INTERNATIONAL STANDARD

ISO 13998

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Protective clothing — Aprons, trousers and vests protecting against cuts and stabs by hand knives

Vêtements de protection — Tabliers, pantalons et vestes de protection contre les coupures et les coups de couteaux à main

Reference number
ISO 13998:2003(E)

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13998 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

Annex ZZ provides a list of corresponding International and European Standards for which equivalents are not given in the text.

For the purposes of this International Standard, the CEN annex regarding fulfilment of European Council Directives has been removed.

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Foreword

This document (EN ISO 13998:2002) has been prepared by Technical Committee CEN/TC 162, "Protective clothing including hand and arm protection and lifejackets", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 94/SC 13 "Personal safety — Protective clothing and equipment".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2003, and conflicting national standards shall be withdrawn at the latest by June 2003.

This document supersedes EN 412:1993

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

The annexes A and B are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard : Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Protective aprons, trousers and vests that offer some protection against stabs and slashes are used in work where a knife is moved towards the users' body, especially when working with hand knives in slaughterhouses, in the meat, fish and shell fish processing industries, in large-scale catering establishments, and in manual boning-out operations to process meat, fish, game and poultry. Protective aprons, trousers and vests that offer some protection against stabs and slashes may also offer adequate protection for those working with hand knives in the plastics, leather, textile and paper industries, when laying flooring and in similar tasks.

Performance level 1 aprons, trousers and vests as specified in this standard provide some cut protection and are only appropriate where the work is light, and where powerful cutting movements towards the body do not occur (see annex A).

Performance level 2 aprons, trousers and vests are appropriate for use in slaughter houses and in boning operations and in processing industries when narrow bladed knives are used in cutting actions in which the point of the knife is not directed towards the body. They are appropriate when broad bladed knives are used in cutting actions in which the point of the knife may be directed towards the body.

Attention is drawn to legislation and other standards concerning public health in the food industry and hygiene in the meat processing industries, that might apply to the construction, construction materials and cleaning of protective aprons, trousers and vests and associated straps and fasteners.

1 Scope

This European Standard applies to protective aprons trousers and vests for use with hand knives, and to other garments providing similar protection to parts of the body in accidents. It specifies requirements for the design, penetration resistance, cut resistance, sizing, ergonomic characteristics, innocuousness, water permeability, cleaning and disinfection, marking and information to be supplied by the manufacturer for users of protective aprons, trousers and vests. It also describes the classification of protection levels and appropriate test methods.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this draft revision of the European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 340:1993, *Protective clothing - General requirements*.

EN 1082-1:1996, *Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives — Part 1: Chain mail gloves and arm guards*.

EN ISO 13997, *Protective clothing — Mechanical properties — Determination of resistance to cutting by sharp objects (ISO 13997:1999).*

EN 20811:1992, *Textiles — Determination of resistance to water penetration — Hydrostatic pressure test.*

3 Terms and definitions

For the purposes of this European standard the following terms and definitions apply:

3.1
apron
a garment covering the front of the body from the chest to the legs

3.2
divided apron
an apron the protective surface of which is vertically divided in the thigh region and restrained to each leg, see Figure 1a

3.3
protective trousers
a garment worn below the waist and provided with separate legs. The protective surface may be confined to certain parts of the garment, see Figure 1b

3.4
protective vest
a garment worn on the torso of the body and covering the chest down to at least the waist, the shoulders, and parts of the upper arms. The protective surface may be confined to certain parts of the garment see Figure 1c and d

3.5
protective surface
that part of a garment that is constructed of material designed to resist penetration by hand knives

3.6
protective material
the material(s) of which the protective surface of a garment is constructed

NOTE This material may be metal chain mail or linked metal plates or materials with the same function.

3.7
interstice
the space or opening between two or more elements of a garment's protective surface

3.8
cover or covering materials
the material that may be used to construct a surrounding bag or a one-sided cover for the protective materials out of which a protective garment is constructed

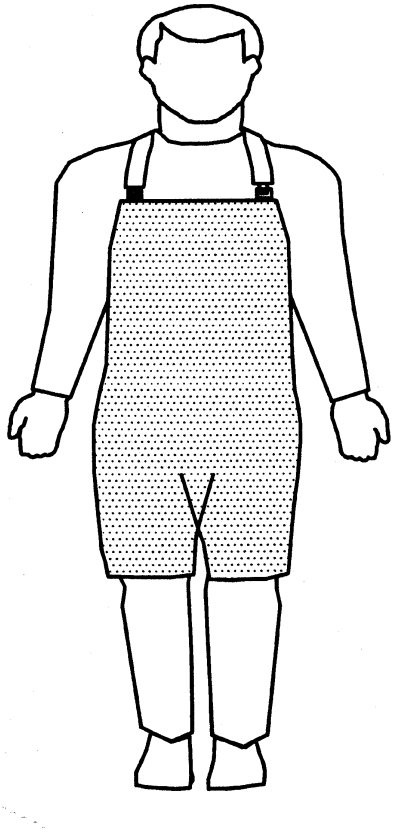
3.9
apron support
the means by which the apron is supported on the body while the apron is in use. Apron supports may be:

- shoulder straps in X-form as shown in figure 2a, and an independent waist belt;
- shoulder straps connected to the waist belt in Y-form as shown in figure 2b;
- sleeveless coats or harnesses to which the protective apron is attached;
- or extensions of the protective material to form an entire garment, e. g., a sleeveless coat with a short back and long front as shown in Figure 1c and d

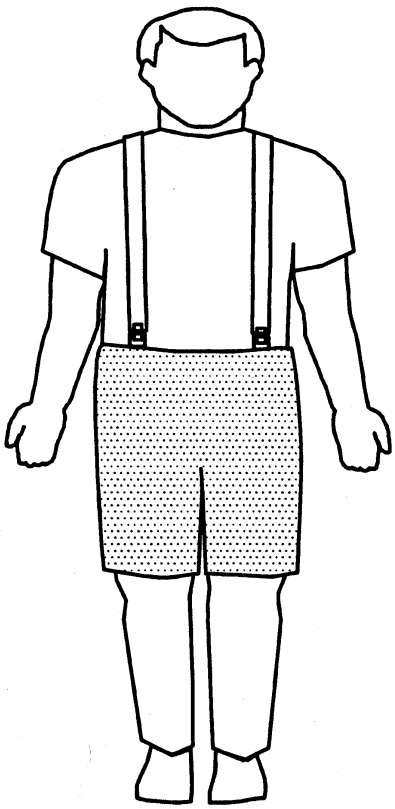
3.10
ultra narrow knife
a knife with a blade less than 8 mm wide, 20 mm from the tip. (See also Annex A)

3.11
narrow knife
a knife with a blade between 8 mm and 12,5 mm wide, 20 mm from the tip

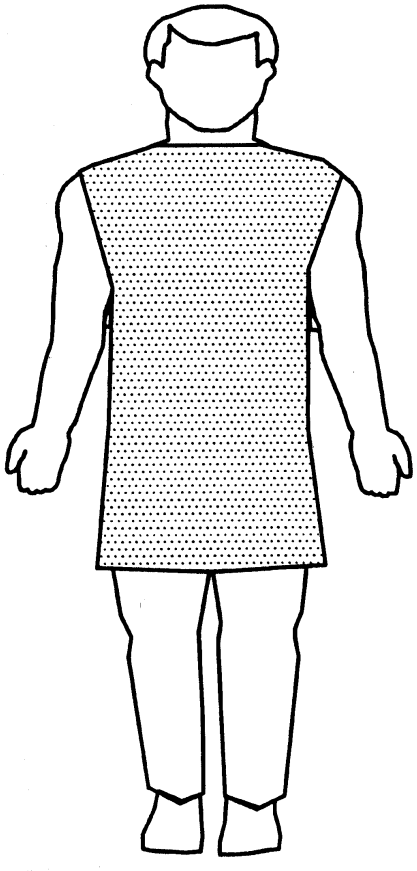
3.12
broad knife
a knife with a blade more than 12,5 mm wide, 20 mm from the tip



