BRITISH STANDARD

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

Part 11: Foot and ankle protectors and foot protectors – Requirements and test methods

ICS 13.340.10

Publishing and copyright information

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

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Foreword

Publishing information

This part of BS 7971 was published by BSI and came into effect on 31 August 2006. It was prepared by Subcommittee PH/3/12, *Protective clothing and equipment for use in violent situations*, under the authority of Technical Committee PH/3, *Protective clothing*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

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;*
- *Part 11: Foot and ankle protectors and foot protectors – Requirements and test methods.*

Product certification/inspection/testing. Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with the relevant parts of BS 7971. Appropriate conformity attestation arrangements are described in BS EN ISO/IEC 17025. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Hazard warnings

WARNING. This British Standard calls for the use of procedures that can 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.

Use of this document

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

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

Foot and ankle protectors and foot 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.

Foot and ankle protectors and foot protectors are intended to reduce the severity of, or prevent, soft tissue injuries resulting from blunt trauma to specific areas of the feet, or the feet and ankles, of the wearer. 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.).

Foot and ankle protectors and foot protectors are not intended to provide ballistic protection or protection against sharp or pointed instruments (e.g. axes, spikes and knives).

Foot and ankle protectors and foot protectors can be separate items, or can be an additional component of the knee and shin protectors specified in BS 7971-4. They can be manufactured from, or encapsulated within, flame retardant materials.

For certain user groups including police and prison officers, foot and ankle protectors or foot protectors might constitute a second line of defence, where a personal defence shield, particularly a full-length shield, provides a degree of primary protection (see BS 7971-3). Whilst shields do not always prevent impacts with the wearer's feet and ankles by missiles or weapons, they can reduce the energy of impacts to levels at which foot and ankle protectors or foot protectors can have a significant effect in the reduction of soft tissue or skeletal injuries. Foot and ankle protectors and foot protectors of one performance level are specified.

The test methods specified in this part of BS 7971 have been selected to measure the performance of foot and ankle protectors and foot 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 others can be exposed in real life situations, where different hazards can be encountered. However, experience has shown that foot and ankle protectors and foot protectors which pass such tests can significantly reduce the incidence and/or severity of injuries.

1 Scope

This part of BS 7971 specifies performance requirements and test methods for foot and ankle protectors and foot protectors to provide protection against blunt trauma, 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.

NOTE 1 Information and guidance on the use of foot and ankle protectors and foot 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.

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*

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*

BS EN ISO 15025:2002, *Protective clothing – Protection against heat and flame – Method of test for limited flame spread*

3 Terms and definitions

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

4 Performance levels

Foot and ankle protectors and foot protectors shall each be of a single type which shall be performance level 3 as specified in BS 7971-1.

5 Construction and performance requirements

5.1 General

Foot and ankle protectors and foot 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

Foot and ankle protectors and foot protectors shall be marked with a size designation. The size shall be related to the size and model of the footwear with which the protectors are intended to be worn (see **5.3**), and the relationship shall be explained in the information supplied by the manufacturer as specified in BS 7971-1 (see also **5.9**).

5.3 Dimensions of zones of protection and test areas for impact testing

The zone of protection shall be such that the following requirements are met, as illustrated in Figure 1a) and Figure 1b). If protection is achieved through the use of various layers of materials, the zone of protection shall be where all layers are present.

a) For foot protectors and foot and ankle protectors, at the front of the protector, the zone of protection shall overlap the rear edge of the safety toecap of the footwear by not less than 15 mm and not more than 30 mm. (Dimension a in Figure 1.)

b) At the rear of the heel there shall be no gap between the edges of the zone of protection of the foot and ankle protector that exceeds 80 mm, or of the foot protector that exceeds a value in centimetres equivalent to twice the UK footwear size (e.g. for UK size 9 footwear the maximum distance would be 18 cm). (Dimension b in Figure 1.)

