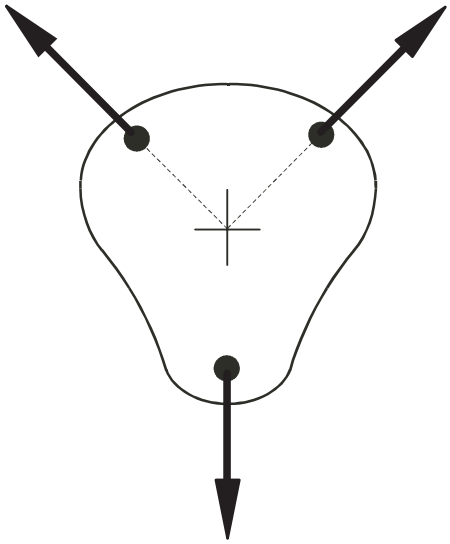
A spring balance or a force gauge shall be clamped to each of the attachment points shown in Figure 8b) or Figure 8c), as applicable, in turn, and the relevant test force given in Table 6 shall be applied for a minimum of 30 s tangential to the surface of the protector at the point of attachment in the relevant direction as shown in Figure 8b) or Figure 8c), as applicable. If it is impractical to apply the force tangential to the surface of the protector, the force shall be applied parallel to the body surface or parallel to the plane of the tangent to the body surface beneath the attachment point.

With the force still applied, and after the force has been removed, the maximum amount of displacement of the protector relative to an independently supported fixed pointer shall be measured to an accuracy of ±5 % of the maximum permitted displacement as given in Table 6 and each measurement shall be expressed as a percentage of the size of the zone of protection, measured along a line passing through the attachment point in the direction of application of the test force. The protector shall be re-positioned and adjusted as necessary between tests.

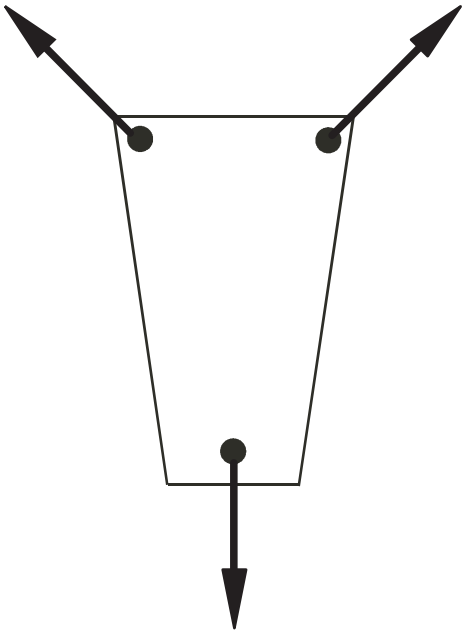
The results shall be recorded in the test report.



a) Abdomen protectors



b) Hard genital protectors



c) Soft genital protectors

Figure 8 — Attachment points on protectors, and directions of force application, for restraint testing of abdomen protectors and genital protectors

6.8 Impact testing

6.8.1 *Conditioning and testing atmosphere*

Prior to impact testing, test specimens shall be conditioned in an atmosphere at (20 ± 2) °C and (65 ± 5) % relative humidity for at least 48 h. If the tests are carried out in a different atmosphere, the tests shall be commenced within 5 min of the test specimens being removed from the conditioning environment and completed within 15 min.

6.8.2 *Apparatus*

6.8.2.1 *Dropping tower*, conforming to BS 7971-4:2002, **6.4.2.1**.

6.8.2.2 *Falling mass guidance system*, conforming to BS 7971-4:2002, **6.4.2.2**.

6.8.2.3 *Carriage and impactor holding block*, conforming to BS 7971-4:2002, **6.4.2.3**.

6.8.2.4 *Instrumentation*, conforming to BS 7971-4:2002, **6.4.2.4**.

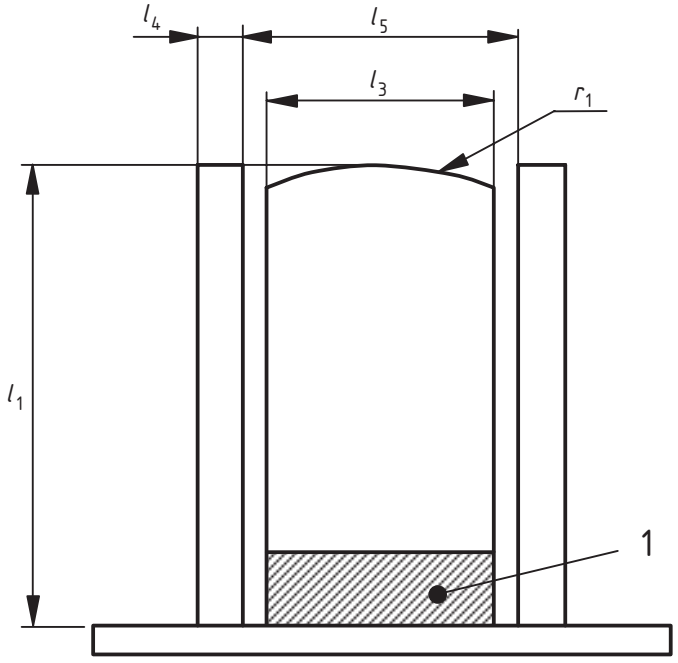
6.8.2.5 *Anvil*, conforming to **6.8.2.5.1** or **6.8.2.5.2**, as applicable.