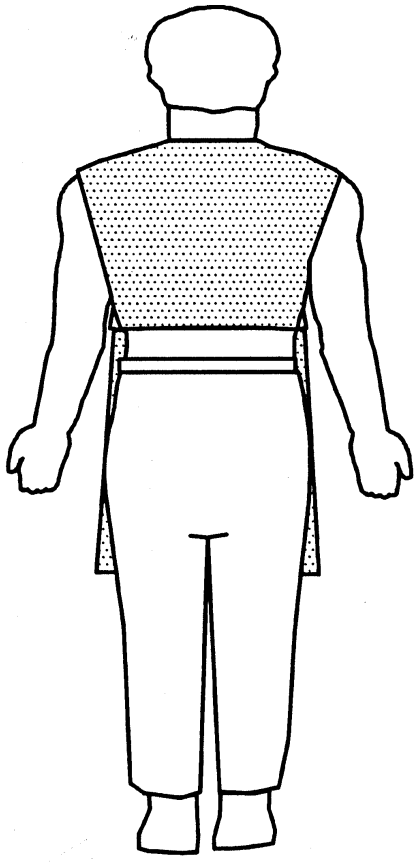
a) A divided apronshowing the overlap providing coverageat the top of the division



b) Shorts, front view

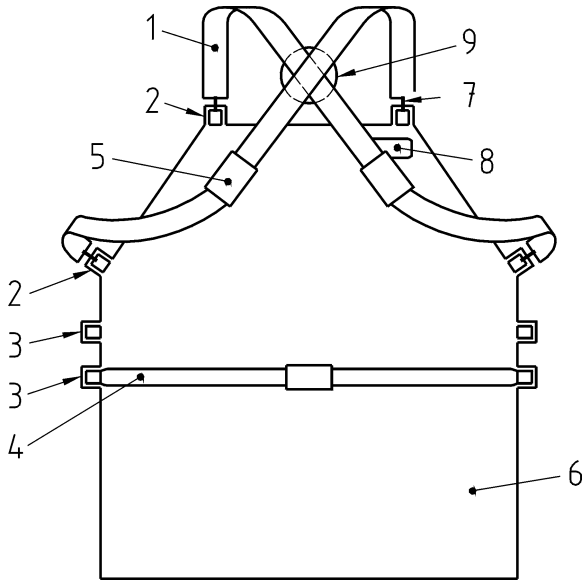


c) Vest, Coat or Tee-shirt style apron; front view

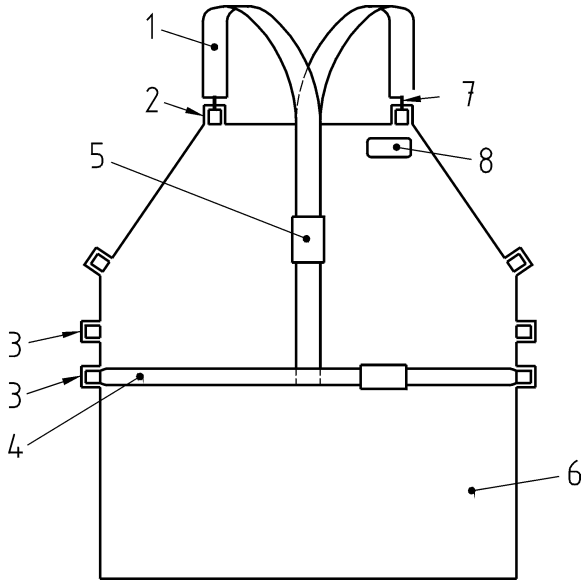


d) Vest, Coat or Tee-shirt style apron; back view

Figure 1 — Types of protective garment other than flat aprons



a — X form shoulder straps



b — Y form shoulder straps

Key

1 Shoulder strap
2 Shoulder strap fastening points
3 Waist belt fastening points
4 Waist belt
5 Adjuster for altering the strap length
6 Protective surface
7 Fastener
8 Identifying mark which is only visible on the outer surface
9 Restraining buckle through which the straps can slide independently

Figure 2 — Straps and belts of aprons

3.13
fastening point
a loop or ring that is an integral part of the garment and to which straps or a belt can be attached

3.14
fastener
the means by which a removable strap or belt is attached to the fastening point on the garment

3.15
outer surface identifying mark
a mark on the outer surface of the garment indicating it is the outer surface

3.16
waist line
the horizontal line marking the plane at the level of the top of the hip bones (supra cristal plane)

3.17
central point of an apron or vest on the chest
the point on the midline of the apron at a distance of ½ l_2 above the waist line (see figure 3)

4 Performance level classification

The performance level number designates the degree of the protection that it is intended the garment should provide. This number is used in designating the test severity to which the garment is to be subjected.

NOTE Level 1:These garments are suitable for working situations where the level of hazard is low such as when only broad bladed knives are used. (See informative annex A).

NOTE Level 2:These garments are suitable for working situations where the level of hazard is higher such as when narrow boning-out knives are used on large carcasses.

5 Requirements

5.1 Innocuousness

Protective equipment shall be designed and manufactured to provide protection when used according to the manufacturer's instructions, without endangering the user or other persons. Construction materials and incorporated substances shall not endanger those coming into contact with them: the manufacturer or his representative in the European Union shall list in the Information Supplied by the Manufacturer, the names of all substances contained in the garment which are generally known to cause allergies or to be sensitizers as required in clause 9. There shall not be hard or sharp edges, seams, buckles or other items on the surfaces, edges or fasteners of the garments that could harm users or other persons. Examinations shall be made according to 7.3.

5.2 Sizing

Protective equipment shall be marked with its size as required in clause 8. In accordance with EN 340:1993 the size shall be related to the height (stature), to the chest girth (or bust girth) and to the waist girth of the user the garment is intended to fit, and this shall be explained in the Information Supplied by the Manufacturer, see clause 9. Protective garments not extending above the waist shall be sized against the user's height and waist girth only. Dimensions and size marking shall be verified in accordance with 7.4.

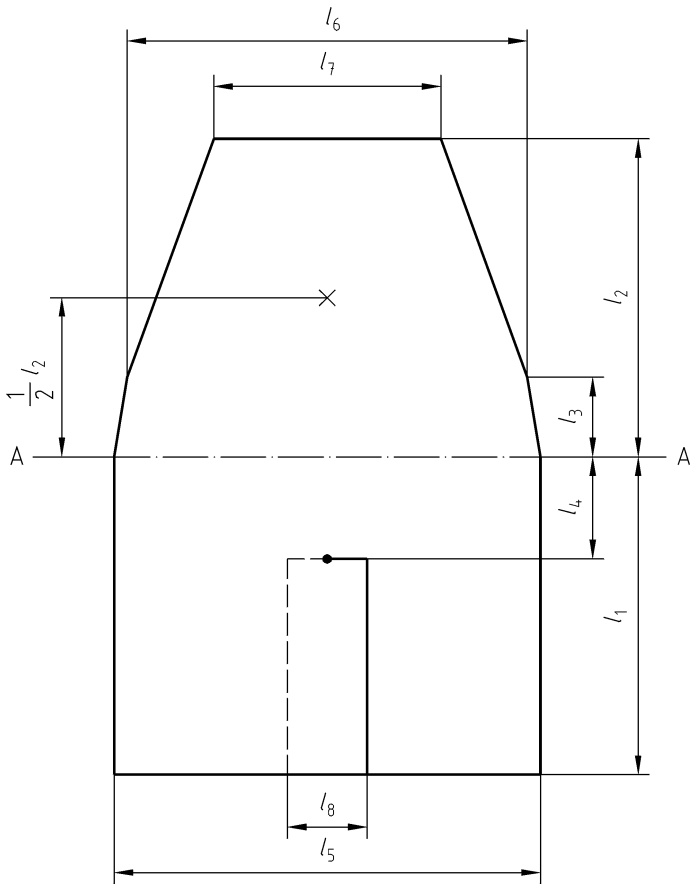
5.3 Minimum dimensions of zones of protection

5.3.1 Performance Level 1 and performance Level 2 Aprons

Protective aprons meeting either performance level, shall have a protective zone the dimensions of which shall be related to the size of the intended users.

The dimensions and position of the zone of protection relative to the overall coverage provided by the garment shall be given in the Information Supplied by the Manufacturer, see clause 9. The minimum zone of protection specified below shall be symmetrical about the vertical midline.

The minimum dimensions of the zone of protection shall be determined by the largest size of user the apron is designed to fit, according to the values in Table 1. These dimensions are illustrated in figure 3. The dimensions of the zone of protection shall be verified according to the method given in 7.5.1.



Key

l_1 to l_8 Dimensions given in Table 1

A – A The waist line as determined when the apron is worn

X Defined central point on the chest

Figure 3 — Dimensions of the zones of protection of level 1 aprons

Table 1 — Minimum dimensions of the zone of protection of performance level 1 and level 2 aprons

Dimension see figure 3	Value of the dimensions of the apron expressed as a percentage of the control body dimension of the largest user the apron is specified to fit		
	height	chest or bust girth	waist girth
l_1	> 22%	-	-
l_2	> 20%	-	-
l_3	> 6%	-	-
l_4 [a]	> 12%	-	-
l_5	-	-	>45%
l_6	-	>45%	-
l_7	-	>25%	-
l_8 [a]	-	-	>10%
[a] Performance Level 1 only			

5.3.2 Performance Level 1 divided aprons

The overall dimensions of divided aprons shall be as for undivided aprons except that the lower part may be divided by a vertical slit. This slit shall not extend higher than a point determined by the dimension l_4 on figure 3 which shall not be less than 12 % of the height of the largest user the apron is intended to fit.