c) For foot protectors and foot and ankle protectors, along its inner and outer lower edges the protector shall be not less than 15 mm from the ground (dimension c_1 in Figure 1) and not more than 15 mm above the nearest part of the upper surface of the permanent insole of the footwear. (Dimension c_2 in Figure 1.)

d) For foot protectors and for foot and ankle protectors, the zone of protection shall be continuous from the toecap of the footwear to at least a point on the instep at which a pointer placed at 45° to the vertical would be normal to the surface of the instep of the footwear. (Dimension d in Figure 1.)

e) For foot protectors and foot and ankle protectors, any horizontal gap between the protector and the instep of the footwear, measured along the centre-line of the footwear, shall be not more than 10 mm. (Dimension e in Figure 1.)

f) For foot and ankle protectors, the ankle zone of protection shall extend to a point which is at a distance in centimetres above the level of the upper surface of the permanent insole of the footwear at the heel equivalent to the UK footwear size. [Dimension f_1 in Figure 1a).] The top contour of the ankle zone of protection shall have a radius in centimetres equivalent to not less than one quarter of the UK footwear size. [Dimension f_2 in Figure 1a).]

g) For foot protectors and foot and ankle protectors, the lowest point of the top edge of the zone of protection between the ankle and the instep shall be at a distance in centimetres above the level of the upper surface of the permanent insole of the footwear at the heel equivalent to not less than 80% of the UK footwear size. (Dimension g in Figure 1.)

The test area shall be the same size as the zone of protection.

Marking of the outline of the zone of protection prior to impact testing shall be carried out in accordance with **6.3**.

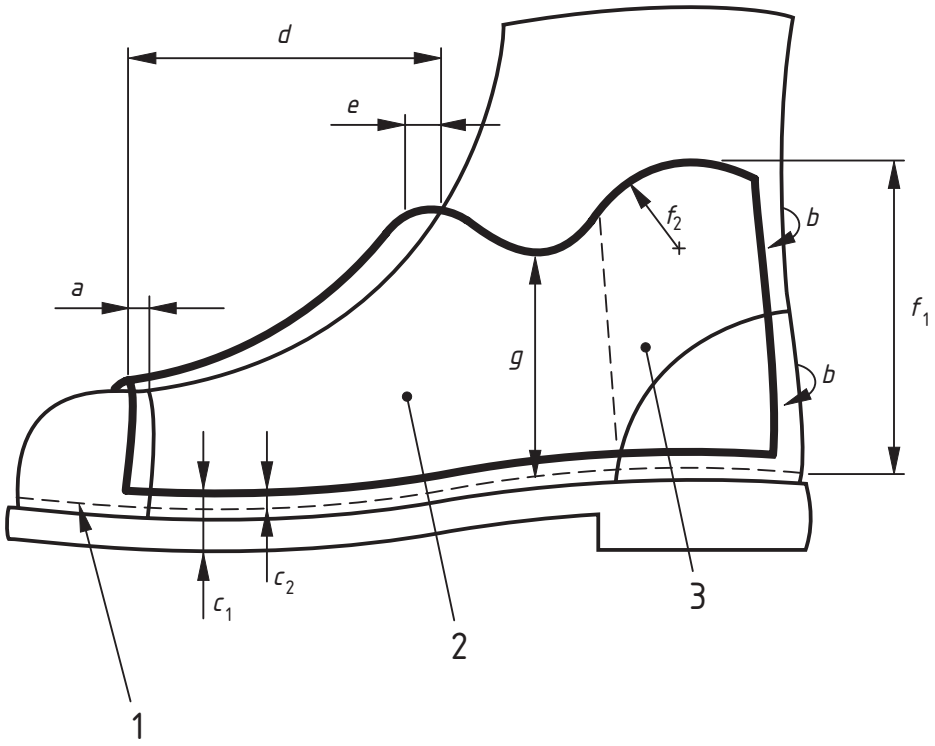
5.4 Restraint

When tested in accordance with **6.4.1** and **6.4.2** each protector shall not be displaced from the foot and ankle, or the foot, of the test subject, as applicable, by more than 20% of its longitudinal dimension or more than 20% of its lateral dimension. In addition, when tested in accordance with **6.4.1** and **6.4.3** the front edge of the protector shall not be pulled upwards by more than 50 mm.