6.8.2.5.1 *Cylindrical anvil with guard ring, for testing pedestrian torso protectors, equestrian torso protectors and abdomen protectors*, (100 ± 1) mm in diameter with a (150 ± 5) mm radius of curvature domed top. The anvil shall be mounted on the load cell or force transducer (**6.8.2.4**), in the case of the load cell with a pre-load in accordance with the load cell manufacturer's instructions, and the load cell or force transducer shall be mounted on the steel base of the dropping tower (**6.8.2.1**). The anvil shall be surrounded by a guard ring with an internal diameter of (120 ± 2) mm and a wall thickness of (20 ± 1) mm. The guard ring shall be solidly mounted on the steel base of the dropping tower. The top of the guard ring shall be adjustable to be (10 ± 0.2) mm above the top of the anvil, or level with the top of the anvil to within ±0.2 mm, as shown in Figure 9. This anvil shall be used with a test specimen fixation system conforming to BS 7971-4:2002, **6.4.2.7**.

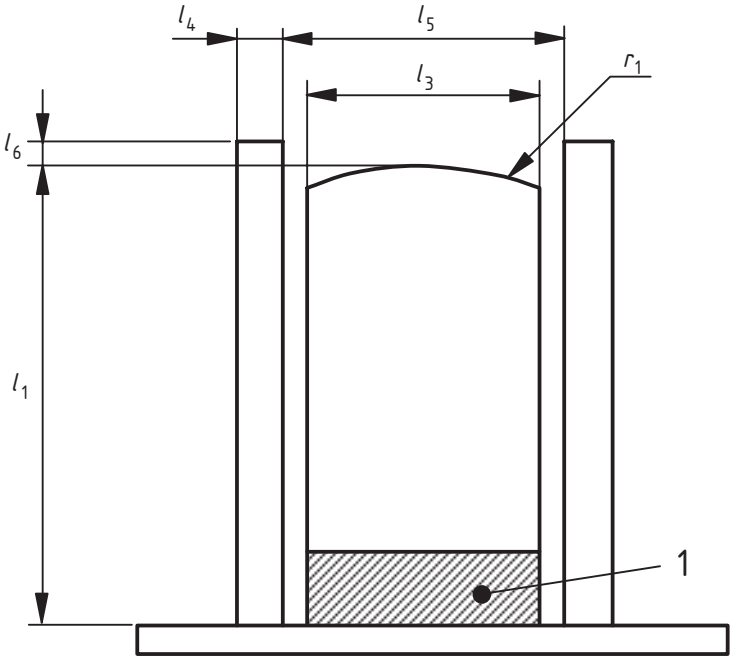
6.8.2.5.2 *Horizontal anvil for testing hard genital protectors*, consisting of a horizontal steel bar at least 200 mm long and (50 ± 2) mm wide, with a top profile of (80 ± 2) mm radius of curvature. The anvil shall be at least 80 mm in height, and positioned so that the steel striker is directly above the top centre, as shown in Figure 10. The protector shall be strapped or clamped in place during impact. The straps or clamps used shall be such that they do not prevent the protector distorting under impact. The anvil shall be covered with a layer of modelling clay (5 ± 1) mm thick, and a natural rubber membrane (0.6 ± 0.05) mm thick placed on top of this. Means shall be provided to measure the minimum internal height of the protector during impact, to an accuracy of ±2 mm.

NOTE A cylinder of inelastic modelling clay approximately 20 mm in diameter placed inside the protector, under the point of impact, is a satisfactory means for measuring the minimum internal height of the protector during impact.