The protective material either side of the slit in divided aprons shall be increased in width so that the two sides overlap by not less than dimension l_8 in figure 3 when the apron is laid on a level surface.

5.3.3 Protective trousers

Protective trousers shall have a continuous zone of protection from the waist to just above the knee. The zone of protection shall cover the anterior surfaces of the abdomen and thighs extending posteriorly to the mid-coronal plane of the body. The zone of protection shall have a width greater than 50 % of the circumference of the part of the body it is designed to protect. The vertical dimension of the zone of protection measured from the waist line towards the knee shall be not less than 30 % of the largest specified user's height. The dimensions of the zone of protection shall be verified according to the method given in 7.5.3.

5.3.4 Protective vests

Protective vests shall have a continuous zone of protection from below the waist to cover the front of the chest, the top and back of the shoulders, and the upper half of the upper arms. The protective zone shall have a width greater than 45 % of the part of the body below the arm holes that is covered. The zone shall extend down the back of the shoulders to the lower level of the arm holes of the garment. The circumference of the neck inlet of the protective zone shall be less than 55 % of the chest circumference of the user the garment is designed to fit. The front length of the protective zone from the top of the shoulders shall be greater than 35 % of the height of the user the garment is designed to fit. The distance between the lower edge of the sleeve measured along the line from the elbow to the centre point of the back of the neck of the garment shall be greater than 42 % of the chest circumference of the user the garment is designed to fit. The dimensions of the zone of protection shall be verified according to the method given in 7.5.3.

5.4 Support and restraint of aprons, divided aprons and protective trousers

5.4.1 All garments

Protective clothing shall be provided with support and restraint systems so that it does not become displaced in normal use or during an accident.

5.4.2 Restraint of aprons

The maximum displacement of the defined central point of the apron on the chest, shall be 75 mm when a force of 30 N is applied in lateral and downwards directions as described in 7.6.

5.4.3 Apron supports

All apron supports shall be adjustable in length and the adjusters shall be of a type that does not slip under load. No strap shall pull through a buckle more than 10 mm under a load of (100 $\pm$ 5) N during testing according to 7.6.1.

The apron support over the shoulder shall be at least 35 mm wide. The apron support around the waist shall be at least 25 mm wide. Provision shall be made so that any free end of a strap or belt can be secured to the straps, belt, or apron after adjustment of the apron support. Fastenings and adjusters shall be irremovable except by intent. Fastening points for X form and Y form straps shall be provided on at least as many points as indicated in figure 2 for aprons designed to take these straps

It may be necessary that fabric supports can be removed for separate cleaning of the support and protective parts of a garment. This could be a requirement in some industries (see the introduction to this European Standard).

Apron supports shall be designed so that they do not exert a force on the back of the neck of the user.

5.4.4 Divided aprons

Divided aprons shall be provided with straps and supports as specified for other aprons, and shall in addition have straps or other closures to restrain the divided sections to the thighs.

5.4.5 Protective trousers

Protective trousers shall be provided with an adjustable waist strap or over-the-shoulder straps (“braces”).

5.4.6 Protective vests

Protective vests shall be provided with adjustable side closures or an adjustable back closure.

5.5 Ergonomic requirements

The protective garments shall be designed to minimise discomfort and impediment while wearing them. When tested according to 7.7 the mean score of all subjects shall be less than 2 for performance level 1 garments and 2,5 for performance level 2 garments.

5.6 Mass

Performance Level 1: Protective aprons and other garments shall be constructed of material in the protective zone of less than 3 kg $\times$ m^{-2}. Testing shall be in accordance with 7.8.

Performance Level 2: Protective aprons shall be constructed of material in the protective zone of less than 4,5 kg $\times$ m^{-2}. Testing shall be in accordance with 7.8.

5.7 Penetration resistance

5.7.1 Interstices and holes

Penetration resistance shall be provided over the whole area of the minimum zone of protection provided by the garment. The dimensions of interstices between chain mail rings or any other components, or holes through any components of the protective material of performance level 1 garments shall be such that the 4 mm wide gauge number 2 described in 5.5 of EN 1082-1:1996 is unable to pass through them when applied as described in 6.3 of EN 1082-1:1996 and 7.9.1 of this European Standard.

The dimensions of interstices between any plates, rings or similar components, or holes through any components of the protective material of performance level 2 aprons shall be such that the gauge described in 6.2 and shown in Figure 4, is unable to pass through the garment when applied as described in 7.9.1.

5.7.2 Blade penetration, Level 1

The material of the protective zone of performance level 1 garments shall resist knife impact penetration when tested in accordance with 7.9.2. (2,45 J). The mean penetration shall not exceed 10 mm and no single penetration shall exceed 17 mm.

5.7.3 Blade penetration, Level 2

Penetration resistance shall be provided over the whole protective surface of performance level 2 garments, and when any part of the surface is tested in accordance with 7.9.2 (4,9 J) the mean penetration shall not exceed 12 mm and no single penetration shall exceed 15 mm.

5.8 Cut resistance of performance level 1 garments

Cut resistance shall be provided over the whole area of the minimum zone of protection provided by the garment. testing shall be conducted in accordance with the method given in 7.10. The mean cutting force shall not be less than 50 N. Garments constructed of metal rings or metal plates are excluded from this requirement.

5.9 Tensile strength of metal rings

The tensile strength of chain mail protective material when tested in accordance with the method in 7.11 for performance level 1 garments shall be such that no ring or link shall break or open when a force of 100 N is applied. When tested according to 7.11 no rings, link or plate in a performance level 2 garments shall break or open when a force of 200 N is applied.

5.10 Water permeability (optional)

The material from which the garment is made, or the covering material, shall be impermeable to water when tested to a pressure of 200 kPa according to 7.12.

6 Test apparatus

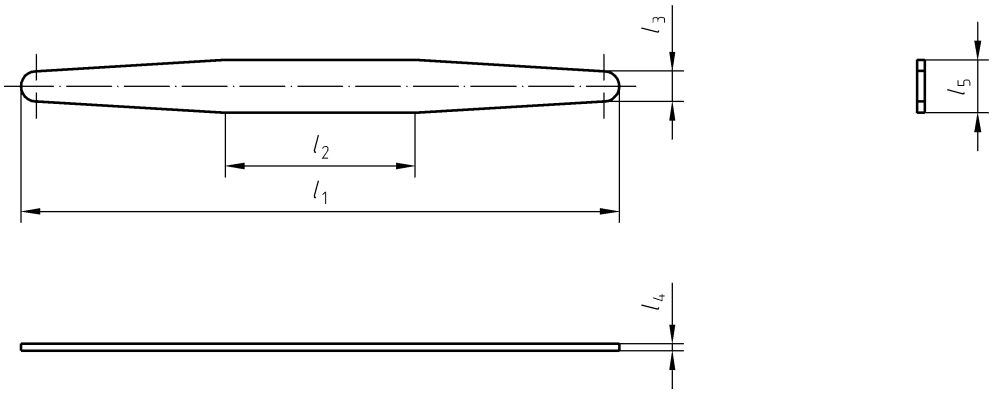
6.1 Accuracy of test instruments

Measuring instruments shall be accurate to a level that permits determinations at the pass/fail point to be accurate to ± 1% of the pass/fail level of the characteristic being measured.

6.2 Gauges for interstices

The gauge for testing performance level 1 garment interstices shall be in accordance with 5.5 of EN 1082-1:1996.

The gauge for performance level 2 garment interstices shall be made of steel and is shown in figure 4.



Key

l_1 (150 ± 5) mm

l_2 Not less than 50 mm

l_3 (8 ± 0,5) mm

l_4 (2 ± 0,05) mm

l_5 (12,5 ± 0,1) mm

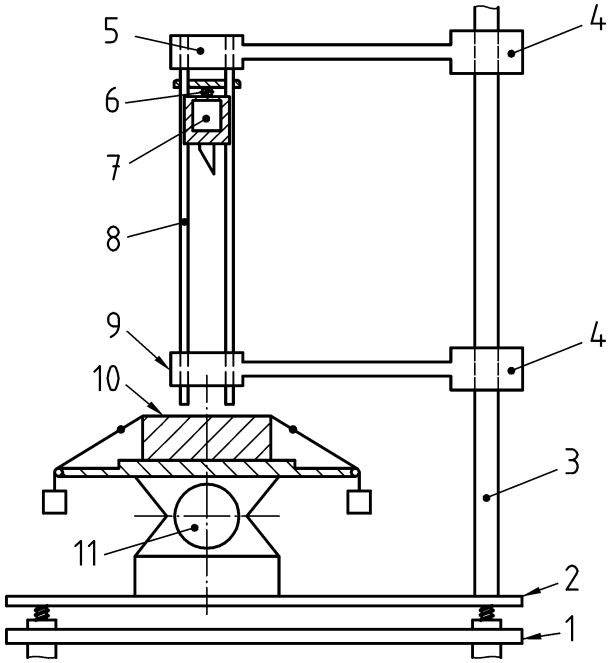
Figure 4 — Gauge for level 2 garment interstices

6.3 Knife impact penetration testing apparatus

6.3.1 Principle

The protective material of garment is tested by repeated impact of standard knife blades held in a guided falling block. The component parts of a test apparatus are shown in figure 5. The design is not normative. Details of the test specimen support, falling block and test blade are given in subsequent clauses.