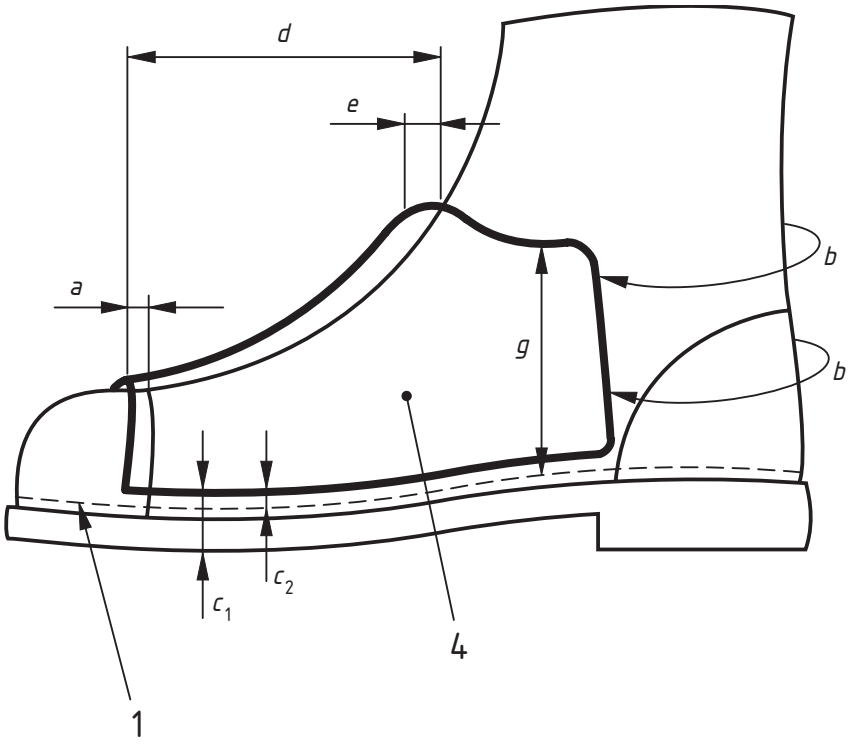
5.5 Ergonomic performance and compatibility

When tested in accordance with BS 7971-1, using the test conditions specified for footwear, foot and ankle protectors and foot protectors shall have a test score equal to or less than 1.

Figure 1 **Zones of protection**



a) Foot and ankle protector



b) Foot protector

Key

1 Level of upper surface of permanent insole of footwear
2 Foot area of zone of protection of foot and ankle protector
3 Ankle area of zone of protection of foot and ankle protector
4 Zone of protection of foot protector

5.6 Impact resistance

5.6.1 Blunt impact resistance

When the protector is tested in accordance with **6.5** using the relevant anvil type and impact energy specified in Table 1, the mean peak transmitted force from all impacts in the test area shall not exceed 2 kN and no single value shall exceed 3 kN.

5.6.2 Blade impact resistance

When the protector is tested in accordance with **6.5** using the relevant anvil type and the impact energy specified in Table 1, the blade impactor shall not cut through the inner surface of the protector at any point in the zone of protection.

Table 1 **Test conditions for blunt impact and blade impact testing**

Type of protector	**Test area**	**Anvil type**	**Impact energy** J
Foot and ankle	Foot area of zone of protection [as shown in Figure 1a)]	Domed cylinder 100 mm radius of curvature (**6.5.2.5**)	20
	Ankle area of zone of protection [as shown in Figure 1a)]	Domed cylinder 25 mm radius of curvature (**6.5.2.5**)	15
Foot	Zone of protection [as shown in Figure 1b)]	Domed cylinder 100 mm radius of curvature (**6.5.2.5**)	20

5.7 Burning behaviour

When tested in accordance with **6.6**, each test specimen shall meet the following requirements.

a) The afterflame time shall be ≤2 s.

b) The afterglow time shall be ≤2 s.

c) There shall be no hole formation through the full thickness of the test specimen.

d) There shall be no flaming or molten debris from the test specimen.