6.8.2.5.3 *Cylindrical anvil with domed top, for testing soft genital protectors*, with a 100 mm radius of curvature, conforming to BS 7971-4:2002, **6.4.2.5**, surrounded by a guard ring as specified in **6.8.2.5.1**, level with the top of the anvil to within ±0.2 mm.



a) Guard ring level with top of anvil

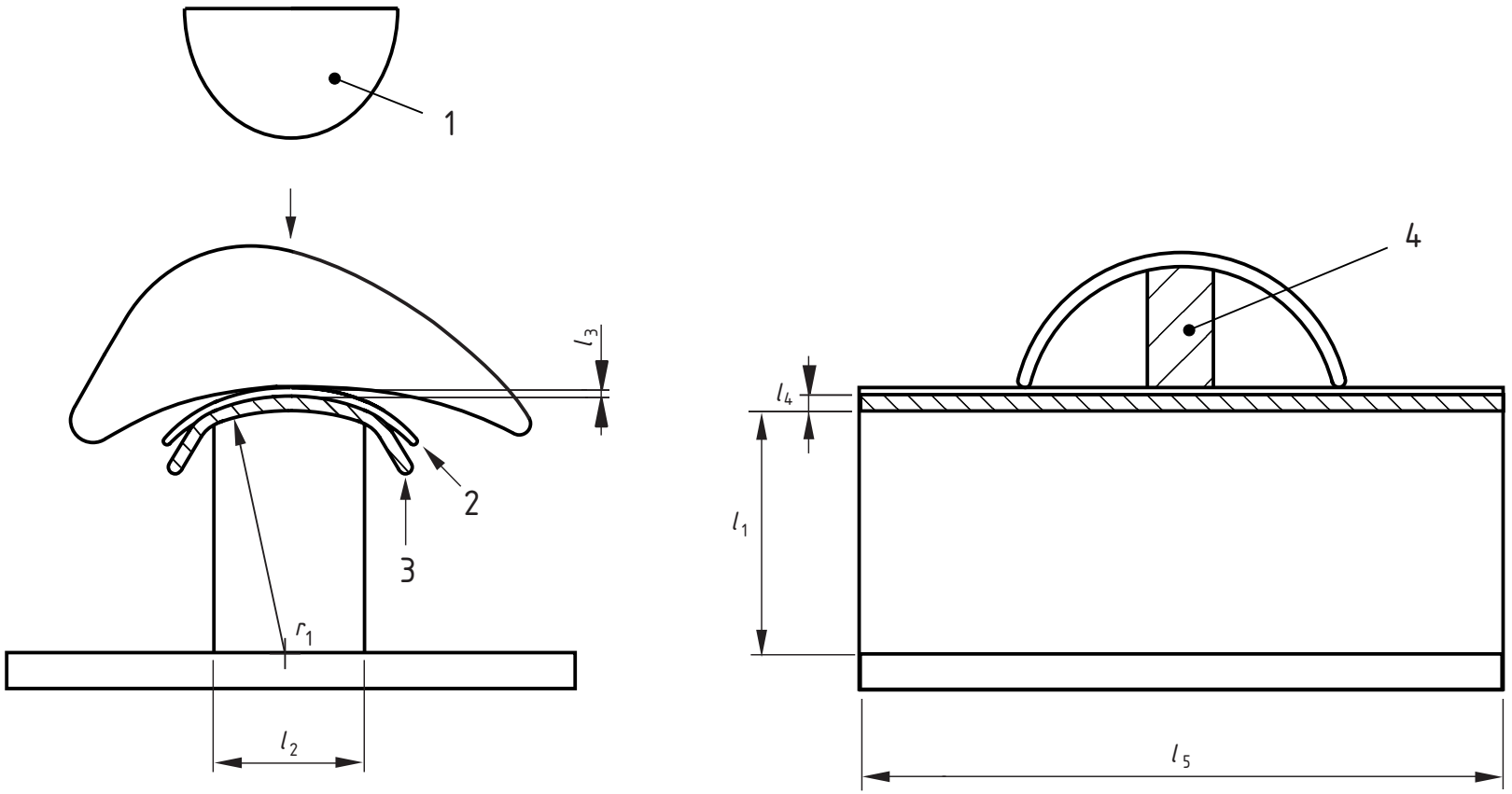


b) Guard ring 10 mm above the top of the anvil

Key
1 Load cell or force transducer

l_1 ≥ 200 mm l_5 (120 ± 2) mm
l_3 (100 ± 1) mm l_6 (10 ± 0.2) mm
l_4 (20 ± 1) mm r_1 (150 ± 5) mm