Design details, such as the means for allowing removal of the block and test blade after impact, and necessary safety guards are not shown.



Key

1 Table
2 Base plate
3 Support
4 Bracket
5 Fixing block for the upper end of the guide rods
6 Electromagnetic release mechanism
7 Falling block and test blade
8 Guide rods
9 Fixing block for the lower end of the guide rods (The falling block passing through)
10 Test specimen
11 Tilting mechanism

Figure 5 — Penetration testing apparatus

6.3.2 Blade holding block

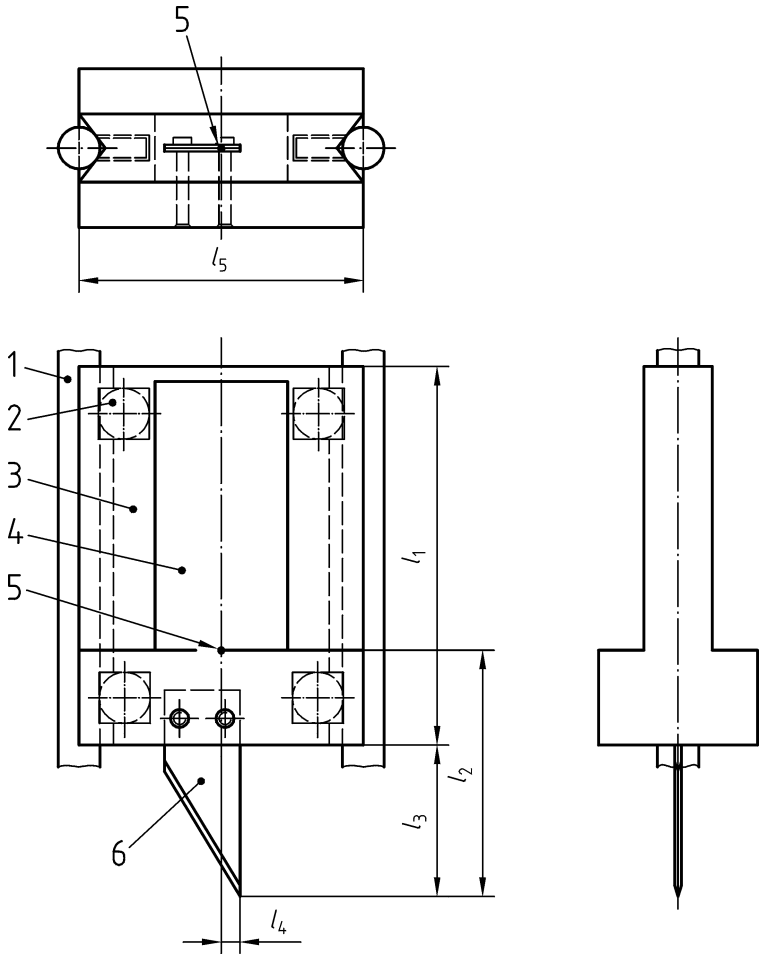
The blade holding block is shown in figure 6.

The test blade shall be held in the block so that it protrudes by (40 ± 1) mm.

The position of the blade tip shall be offset by distance l_4 from the centre line of the block which shall pass through the centre of gravity of the block, The centre of gravity of the block and blade shall be (65 ± 1) mm above the blade tip level.

The block shall be held in its initial position by an electromagnet. The block shall have four wheels or bearings and shall run freely on the two guide rods.

The height from which the block is released shall be set so that the velocity of the blade tip as it is about to strike the garment material equals that of a mass falling freely in a vacuum from the prescribed test height of 250 mm or 500 mm to give impacts of (2,45 ± 0,1) J or (4,9 ± 0,2) J.



Key

1 Guide rod

2 Wheel or bearing

3 Block

4 Cut out space to achieve correct mass distribution

5 Centre of gravity of block plus test blade

6 Test Blade

l_1 (100 ± 1) mm

l_2 (65 ± 1) mm

l_3 (40 ± 1) mm: an exception is given in 7.9.2

l_4 (5 ± 0,1) mm

l_5 (75 ± 1) mm: this is the distance between the guide rod centres, not the width of the block which is not prescribed

Mass (1000 ± 5) g

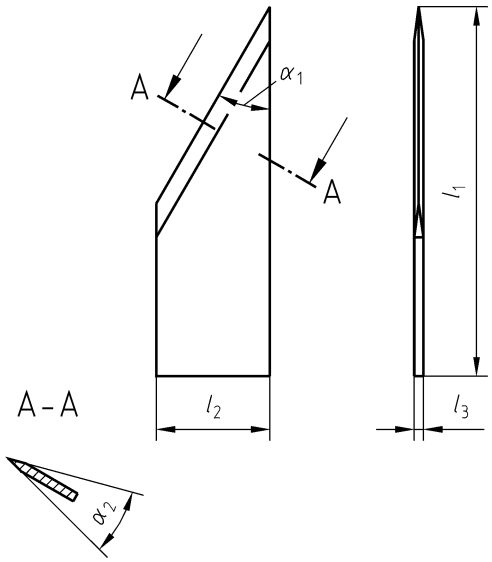
The remaining dimensions are not prescribed

Figure 6 — Blade holding block

6.3.3 Test blade

The test blade shall have the profile and dimensions shown in figure 7. It shall be made of cold-forged stainless steel with a degree of hardness of more than (47 ± 2) HRC. Its edge shall be straight and sharp. Before every penetration test, the impact blade shall conform to the specification.

NOTE After machine grinding, the blade edge should be made smooth and sharp by hand finishing on an oil stone.



Key

α_1 Angle of the sharp edge to the back of the blade: (30 ± 1)°

α_2 included angle of the sharp edge: (30 ± 1)°

l_1 length of the blade: not less than 65 mm

l_2 Width of the blade (20 ± 0,5) mm

l_3 Thickness of the blade: (1,5 ± 0,05) mm

Figure 7 — Test blade

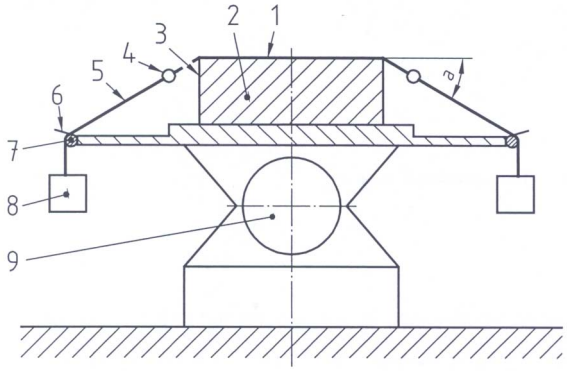
6.3.4 Test specimen and support

Figure 8 illustrates the apparatus described below. The test specimen of the protective material of the garment shall be supported on a tray with internal dimensions of not less than 300 mm × 300 mm and 100 mm deep**.** The tray shall be filled level with its top edge with flesh simulant plastic mass (see 6.3.5).

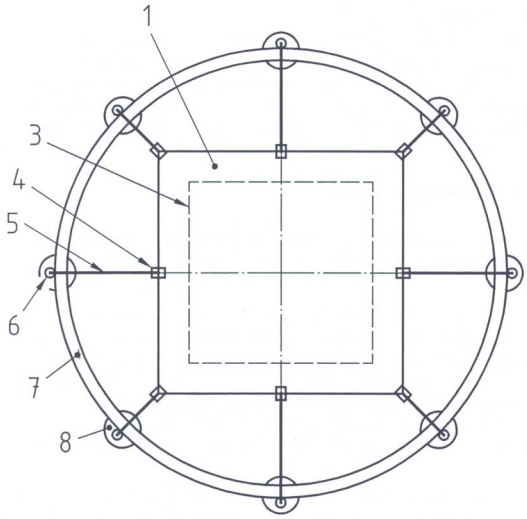
The test specimen shall be not smaller than 400 mm × 400 mm. It shall be tensioned by eight weights of (400 ± 10) g each on a string arranged to fall over a hoop with an outside diameter of not less than 800 mm. The distance between the hoop and the top of the tray shall be such that a string from the garment material at 90° to the mid point of a side of the tray lies at (30 ± 15)° below the plane of the surface of the flesh simulant mass.

The strings shall pass through rings that can be fixed in position on the hoop.