5.8 Marking

Protectors shall be marked in accordance with BS 7971-1. The marking shall remain legible after the washing or cleaning process in accordance with **6.1.2**.

5.9 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 instructions and information:

a) instructions that the protectors are only to be used with footwear fitted with safety toecaps (such as footwear conforming to BS EN ISO 20345 or BS 7971-5);

b) the sizes, makes, models and years of manufacture of the footwear with which the protectors can be worn and a warning not to wear the protectors with any other footwear without first consulting the supplier of the protector;

c) a statement that, when correctly fitted, the foot and ankle protector, or foot protector, should overlap the rear edge of the safety toecap of the footwear by not less than 15 mm and not more than 30 mm.

6 Test methods

6.1 Test specimens

6.1.1 General

One pair of each type of protector in each size produced by the manufacturer shall be submitted for assessment and/or testing. At least one size of each model of protector shall be assessed and tested in accordance with **6.2** to **6.6** inclusive.

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 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 **6.5** shall be conditioned in accordance with **6.5.1**.

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**.

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 any closures;

g) the extent of overlap of reduced thickness materials in any 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;*
- *at rivets or fixing studs;*
- *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 **5.9**) 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 Zone of protection

The protector shall be donned by a suitable test subject who is wearing the largest size of footwear stated by the manufacturer to be compatible with the particular model of protector, and securely fastened in accordance with the manufacturer's instructions.

NOTE If a suitable test subject is not available the footwear and protector may be put on an anatomically correct mannequin leg and foot.

The zone of protection as specified in **5.3** shall be marked on the protector.

In the case of foot and ankle protectors, a line shall be drawn as shown in Figure 1a) to indicate the boundary between the foot area of the zone of protection and the ankle area of the zone of protection.

6.4 Restraint assessment

6.4.1 General

The protector shall be donned by a suitable test subject who is wearing footwear stated by the manufacturer to be compatible with the particular model of protector, and securely fastened in accordance with the manufacturer's instructions.

NOTE If a suitable test subject is not available the footwear and protector may be put on an anatomically correct mannequin leg and foot.

6.4.2 Resistance to lateral displacement

A hand held force gauge capable of measuring forces up to 30 N to the nearest 1 N shall be clamped securely to each of the attachment points shown in Figure 2 in turn, and a force of 20 N shall be applied for between 10 s and 30 s tangential to the surface of the protector at the attachment point in the relevant direction as shown in Figure 2.

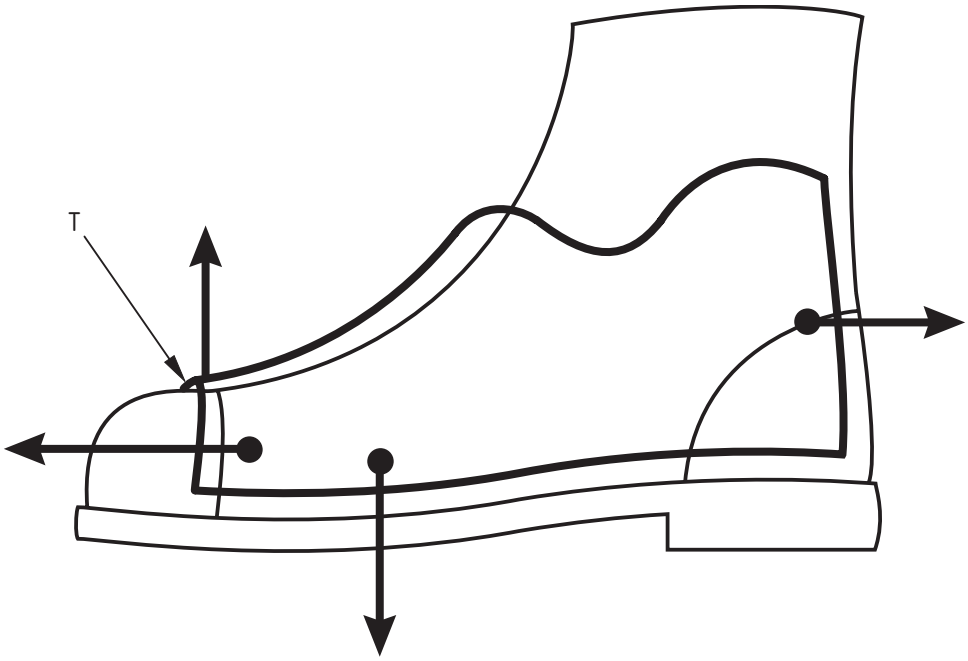
The force gauge shall be attached to each of the attachment points on the lateral surface of the protector, and to each of the corresponding attachment points on the medial surface of the protector. For the tests in which the force is applied downwards with the force gauge attached to one of the lower edges of the protector, the foot shall be placed on a raised step with the lateral or medial edge of the foot, as applicable, at the edge of the step.