Figure 9 — Cylindrical anvil with a guard ring



a) End view

b) Longitudinal sectional view

Key

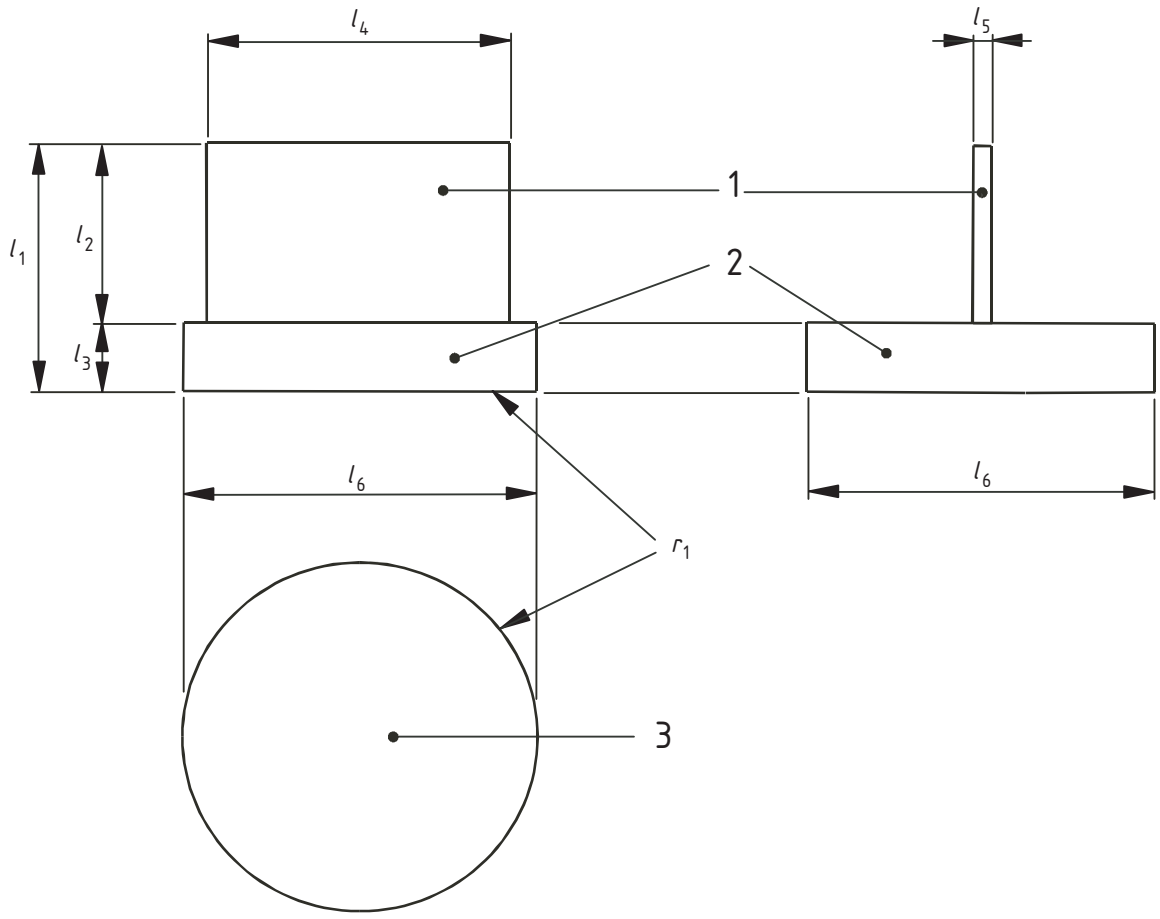
1 Striker
2 Rubber membrane (0.6 ± 0.05) mm thick (l_3)
3 Layer of modelling clay (5 ± 1) mm thick (l_4)
4 Cylinder of modelling clay
l_1 ≥ 80 mm
l_2 (50 ± 2) mm
l_5 ≥ 200 mm
r_1 (80 ± 2) mm

Figure 10 — Horizontal anvil for impact testing of hard genital protectors

6.8.2.6 *Impactor*, conforming to **6.8.2.6.1**, **6.8.2.6.2** or **6.8.2.6.3**, as applicable.

6.8.2.6.1 *Flat impactor*, with a striking block consisting of a horizontal steel plate (80 ± 2) mm in diameter with (0.5 ± 0.1) mm radius corners between the striking face and vertical sides of the striking block as shown in Figure 11. The combined mass of the impactor and carriage shall be (2 500 ± 25) g.

NOTE This impactor is intended to represent the ground and large objects in testing protectors on cylindrical anvils. It is used in torso protector testing with the guard ring set level with the top of the anvil to assess whether the foam in the protector is soft enough to protect the rib cage.