Provision shall be made so that the test specimen, tray and hoop can be inclined as a single unit at (30 ± 2)° to the horizontal.



a) Side view



b) Top view

Key

1	Test specimen	6	Ring on the hoop
2	Mass	7	Hoop
3	Tray	8	Weight
4	Clamp	9	Titling mechanism
5	String	a	Angle of the string to the surface of the mass: (30 ± 15)°

Figure 8 — Test specimen support

6.3.5 Flesh simulant plastic mass

6.3.5.1 Principle

The material supporting the garment material during test blade impacts shall simulate human flesh. It should be deformable, non-elastic and have inertial characteristics similar to flesh. Any material with the density and deformation characteristics prescribed in clause 6.3.5.2 is suitable. The utilisation of a low density powder dispersed in non-drying oils to form a soft mass is convenient as its properties are temperature dependent .[1)]

1) Flesh Simulant is the trade name of a product of this type that has at times been available. Details of current suppliers are available from the Secretariat of CEN/TC 162 at DIN Deutsches Institut fur Normung e. V., D-10772 Berlin, Germany. This information is given for the convenience of users of this European standard and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same result.

6.3.5.2 Properties of the plastic non-elastic material (plastic mass)

The density of the material shall be between 1000 $kg.m^{-3}$ and 1500 $kg.m^{-3}$.

NOTE Such a material may be made by mixing fine white maize flour with liquid paraffin (*Paraffinum liquidum*: European Pharmacopoeia – 1997:0239). It has been found that 1 kg of flour requires about 170 ml of 0,84 to 0,86 density paraffin. If the mix is too hard more paraffin can be added, or conversely more flour. When tested in accordance with 6.3.5.3 the mean impression depth is (20 ± 2) mm. The temperature at which this result is obtained ± 2 °C is used for conditioning of the mass for at least 48 h before testing apron material.

6.3.5.3 Verification of the rheological properties of the plastic mass

The plastic mass shall be packed into the tray used to support the test specimens so that it is completely filled level with its top edge. Air pockets shall be minimised. The tray shall be kept in a temperature-controlled environment, ± 1 °C, for at least 24 h.

The tray containing the plastic mass shall be placed on a rigid base such as a concrete floor. A dropping mechanism supporting a steel ball (63,5 ± 0,05) mm in diameter, and weighing (1043 ± 5) g shall be provided[2]). The lower surface of the ball shall be adjusted to be (2000 ± 5) mm above the surface of the filled tray. The surface at the point of impact of the ball shall be horizontal to an accuracy of ± 50 mm in 1 m. The ball shall be dropped onto the plastic mass ten times. The points of impact shall be more than 60 mm from any edge of the tray and more than 90 mm from any other point of impact. The depth of the centre of each depression relative to undisturbed material or the edge of the box, shall be measured to an accuracy of ± 0,5 mm. The mean depth of indentation shall be calculated.

The plastic mass is acceptable for use at the conditioning temperature used if the mean depth of the depressions is between 18 mm and 22 mm. If this result is not obtained the tray should be re-conditioned at a different temperature, or the material should be re-mixed with more parafin oil or flour, or the material should be discarded.

The properties of the plastic mass shall be verified at least before every test of an apron specimen, or of a group of specimens of an apron material.

6.4 Tensile strength testing apparatus

The apparatus shall consist of two metal rods that can be inserted into the metal rings to be tested. The apparatus shall exert a force of (100 ± 10) N moving the metal rods apart for performance level 1 garment materials and (200 ± 10) N for performance level 2 garment materials. The peak force shall be reached smoothly in not less than 2 s or more than 10 s. The peak force does not need to be maintained. The metal rods shall be (1,2 ± 0,1) mm in diameter for performance level 1 materials and (2 ± 0,2) mm for performance level 2 materials. If, however, the aperture into which the rod is to be inserted is smaller, the rod shall be reduced in size until it just enters the aperture.

Information about the principles underlying this test and some possible types of apparatuses are given in informative annex B.

6.5 Cut resistance apparatus

The cut resistance measuring apparatus shall be as described in EN ISO 13997.

6.6 Water permeability

The apparatus for measuring water permeability shall conform with EN 20811:1992.

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[2]) Sphere RB-63 is the trade-name of a product supplied by SKF-Kugellager-Fabriken GmbH, D-70336 Stuttgart. This information is given for the convenience of users of this European standard and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same result.

7 Test procedures

7.1 General

For each of the required sequences of measurements performed in accordance with this standard a corresponding estimate of the uncertainty of the final result shall be determined. This uncertainty (Um) shall be given in the test report in the form Um = ± X. It shall be used in determining whether a "Pass" performance has been achieved. For example if the final result minus Um is below the pass level when the requirement states that a certain value shall be exceeded, the sample shall be deemed to have failed.

7.2 Test specimens

Test items shall be supplied by manufacturers or their agents complete with labels and the Information Supplied by the Manufacturer that will be supplied with the garments. Test items shall be washed, disinfected and dried five times according to the manufacturer's instructions in the Information supplied by the manufacturer, see clause 9, before testing according to the procedures in 7.3 to 7.12.

Test specimens for procedures 7.7 to 7.12 shall be conditioned in an environment of (20 ± 2) °C, and a relative humidity of (65 ± 5) % for at least 48 h before testing. Testing shall be carried out in the same environment, or immediately after the specimens are taken from the conditioning environment.

7.3 Innocuousness

The garment shall be examined visually and by hand to locate any hard or sharp edges, seams, buckles or other items that might injure the user or other persons. The Information Supplied by the Manufacturer shall be examined for a list of allergenic or sensitizing materials used in the garments. The results of the examination shall be recorded in the test report.

7.4 Sizing

The dimensions of the garment, restraint systems and adjustments, shall be measured with appropriate tape measures or other devices, and compared to the size marked on the garment and details in the Information Supplied by the Manufacturer, to determine whether the garment corresponds to the marking and to the information given. The garment may be checked by fitting to subjects of the appropriate body dimensions. The results of the examinations shall be recorded in the test report.

7.5 Measurement of the dimensions of zones of protection

7.5.1 Performance Level 1 aprons

The minimum dimensions of the zone of protection for the largest user that the apron is labelled to fit, shall be calculated from Table 1 in 5.3.1. The extent of the material in the apron providing protection shall be determined and its dimensions measured. The measurements shall be made on the apron after it has been laid flat on a level surface and stretched in all directions with the flat palm of the hand to maximise its surface area. If the apron has a three dimensional structure, the measurements shall be made on the outer face of the curved dimension.

The dimensions l_1, l_2 and l_4 in 5.3.1 are measured from the line A-A which is the line of the waist. The position of this line shall be determined by fitting and adjusting the apron to an appropriate subject, see annex A 6.2, and marking the level of the waist which is defined as the horizontal plane above the hip bones.

The results of the comparison of the calculated minimum dimensions and the measurements made shall be recorded in the test report.

7.5.2 Performance Level 2 aprons

Place the apron on a level surface. Stretch it in all directions with the flat palm of the hand to maximise its surface area. Allow the apron to adopt its untensioned state. Measure the dimensions l_1 to l_3 and l_5 to l_7 in figure 3 with a rule accurate to within ± 1 %. Report the values in millimetres.

7.5.3 Protective trousers and vests

The dimensions of the zones of protection in trousers and vests shall be measured as for aprons (7.5.1). It may be necessary to cut the supporting material of the trousers or vests to lay the material flat or alternatively to make the measurements while the trousers or vests are worn by a suitable subject.

The results of the comparison of the calculated minimum dimensions and the measurements and examination of the coverage provided by the protective material shall be recorded in the test report.

7.6 Support and restraint testing of aprons and protective vests

7.6.1 General

The garment shall be fitted to a dummy or shall be put on by a subject. The available range of adjustment of the supports and fastenings shall be examined to determine whether it is appropriate for the range of sizes of users stated on the label.

The garment shall be fitted to a dummy or shall be put on by a subject. The restraint system shall be adjusted according to the Information Supplied by the Manufacturer. A spring balance, force gauge, or other suitable device shall be attached sequentially to at least ten points on the protective material. These points shall be on the sides above the waistline and along the bottom edge of the garment. A force of (30 ± 2,5) N shall be applied tangential to the surface of the protective material and at approximately 90° to the edge at each point, and maintained for at least 30 s.

The movement of the defined central point of the apron or vest on the chest during application of the force shall be measured. The position of the garment and its adjustment shall be corrected between each force application.

The results of this testing shall be recorded in the test report.

7.6.2 Support and restraint testing of protective trousers

The garment shall be fitted to a dummy or shall be put on by a subject. The restraint system shall be adjusted according to the Information Supplied by the Manufacturer. A spring balance, force gauge, or other suitable device shall be attached sequentially to at least ten points on the protective material. These points shall be chosen so that the forces applied during testing will pull the garment in directions similar to those that may occur in use. A force of (30 ± 2,5) N shall be applied tangential to the surface of the protective material and at approximately 90° to the edge at each point, and maintained for at least 30 s.

The movement of the garment under load shall be observed and the adequacy of the restraint system determined.