NOTE If necessary, holes may be made in the protector for attachment of the force gauge.

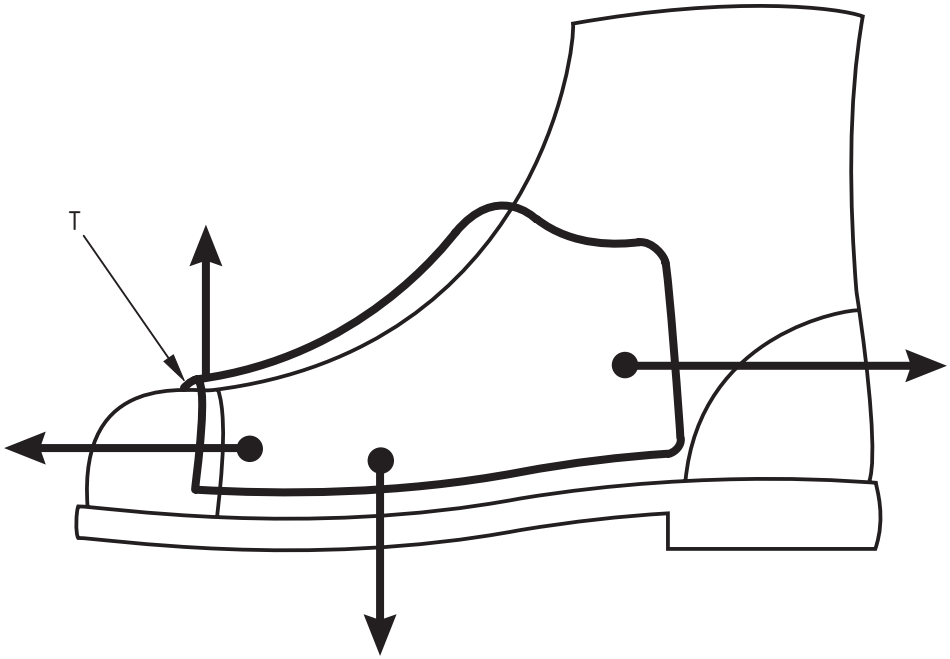
6.4.3 Resistance to upward displacement

A hand held force gauge capable of measuring forces up to 30 N to the nearest 1 N shall be clamped securely to attachment point "T" as shown in Figure 2 and a force of 20 N shall be applied for between 10 s and 30 s in a vertically upwards direction as shown in Figure 2.

Figure 2 **Attachment points on protectors, and directions of force application, for restraint testing**



a) Foot and ankle protector



b) Foot protector

Key

T Attachment point for upward displacement test

6.5 Impact testing

6.5.1 Conditioning and testing atmosphere

Test specimens shall be conditioned in an atmosphere at (20 ± 2) °C and (65 ± 5)% relative humidity for at least 48 h before testing. If the tests are carried out in a different atmosphere, the tests shall be commenced within 1 min of the test specimens being removed from the conditioning environment and completed within 3 min.