Key

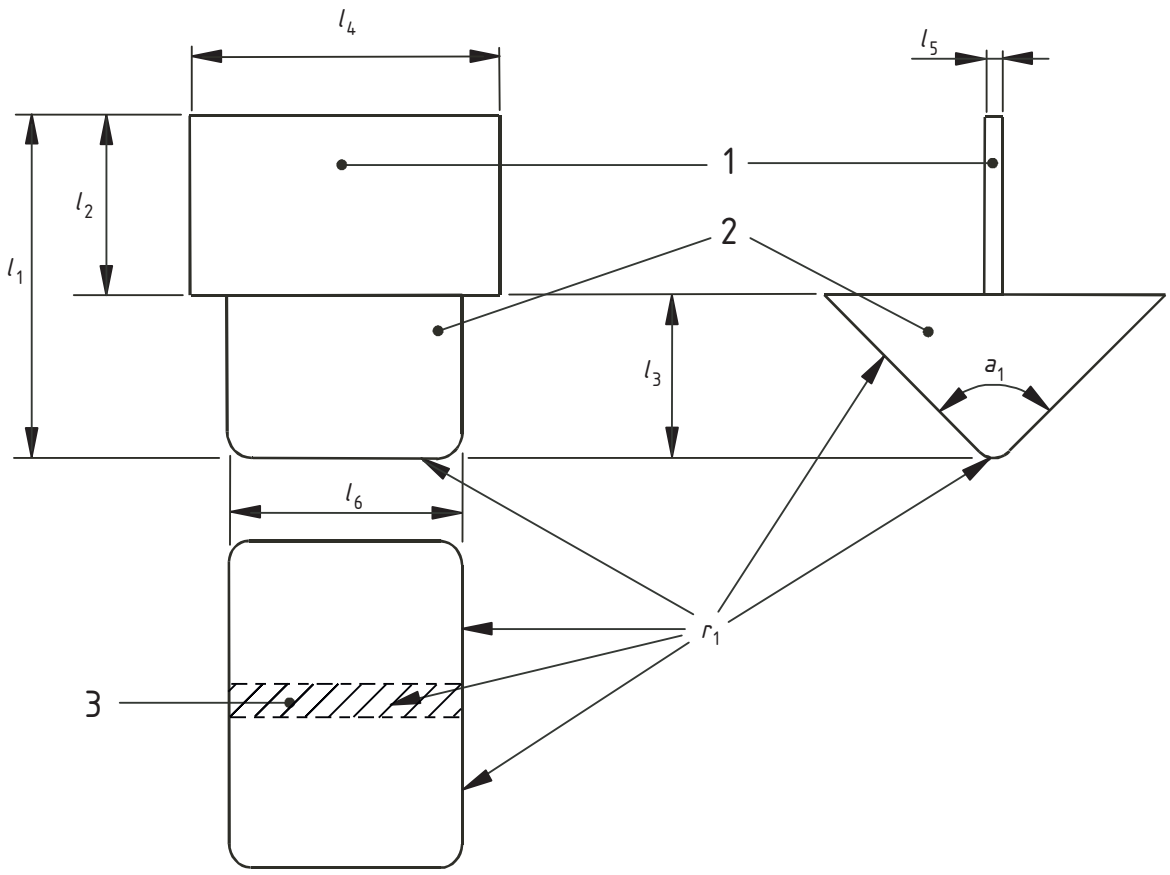
1 Insert plate
2 Striking block
3 Striking face of striking block

l_1 (55 ± 7) mm
l_2 (40 ± 5) mm
l_3 (15 ± 2) mm
l_4 (70 ± 5) mm
l_5 (4.8 ± 0.2) mm
l_6 (80 ± 2) mm
r_1 (0.5 ± 0.1) mm

Figure 11 — Flat impactor

6.8.2.6.2 "*Brick edge*" *impactor*, with a striking block having a horizontal steel edge (60 ± 3) mm long with a (90 ± 1)° included angle and a (5 ± 1) mm radius of curvature as shown in Figure 12. The faces of the block meeting at the lower edge shall each be at an angle of (45 ± 2)° to the horizontal. The ends of the block shall be vertical to within ±5°. The radius of curvature of the corners between the ends of the block and the 45° faces shall be (5 ± 1) mm. The combined mass of the impactor and carriage shall be (2 500 ± 25) g.

NOTE This impactor is intended to represent the edge of a thrown object such as a brick or a block of concrete.