7.6.3 Testing for slippage of buckles

Six buckles and associated straps of each type present on the garment shall be prepared for testing. They shall be clean and dry. Three shall be dipped into pig lard at (80 ± 2) °C for (30 ± 5) s and hung up to drain and cool for at least 30 min prior to testing. Three shall be dipped into water at (20 ± 2) °C for (30 ± 5) s immediately before testing.

For testing the strap fixed to the buckle shall be fixed to a rigid support. The running strap shall be pulled through the buckle by (100 ± 10) mm as though tightening the fastening of the garment. The end of the running strap that would be attached to the garment shall then be subjected to a sustained pull of (100 ± 5) N for (30 ± 5) s. Any movement of the strap through the buckle shall be measured.

7.7 Ergonomic testing

7.7.1 General

The garments shall be examined to determine whether they are ergonomically satisfactory. The sizes, the fit and the ergonomic characteristics of garments shall be determined by an assessor with the help of a test panel of subjects who wear the garments and perform a number of prescribed actions and answer questions.

7.7.2 Test panels

The members of the test panel do not have to be habitual wearers of the protective garments. They shall be selected to have physiques that would be expected of users of the garments. They shall be medically fit. Their body dimensions shall be measured and provided to the manufacturer or supplier of the garments to be tested. At least five men and five women should be available as test panel members. Their body dimensions should be such that garments regarded as small, medium and large can be assessed.

7.7.3 Procedures

Three subjects shall put on the garments and adjust them according to the manufacturer's instructions in the Information Supplied by the Manufacturer. They shall perform movements to assess the restriction and discomfort imposed by the garments, their straps and fasteners. The movements shall be typical of those made by users of the garments, and shall include:

— Raising the arms forwards to above the head;

— Raising the arms sideways to above the head;

— Bending the torso forwards with the arms outstretched as if to pick up an object placed about 300 mm above the floor;

— Bending forward with the legs flexed to pick up an object from the ground;

— Kneeling down to place the hands on the ground in front of the body as though working on flooring materials;

— Standing in front of a working surface about 800 mm high and bringing the hands together to manipulate small;

— objects;

— Walking;

— Climbing stairs;

— Other movements deemed to be typical of users of the garments.

After performing each movement several times, the subjects shall report their responses which shall be scored:

0 No restriction and no discomfort;

1 Slight restriction of movement, not uncomfortable;

2 Some restriction of extreme movements with discomfort;

3 Significant restriction of movement and discomfort;

4 Movement not possible without effort and discomfort;

5 Movement not possible.

The scores recorded by each subject shall be added up and divided by the number of movements performed. For each subject in the initial panel giving an average score of 3 or above, one further subject shall carry out the procedure. The mean value of the scores of all subjects shall be calculated.

The individual scores of subjects and the mean value obtained shall be included in the test report.

7.8 Determination of mass

Specimens of the materials in the protective zone of the garments shall be prepared. The linear dimensions and weight of the specimens shall be measured and the mass per unit area calculated. This procedure shall be repeated for all combinations of materials in the protective zone

The results shall be included in the test report.

7.9 Penetration testing

7.9.1 Interstices

The gauge No 2 described in 5.5 of EN 1082-1:1996 shall be used to probe any interstices in the protective zone of performance level 1 garments. Performance level 2 garments shall be tested with the gauge described in 6.2 and shown in figure 4. The gauge shall be pushed against the interstice with a force of up to $(10 \pm 0{,}5)$ N.

The material should be permitted to bend under test and to fold if the gauge enters further as this happens. Five examples of each type of interstice shall be tested, unless fewer than five are present. Interstices shall be similarly tested if they are covered or filled with a soft plastics material, rubber or similar compound.

All instances and positions where the gauge passes through the protective material shall be included in the test report.

7.9.2 Knife impact penetration testing

Knife impact penetration testing of performance Level 1 garments shall be carried out as described below. The nominal dropping height shall be 250 mm to provide an impact of $(2{,}45 \pm 0{,}1)$ J. Performance Level 2 garments shall be tested with a nominal dropping height of 500 mm providing an impact of $(4{,}9 \pm 0{,}2)$ J. All types of construction within the protective zone shall be separately tested with ten impacts on the horizontal material.

Adjust the height of the electromagnetic release mechanism to the appropriate height. 10 penetration tests shall be carried out with sharp, oiled test blades impacting the test specimen(s) at random. The specimen and support material shall be horizontal. After each test rotate the specimen approximately 35° with respect to the blade to provide 10 different orientations of impact. The impact site shall be at least 80 mm from the edge of the tray with the undamaged test specimen on smooth plastic mass.

Repeat the series of impacts with the tray, specimen and hoop inclined at $(30 \pm 2)°$ to the horizontal. Fix the rings through which the strings pass over the hoop to the hoop before inclining the apparatus. Make five tests with the vertical axis of the apron material down the inclined plane of the tray, and five tests with it transversely across the plane of the tray. Rotate the tray, specimen and hoop approximately 60° with respect to the test blade before each test. Check that the blade holding block does not strike the specimen. If it does at any particular orientation the blade length projecting from the block shall be increased. This is dimension l_3 in figure 6. Normally the blade shall project by (40 ± 1) mm.

After each test measure the length of the back of the blade exposed below the test specimen to an accuracy of $\pm 0{,}1$ mm. Calculate the mean penetration in the horizontal tests and inclined tests. Report the mean and the maximum penetrations from both series of tests.

7.10 Cut resistance testing

7.10.1 General

Cut resistance testing of performance level 1 garments shall be carried out as described in EN ISO 13997.

7.10.2 Test specimens

Test specimens shall be cut from the test item not less than 35 mm × 100 mm, to represent each type of construction in the protective zone. Test specimens shall be cut in groups of three at 60° to each other such that the test cuts are orientated at 120° to each other. At least two sets of test specimens will be required. A cutting force shall be determined for each orientation and the mean value calculated.

Test specimens of material with a multilayer construction shall be prepared for testing by stitching or stapling along their long sides to hold the layers in their normal orientation. The curvature of the test specimen holder shall be allowed for in preparing such test specimens.

7.10.3 Test specimen mounting

Freshly cut and prepared test specimens shall be laid on the adhesive tape on the test specimen holder and pressed into place without being stretched.

7.10.4 Number of tests

Each cutting force determination involves at least fifteen cuts. This determination is made for each of the three orientations of the specimens. If the material appears particularly cut orientation sensitive, further specimens shall be prepared at the intermediate orientations between the first series of three specimens. This will result in six cutting force figures being available. The mean value of the three or six figures shall be calculated.

The test report shall contain the individual cutting force values and the calculated mean value.

7.11 Tensile strength testing

Adjust the force that the apparatus exerts (see 5.9). Fix the metal rods into a pair of interlocking rings, or into a pair of rings on opposite sides of a plate or into similar links. Smoothly and progressively apply a force pulling the rings apart as it rises from 0 N to 100 N, or 0 N to 200 N, over a period of 2 s to 10 s.

Carry out 50 trials on an undamaged garment at random sites. Report all instances of rings or plates opening or breaking at a force below 100 N or 200 N, as appropriate. It is not required to report the force applied when breaking occurs.

7.12 Water permeability measurement

Water permeability testing shall be carried out according to EN 20811:1992 in an apparatus capable of sustaining pressures of 300 kPa. Five test specimens shall be used. The pressure shall be applied at the rate of 60 kPa/min to 100 kPa/min. Record the pressure at which the water appears at the third place on the surface of the specimen, or the pressure at which the specimen bursts, or that a pressure of 300 kPa is reached.

Calculate of the mean value of the individual results obtained and report all values.

8 Marking

The protective garments shall be permanently and conspicuously marked with at least the following:

— the name or trademark of the manufacturer or his authorised representative in the European Union;

— the manufacturer’s designation of the garment type, commercial name or code that uniquely identifies the item;

— the size designation according to EN 340;

— the level of performance of the garment;

— a mark indicating that the surface is the outer surface when this is not otherwise obvious;

— the appropriate protection level pictogram on the outside of the garment;

— an instruction to see the information supplied by the manufacturer, or the appropriate pictogram, figure 10 c);

— the number of this European Standard.

The following information should be given on the garment whenever practical:

— the type of use for which the garment is intended. Any type of use for which the garment is specifically not intended;

— the hazards specific to hand knife use against which some protection is given;

— the hazards specific to hand knife use against which protection is **NOT** given;

— textile and material types in the garment;

— Care labelling according to EN 340 including international care label symbols (negative labels are important).