6.5.2 Apparatus

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

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

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

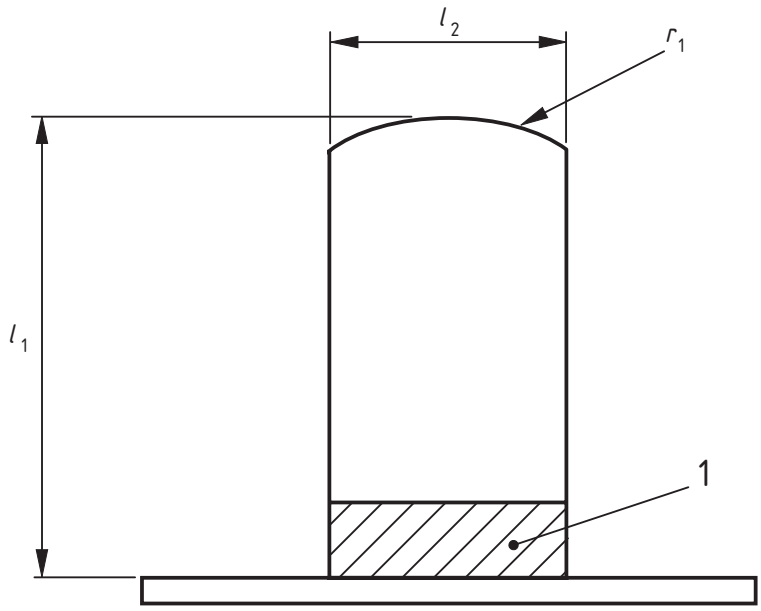
6.5.2.4 *Instrumentation*, conforming to BS 7971-4:2002, **6.4.2.4**.

6.5.2.5 *Cylindrical anvils with domed tops*, as shown in Figure 3, having a radius of curvature as specified in Table 1. The anvil shall be mounted on the load cell or force transducer (**6.5.2.4**), 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 (**6.5.2.1**). These anvils shall be used with a test specimen fixation system conforming to BS 7971-4:2002, **6.4.2.7**.

6.5.2.6 *"Brick edge" impactor*, conforming to BS 7971-8:2003, **6.8.2.6.2**.

6.5.2.7 *Blade impactor*, conforming to BS 7971-4:2002, **6.4.2.9**.

Figure 3 **Dimensions of cylindrical anvils**



Key

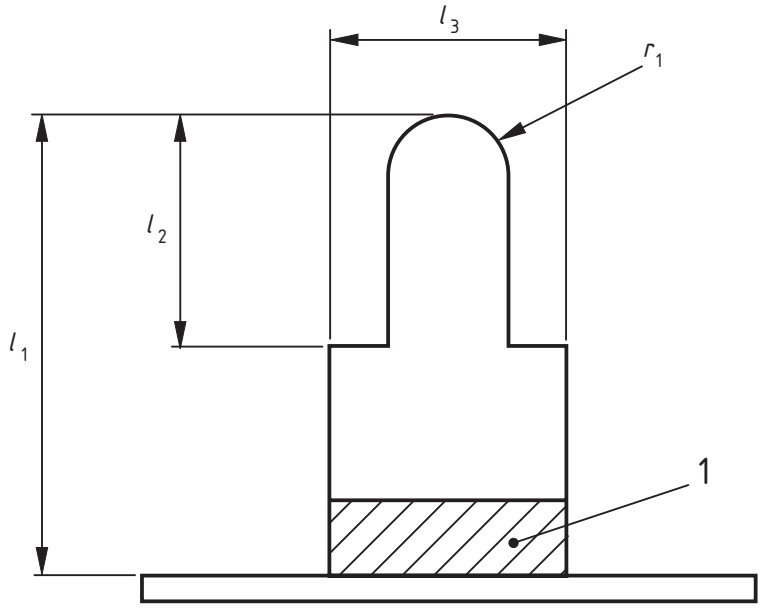
1 Load cell or force transducer (not shown to scale)

l_1 >100 mm

l_2 (100 ± 2) mm

r_1 (100 ± 2) mm

a) 100 mm radius anvil for testing foot protectors and the foot area of foot and ankle protectors