Key

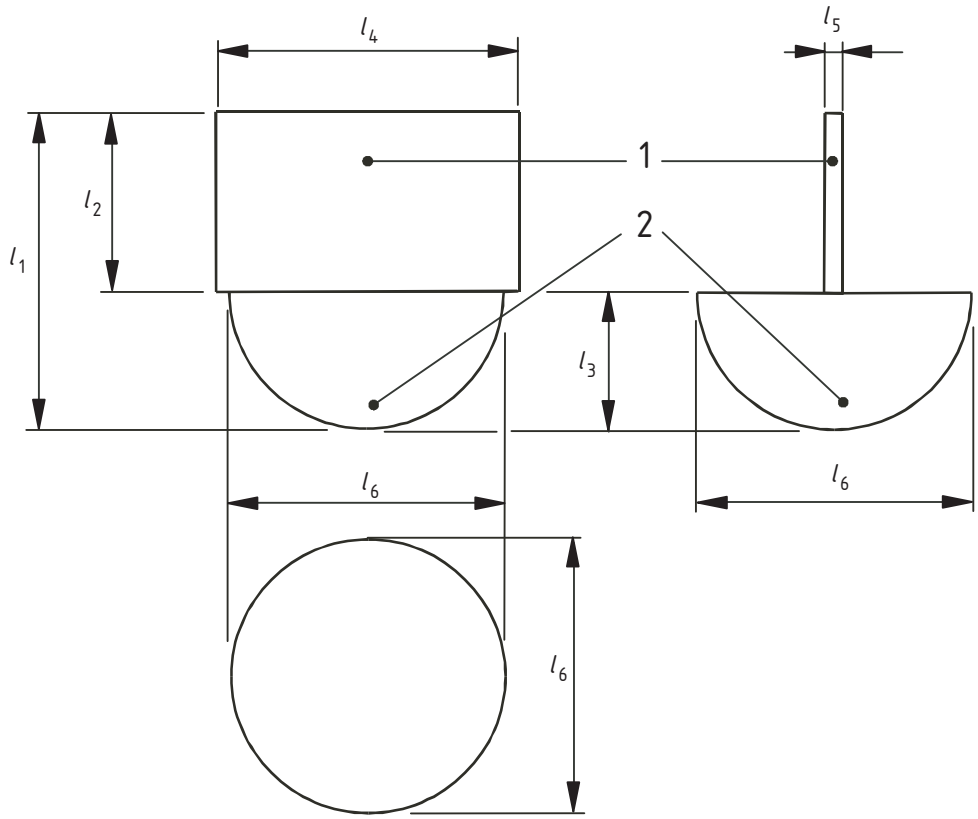
1 Insert plate
2 Striking block
3 Striking edge of striking block

l_1 (80 ± 10) mm
l_2 (40 ± 5) mm
l_3 (40 ± 5) mm
l_4 (70 ± 5) mm
l_5 (4.8 ± 0.2)mm
l_6 (60 ± 3) mm
r_1 (5 ± 1) mm
a_1 (90 ± 1)°

Figure 12 — "Brick edge" impactor

6.8.2.6.3 *Ball impactor*, with a striking block consisting of a hollow steel hemisphere (72 ± 2) mm in diameter as shown in Figure 13. The combined mass of the impactor and carriage shall be (2 500 ± 25) g.

NOTE This impactor is intended to represent a cricket ball, a field hockey ball or other rounded object such as a knee.



Key

1 Insert plate
2 Striking block

l_1 (76 ± 6) mm
l_2 (40 ± 5) mm
l_3 (36 ± 1) mm
l_4 (70 ± 5) mm
l_5 (4.8 ± 0.2) mm
l_6 (72 ± 2) mm

Figure 13 — Ball impactor

6.8.3 ***Procedures for blunt impact testing***

6.8.3.1 *Pedestrian torso protectors and equestrian torso protectors*

6.8.3.1.1 The protector shall be cut into pieces approximately 200 mm wide. The cut edges of each piece shall be bound with adhesive tape to retain the normal relationship between the components of the protector.

6.8.3.1.2 Six randomly placed impacts shall be made on each type of construction present in 10 % or more of the area of the zone of protection as identified in the examination in accordance with **6.2**. Two impacts shall be made on each type of weak area or weak point identified in the examination in accordance with **6.2**.

6.8.3.1.3 A series of impacts, as specified in **6.8.3.1.2**, shall be carried out, using an impact energy of 20 J, under each of the following conditions:

a) using the brick edge impactor (**6.8.2.6.2**) and the cylindrical anvil (**6.8.2.5.1**) with the top of the guard ring 10 mm above the top of the anvil;

b) using the flat impactor (**6.8.2.6.1**) and the cylindrical anvil (**6.8.2.5.1**) with the top of the guard ring level with the top of the anvil.

6.8.3.1.4 Impact sites shall be marked so that no area is impacted more than once. The centres of impact shall be not less than 60 mm apart and not less than 30 mm from the edge of the zone of protection marked on the protector.

6.8.3.1.5 Individual peak transmitted force values, and the mean peak transmitted force for all the impacts under each condition shall be recorded in the test report.

6.8.3.2 *Abdomen protectors*

6.8.3.2.1 Test specimens shall be prepared from abdomen protectors that have had the minimum dimensions of the zones of protection marked on their outer surface. The protectors shall be cut up and the straps removed as necessary to position the test areas on the anvil. If the protector loses its integrity on being cut up, the cut edges shall be bound with adhesive tape to retain the normal relationship between the components of the protector.

6.8.3.2.2 Five randomly placed impacts shall be made on each type of construction present in 10 % or more of the area of the zone of protection as identified in the examination in accordance with **6.2**. Two impacts shall be made on each type of weak area or point identified in the examination in accordance with **6.2**.