9 Information supplied by the manufacturer

Garments providing protection against hand knives shall be supplied with information and instructions for use. Instructions shall be precise and comprehensible and in the official language(s) of the country of destination. They shall contain at least the following information where applicable to the particular garment:

— the information required in clause 8;

— the full address of the manufacturer or importer;

— a statement of the types of work for which the garment is suitable;

— an explanation of the levels of performance of garments available under this standard and a detailed description of the extent of the protective material in the garment and the zone of protection;

— how to select the correct size of garment for the user. How to check its fit;

— how to position and adjust the garment including a warning that the slit in divided aprons should have its highest point below the genitalia;

— instructions about wearing other PPE to obtain the protection desired;

— a warning that protection is limited to cuts and stabs from hand knives;

— a warning that level 1 garments do not provide protection against accidental stabs;

— a warning that level 1 garments should not be used where cutting movements are made towards the body;

— a warning about the dangers associated with using ultra narrow and narrow bladed knives. The warning shall include reference to a diagram of the form in figure 9. The minimum width l_2 of knife that should be used with the garment shall be stated as a minimum width at a distance of 20 mm from the knife tip;

— a warning only to use the garment in the form supplied;

— a warning to secure all loose ends of straps and to shorten free ends to 50 mm or less;

— a warning about any changes in environmental conditions, such as temperature, that would seriously reduce the performance of the garment;

— a warning that no garment can offer full protection against injuries;

— a warning about any contamination or misuse that would reduce the performance of the garment;

— a warning about any constituent materials used in the garment that may cause allergenic responses or are sensitizers;

— a warning about any types of work in which the garment could place the user at risk of injury. In particular state the hazards of powered tools and machines with moving parts, and that the garment conducts electricity if this is the case;

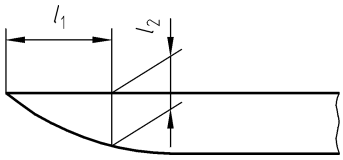
— instructions on how to clean and disinfect the garment. In particular state procedures that damage the garment;

— instructions on the examination of the garment to detect wear and degradation: give tests and actions to be taken when wear is apparent;

— the criteria to be used to decide between repair or discharge of the item;

— instructions on how to clean and disinfect water impermeable aprons and water impermeable covers;

— advice on other PPE to be worn with water impermeable aprons.



Key

l_1 20 mm

l_2 a value specified by the manufacturer or importer

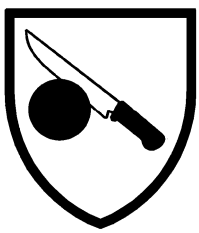
Figure 9 — Knife tip diagram

10 Pictograms

Garments fulfilling the requirements of this standard shall be marked with the pictogram shown in figure 10. The pictogram are to be placed on the garment and on the package in which it is supplied. In the case of the protection pictograms, the width of the shield shall be at least 30 mm.

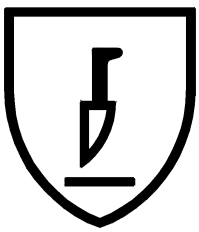
The pictogram shown in figure 10a shall be placed on the outside of every level 1 garments.

The pictogram shown in figure 10b shall be placed on the outside of every level 2 garments.



ISO 7000 - 2619

10 a)



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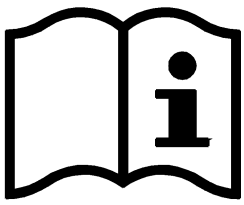
10 b)



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10 c)

Figure 10 — Pictogram

Annex A
(informative)

Advice on risk assessment, and the selection and fitting of different sizes of apron and other garments

A.1 Scope

The information in this annex is provided to assist users, employers and manufacturers to make risk assessments in order to define what type and performance level of garment is appropriate for particular jobs. The content is not normative.

A.2 Content

This annex contains information on the measurement of individual workers and the determination of the area of their body that should be covered by a protective apron or other garment, and advice on fitting an apron to a worker to ensure maximum protection. Advice is given on how to determine the level of protection required and the type of garment that may be most suitable.

A.3 Risk assessment

The choice of the type of garment to be used and the level of protection required should be made after carrying out a risk assessment of the job the user does.

A risk assessment could include the following steps:

Step 1 Primary hazard identification

— the profile of the knife and its sharpness;

— the movements made with the knife relative to the user's body during cutting the work piece, placing the work piece in position, removing the cut pieces, and any associated operations;

— the toughness of the work piece and the forces exerted with the knife;

— the variability of the work piece;

— the presence of machines with moving parts;

— the use of powered tools;

— the presence of sources of electric shocks in normal working or if machinery, tools or lights become faulty;

— chemical or biological hazards associated with the work or the environment.

Step 2 Secondary hazard identification

— the quality of the work station; such as the bench design, footwear-floor interaction, presence of interfering objects such as trolleys, possibility of sudden or continuous distracting events;

— the lighting conditions;

— the environmental conditions such as excessive heat, cold or noise;

— the skill and training level of the worker;

— the required work rate, and incentives to increase work rates.

Step 3 Risk estimation — Severity

— the severity of injuries should be considered by a study of plant accident and sickness records, those from comparable plants and the industry as a whole. The use of protective equipment should be taken into account in examining the records;

— injuries should be categorised into classes such as:

  — **slight —** fully reversible without time loss;

  — **moderate —** reversible but with loss of working time that is less than three days;

  — **serious —** irreversible and with more than three days loss of working time, possibly disabling;

  — **fatal**;

— the exact sites of the injuries should be analysed and correlated with the work being performed;

— the absence of reliable data is not a proof of safety.

Step 4 Risk estimation — Probability

— the duration of exposure of workers;

— the number of intercepted hazardous events as shown for example by the number of knife marks on used protective equipment;

— risk compensation by workers who feel protected by PPE, or who may change working practices when PPE is perceived to be improved;

— information from continuous monitoring of accident and sickness records;

— observations of changes in working practices as a consequence of deviations from safe working practices or changes in pay or bonus schemes;

— the measurement of the effectiveness of supervision to maintain safe working practices and the correct use of PPE.

Step 5 Risk evaluation — Risk reduction

— the risks and associated factors should be evaluated;

— changes in all aspects of the work should be considered to reduce the risks;

— if risk of injury remains, the use of PPE should be evaluated;

— the reduction of risk expected to be achieved by using different types of PPE should be evaluated;

— risks arising from the use of PPE such as entanglement; impediment or allergic responses should be evaluated.

Step 6 Residual risk

— the residual risk should be evaluated and accepted, or further changes made to the job;

— systems should be established to ensure all risk reducing measures are maintained;

— workers should be informed about the risks associated with the work;

— adequate equipment, procedures and training should be established to mitigate the effects of any foreseeable accident and injury.

Step 7 Specification of PPE to be used

— the performance level of stab resistance required;

— the performance level of cut and slash resistance required;

— the body area to be covered;

— the support and restraint systems necessary to provide comfort and ease of working with adequate restraint in the particular job;

— the possible requirement for high electrical resistance (non conducting material);

— the possible requirement for fluid and/or biological barrier materials (water impermeable);

— the requirements for cleaning and disinfection associated with the work;

— the need to wear other PPE for chemical, thermal or hygiene reasons and its compatibility.

A.4 Knife profiles

The risk of a serious injury to the body while wearing a protective apron is very significantly correlated with the profile of the knife being used. The working technique, protective clothing and knife profile should be monitored in the work place. Three knife types are distinguished in Table A.1.

Ultra narrow knives are dangerous and should never be used if an alternative technique is available that would allow the job to be done in greater safety; ultra narrow blades can penetrate deeply through most apron materials and also through normal chain mail gloves.

Narrow bladed knives should not be used with Performance level 1 garments in work where the point of the knife is directed towards the body.

Work on heavier animal carcases requires Performance level 2 protection. However ultra narrow bladed knives should not be used even with performance level 2 garments.

Table A.1 — Width of the blades as used in factories at 20 mm from the knife tip

Knife type	Width of the blade 20 mm from the tip, mm
Ultra narrow	< 8
Narrow	8 to 12,5
Broad	> 12,5

A.5 PPE performance levels and garment types

The requirements for protective aprons and other garments in this European Standard are for two performance levels of garments. It is necessary that knife profiles are carefully considered when choosing protective garments. Knife profiles should be monitored in the work place and there should be a rigorous policy of destroying knives that become too narrow.

a) Level 1 performance garments should provide adequate protection in jobs where the knives have broad blades and cutting movements are not made towards the body. Divided aprons are particularly suitable for use where extended protection down the thighs is required and when the job requires frequent torso bending movements or when the job requires frequent foot and leg movements. The additional restraints of the apron to the legs can reduce the strain of wearing the apron and increase the acceptability of PPE.

b) Level 2 performance garments have generally been found to provide adequate protection in abattoirs and meat cutting plants. However, in some operations it has been found necessary to provide protection over an increased area of the body; in particular the upper chest and shoulders, when cutting is done at this level or above.

c) Protective trousers are usually designed to end just above knees. These garments are particularly suitable for workers laying sheet flooring, wearing knee pads and working in the kneeling position.

Protective vests are particularly suitable for workers using knives level with their upper chest and above. They should end more than 100 mm below the waist and if worn with suitable trousers should give protection to the whole torso and thighs.