Key

1 Load cell or force transducer (not shown to scale)

l_1 >200 mm

l_2 >100 mm

l_3 (100 ± 2) mm

r_1 (25 ± 1) mm

b) 25 mm radius anvil for testing the ankle area of foot and ankle protectors

6.5.3 Procedure for blunt impact testing

6.5.3.1 Test specimens shall be prepared from protectors that have had the dimensions of the zone of protection marked on their outer surface in accordance with **6.3**. 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.

6.5.3.2 Using the brick edge impactor (**6.5.2.6**), five randomly placed impacts shall be made on each type of construction present in 10% or more of the zone of protection, or each area of the zone of protection, as applicable, 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**.

6.5.3.3 Impact sites shall be marked so that no area is impacted more than once. The centres of impact shall be not less than 50 mm apart. In the case of foot protectors, the centres of impact shall be not less than 25 mm from the edge of the zone of protection marked on the protector. In the case of foot and ankle protectors, the centres of impact shall be not less than 25 mm from the edge in the foot area of the zone of protection and not less than 15 mm from the edge in the ankle area of the zone of protection, but impacts may be made up to or on the line separating the two areas.

6.5.3.4 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.

6.5.4 Procedure for blade impact testing

6.5.4.1 Using the blade impactor (**6.5.2.7**), three blade impacts shall be made on each type of construction identified in the examination in accordance with **6.2**. One impact shall be made on each type of weak area or point identified in the examination in accordance with **6.2**.

6.5.4.2 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. In the case of foot protectors, the centres of impact shall be not less than 25 mm from the edge of the zone of protection marked on the protector. In the case of foot and ankle protectors, the centres of impact shall be not less than 25 mm from the edge in the foot area of the zone of protection and not less than 15 mm from the edge in the ankle area of the zone of protection, but impacts may be made up to or on the line separating the two areas.

*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 cut resistance requirement specified in **5.6.2**.*

6.5.4.3 The blade shall impact the test specimen at an angle of approximately 90° to the position of the long axis of the foot or ankle, as applicable. 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.

6.5.4.4 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.

6.5.4.5 All results shall be recorded in the test report.

6.6 Burning behaviour

Testing shall be carried out in accordance with BS EN ISO 15025: 2002, Procedure A with the following modifications.

a) For each component or construction in the protector, identified in accordance with **6.2**, two test specimens 80 mm by 80 mm shall be used.

b) Each test specimen shall be positioned horizontally with the outer surface facing downwards.

c) A vertical flame of height 40 mm shall be used.

d) The burner shall be arranged so that the flame strikes the test specimen in the centre.

e) The flame shall be applied to the test specimen for 15 s.

Annex A (informative)

Information and guidance on use of foot and ankle protectors and foot protectors

This part of BS 7971 specifies foot and ankle protectors and foot protectors that provide coverage to specific areas from above the ankle joint neck to the base of the toes. The protectors can be expected to protect the wearer from blunt impacts caused by thrown missiles or physical assaults, with or without weapons, striking the feet.

Foot protectors are suitable for use with lower leg protectors that include ankle protection, while foot and ankle protectors are suitable for use with lower leg protectors that do not include ankle protection. This is to ensure that the ankle is always protected.

Foot and ankle protectors and foot protectors have a hard plastics outer shell which can be expected to protect against hypodermic needles and slashing knife cuts.

WARNINGS:

- Foot and ankle protectors and foot 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 firearms or explosive devices.
- Foot and ankle and foot protectors give finite coverage. The user is vulnerable to blows that impact any gaps and to blows near the edges of the protectors.

Bibliography

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 7971-5:2004, *Protective clothing and equipment for use in violent situations and in training – Part 5: Footwear – Requirements and test methods*

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

BS EN ISO 20345:2004, *Personal protective equipment – Safety footwear*

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