6.8.3.2.3 A series of impacts, as specified in **6.8.3.2.2**, shall be carried out, using an impact energy of 10 J, under each of the following conditions:

a) using the brick edge impactor (**6.8.2.6.2**) and the cylindrical anvil (**6.8.2.5.1**) with the top of the guard ring 10 mm above the top of the anvil;

b) using the flat impactor (**6.8.2.6.1**) and the cylindrical anvil (**6.8.2.5.1**) with the top of the guard ring level with the top of the anvil.

6.8.3.2.4 Impact sites shall be marked so that no area is impacted more than once. The centres of impact shall be not less than 60 mm apart and not less than 30 mm from the edge of the zone of protection marked on the protector.

6.8.3.2.5 Individual peak transmitted force values, and the mean peak transmitted force for all the impacts under each condition shall be recorded in the test report.

6.8.3.3 *Hard genital protectors*

Two genital protectors shall be tested using the horizontal anvil (**6.8.2.5.2**) and the ball impactor (**6.8.2.6.3**). If the hard genital protectors are enclosed in fabric covers they shall be tested with the covers in place. Each protector shall be impacted three times, using an impact energy of 15 J. Centres of impact shall be at least 15 mm apart, and not less than 25 mm from the edge of the protector. Impacts shall fall on, or within 2 mm of, the vertical centreline marked in accordance with **6.6.3.1**. Prior to each test, the anvil shall be covered in a fresh layer of modelling clay (5 ± 1) mm thick, and covered with an undamaged rubber membrane (see **6.8.2.5.2**). The protector shall be fixed in place, with a cylinder of modelling clay or other measuring device to determine the internal depth of the protector when in position. After each impact the minimum internal depth of the protector during the impact shall be determined. The rubber membrane shall be examined for cuts or tears, and the protector examined for cracks, splits, permanent deformation or other damage.

The mean value of the minimum internal depth of the protectors in the six impact tests shall be calculated and expressed as a percentage of the minimum internal depth specified in Table 4.

The results shall be recorded in the test report.

6.8.3.4 *Soft genital protectors*

Soft genital protectors on which the impact test area has been marked in accordance with **6.6.3.2** shall be used. The protectors shall be cut up and any straps removed, as necessary to position the impact test area on the anvil. If the protector loses its integrity on being cut up, the cut edges shall be bound with adhesive tape to retain the normal relationship between the components of the protector.

If the protectors have been found to be of similar construction throughout the impact test area when examined in accordance with **6.2**, five impacts shall be carried out. Centres of impact shall be at least 60 mm apart. If there are weak areas in the impact test area identified in the examination in accordance with **6.2**, two additional impacts shall be carried out in each of these.

NOTE More than one protector is likely to be needed to complete the testing.

Two sets of impacts shall be carried out, with an impact energy of 10 J, using the cylindrical anvil and guard ring (**6.8.2.5.3**). One set shall be carried out using the flat impactor (**6.8.2.6.1**) and one set shall be carried out using the brick edge impactor (**6.8.2.6.2**).

Individual peak transmitted force values, and the mean peak transmitted force for all the impacts with each impactor shall be recorded in the test report.

6.8.4 *Blade impact testing of pedestrian torso protectors, equestrian torso protectors, shoulder protectors, abdomen protectors and hard genital protectors*

Three blade impacts shall be carried out on each type of construction identified in each type of protector in the examination in accordance with **6.2**. A single impact shall be carried out on each type of weak area or weak point identified in the examination in accordance with **6.2**. The centres of impact shall be not less than 40 mm apart and not less than 30 mm from the edge of the zone of protection marked on the protector.

NOTE If there is doubt about the ability of the protector to resist the blade impact when mounted directly on the steel anvil, it is recommended that preliminary impacts should be carried out with a layer of hard rubber or cork at least 10 mm thick placed on the anvil to prevent unnecessary damage to the blade and anvil. If the blade cuts through the protector in this test, the protector may be deemed to have failed without the need to carry out further testing. However, if the protector passes this test, it still has to be subjected to testing directly on the steel anvil to determine whether it conforms to the blade impact resistance requirement specified in **5.5**.

The blade shall impact the protector at approximately 90° to the long axis of the body. If the examination carried out in accordance with **6.2** identified a particular orientation that might be weaker, an impact shall also be carried out in this orientation.

After each blade impact, the inner surface of the protector shall be examined and the dimensions of any hole made by the blade measured. A cut through the inner surface of the protector shall be deemed to have occurred if the blade has made a hole in the inner surface of the protector greater than 0.5 mm in any direction. If the protector does not have an inner surface that would reveal such a hole, a witness layer of natural rubber (0.6 ± 0.2) mm thick shall be placed on the anvil. This shall be examined for holes after each blade impact.

All results shall be recorded in the test report.

7 Information to be supplied by the manufacturer

In addition to the information and instructions specified in BS 7971-1, protectors shall be supplied with the following information:

a) for pedestrian torso protectors and equestrian torso protectors, the sizing pictograms specified in **5.2.2.1**, if these are not given on a label attached to the protector;

b) for abdomen protectors and genital protectors, details of how restraint of the protector is to be achieved;

c) details of any tapered regions of the protector that are claimed to form part of the zone of protection;

d) the ordinary clothing that should be worn under the protector.

Annex A (informative)
Information and guidance on the use of torso, shoulder, abdomen and genital protectors

This part of BS 7971 specifies torso, shoulder and abdomen protectors and hard and soft genital protectors with one of two different levels of performance on the basis of the severity of testing to which they are subjected. All the protectors can be expected to reduce the severity of, or prevent, soft tissue injuries caused by thrown missiles such as bricks, bottles and bars, and by weapons such as metal bars, baseball bats and poles wielded by opponents. They can also be expected to protect against injuries from trips and falls and from blows delivered by the wearer that accidentally hit a solid object. All protectors, except for soft genital protectors, can be expected to provide protection against skimmed glass, slates and tiles.

The torso and abdomen are more massive than the limbs and more difficult to protect from impact injury. However, a shield is more effective in deflecting blows directed at the user's torso and abdomen than it is at deflecting blows towards limbs.

The protectors can be expected to protect against missiles thrown from a distance that are not intercepted by a shield and against blows from hand held weapons partially attenuated by a shield.

Normally the protectors have a hard plastics outer shell, or inner layers, which can be expected to protect against slashing knife cuts and hypodermic needles, provided that these layers are not perforated for example to aid ventilation, to provide flexibility, or to reduce weight.

The torso protectors also provide a measure of protection from unanticipated missiles coming from behind the wearer, which cannot be intercepted by a shield.

WARNINGS:

— The protectors should not be expected to protect against sharp machetes, felling axes, chain saws, samurai swords, impacts by vehicles, impacts from heavy masses dropped onto the operatives from buildings etc., or explosive devices.

— The protectors should not be expected to protect against firearm projectiles or cross-bow bolts.

— Torso and abdomen protectors give finite coverage. The user is vulnerable to blows that impact any gaps and to blows near the edges of the protectors. As the neck can be visibly unprotected, it is in danger of becoming a target.

Annex B (normative)
Additional test for ergonomic performance and compatibility for equestrian torso protectors

B.1 General

The test subjects shall perform the movements specified in **B.2**. For each movement, each test subject shall make an assessment on the basis of the questions listed and score the item in accordance with the scoring system given.

B.2 Forward bend while seated

NOTE The movements in this test are intended to represent the movements of a horse rider in the saddle.

Sit on a chair or stool of a height such that when your shins are vertical your thighs are slightly inclined upwards towards your knees. Bend forwards as far as you can or until the fronts of your shoulders touch your knees. Lift your head to look forwards. Look downwards and reach for the floor with one hand in front of your foot on the same side. Sit up looking forwards with your back vertical. Rotate your shoulders and torso to look behind you.

How easy is it to carry out the movements? To what extent are your movements and your reach restricted?

Score as follows:

0: No problem.

1: Slight restriction of torso movements, but the forward bend not compromised; shoulders touch knees.

2: The forward bend is slightly restricted and shoulders do not touch knees; or shoulder mobility is reduced so that the forward and downward reach is restricted.

3: The forward bend is difficult or uncomfortable (usually due to restriction at the waist); or the lifting of the head to look forwards is restricted (usually by conflict between the torso protector and the helmet).

4: All movements are restricted to a significant extent or are only completed with unacceptable discomfort.

Bibliography

Standards publications

BS 7971-2:2003, *Protective clothing and equipment for use in violent situations and in training — Part 2: Guidance on risk assessment and on the selection, use, cleaning and maintenance of protective clothing and equipment*.

BS EN 13158:2000, *Protective clothing — Protective jackets, body and shoulder protectors for horse riders — Requirements and test methods*.

BS EN ISO/IEC 17025:2000, *General requirements for the competence of testing and accreditation laboratories*.

Other publications

[1] POLICE SCIENTIFIC DEVELOPMENT BRANCH. *Body armour standards for UK police, Part 1: General requirements*. Publication No. 7/03/A, 2003[1)].

[2] POLICE SCIENTIFIC DEVELOPMENT BRANCH. *Body armour standards for UK police, Part 2: Ballistic resistance*. Publication No. 7/03/B, 2003[1)].

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[1)] Available from Police Scientific Development Branch, Sandridge, St Albans, Hertfordshire, AL4 9HQ. Telephone: + 44(0) 1727 865051 Fax: + 44(0) 1727 816233.

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