A.6 Apron sizing and fit

A.6.1 General

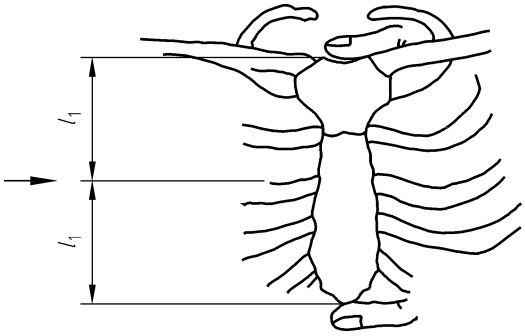
This European standard requires that garments be sized according to the dimensions of user they are intended to fit. The requirements specify the minimum areas of protective materials. The risk assessment may have shown greater areas of protective material are needed. In choosing a protective garment the clothing normally worn under it should be taken into account.

The size of an apron should be adequate to cover the front of the body from the middle of the sternum to the level of the middle of the thigh. (See below).

The user should put on the apron and adjust the straps to hold the apron in the correct position. The waist belt fixings should be adjusted for height if necessary. The user should then go through the normal movements of his job. A supervisor or other suitable person should ensure that the top edge of the apron is sufficiently stiff, and that the straps are correctly adjusted so that sagging is minimised, and that areas of the body that should be protected do not become uncovered.

A.6.2 Minimum body coverage by aprons

The top of the apron should have a particular relation to the mid point of sternum. This point is determined by feeling with a finger for the top of the sternum between the clavicles, and for the bottom of the sternum between the lower ribs; see figure A.1. In normal meat cutting work the top of the apron should be at or above the middle point of the sternum. If the knife is often used above the middle of the chest a higher apron is appropriate, because it is important to protect the heart and major arteries. The danger zone for stab wounds extends upwards to the level of the top of the sternum and over the top of the shoulders. The lower edge should be at the middle point of the thigh or below. The mid thigh level is approximately at the level of the tip of the middle finger when the fingers are extended along the thigh when the subject is standing upright.



The figure shows the finger positions in relation to the sternum. l_1 is half the distance between the fingers. The arrow is at the level of the mid point of the sternum.

Figure A.1 — The mid point of the sternum

A.6.3 Straps for aprons

Performance Level 2 aprons are heavy and may cause strain to users if the straps are not wide enough or are not adjusted correctly.

Performance Level 2 aprons are generally fitted with straps in an X or Y form, and a waist belt, see figure 2. This European Standard requires that all straps shall be adjustable in length, that there shall be no unsecured loose ends, and that fastenings and adjusters shall be irremovable except by intent.

For all aprons the force required to open a fastener should be greater than any accidental force that is likely to be applied to the fastener in use.

Shoulder straps in the X form should be adjustable by at least 150 mm in length.

Shoulder straps in the Y form should be adjustable by at least 150 mm in length. The vertical strap should be adjustable by at least 80 mm in length.

The waist belt for aprons should be adjustable by at least 200 mm in length, other lengths of straps and belts should be available to ensure an apron can be correctly fitted to a particular individual.

A.6.4 Performance Level 2 garments with extended areas of protection

Some workers may require performance Level 2 protection of the upper chest and front of the shoulders. Garments are manufactured with protective material covering these areas. The garments are usually like sleeveless coats with a short back and long front. They may be put on over the head or fastened at the back or side of the body. They can provide all the protection afforded by a standard apron and the additional protection mentioned. The weight of the garment should be taken on the shoulders not the neck. A range of sizes should be available to provide a close but not restrictive fit on the user. Some adjustment of fit should be provided on every garment to allow for changes in working conditions.

Annex B
(informative)

Testing for imperfect welds

B.1 Scope

The information in this annex is provided to assist manufacturers, and testing agencies check the quality of welds. The content is not normative.

B.2 Content

This annex contains information on the principles underlying the test described in 5.9 and 6.4, and on possible forms of apparatus.

B.3 Background of the test

The protective surface of aprons is frequently constructed from metal plates joined by welded metal wire rings, or from metal wire rings linked to form chain mail. If the welds are imperfect these materials may have weak areas that are not readily apparent. By stretching the weld its quality may be assessed.

An apparatus according to 5.9 is used to test the welds. Most poor welds in performance level 2 garments break at a force below 100 N, good welds withstand forces exceeding 200 N. 200 N is not a critical threshold value for safety, but a measure of manufacturing quality and consistency. Similarly performance level 1 welds will withstand forces in excess of 100 N if well made.

B.4 Principle of the test

A force is applied to pull apart two interlocked rings or rings through opposite sides of a plate. The rings pull on each other or the plate and bend around each other. When the peak force of 100 N or 200 N is applied the tension in the wire and thus across the weld is close to 50 N or 100 N.

B.5 Types of tensile strength testing devices

Any device conforming to the requirements of 5.9 and 6.4 may be used. The following are examples of possible types of apparatuses.

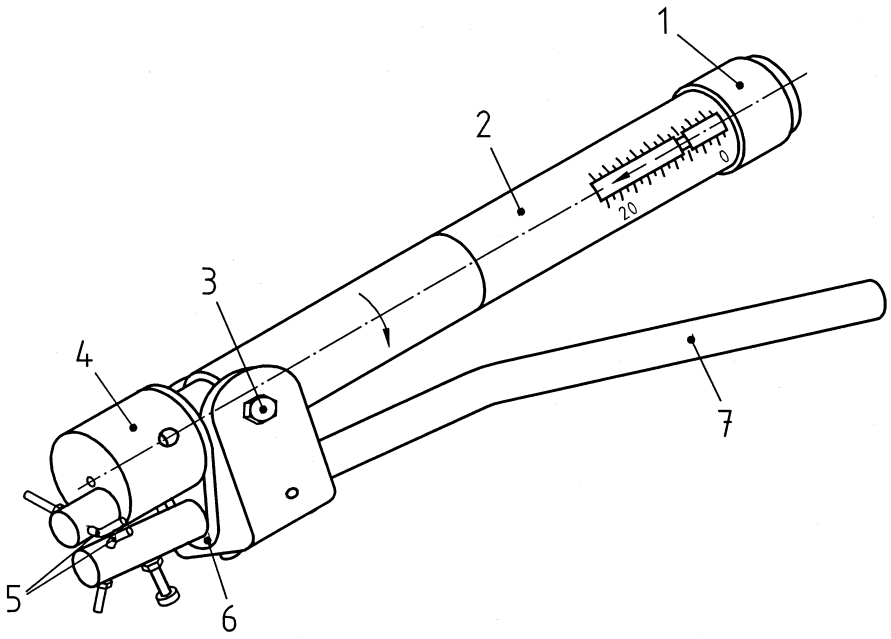
a) A tensile testing apparatus that can be set to reach a particular force in a set time. This could be a modified fabric or leather tester.

b) A tensile testing apparatus that tests to breaking point and which applies the required force at a time during the allowed interval. A force time record needs to be produced. This could be a modified fabric or leather tester.

c) A simple apparatus in which a mass of 10 kg or 20 kg is suspended from one ring while the interlocked ring is supported. The mass of the rest of the garment has to be supported so that it does not act on the pair of rings under test.

d) An apparatus acting on the basis of a pair of outwardly acting pliers. This could be equipped as described in b) or based on a torque wrench type mechanism so that it is in fact an apparatus type a).

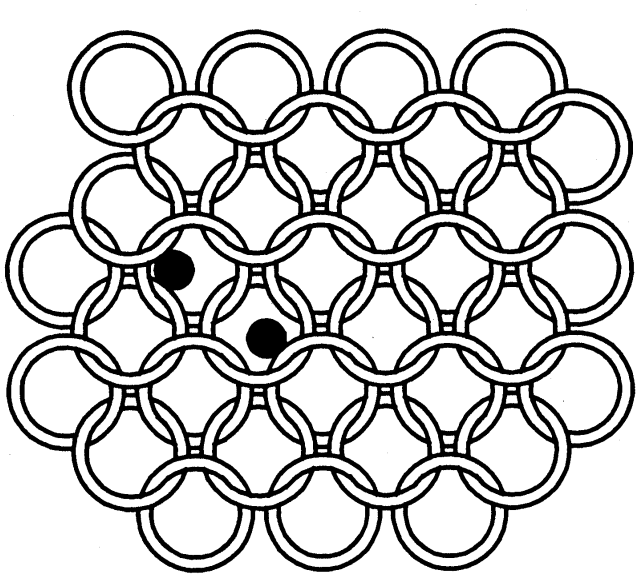
A torque wrench apparatus based on a side acting torque wrench is illustrated in figure B.1. It can be set to apply a separation force between the metal rods that form its tips, by using weights. Such an apparatus is easy and rapid to use but it should be checked carefully before being used to ensure that the force exerted is within the limits in 5.9.



Key

1 Adjuster for torque setting
2 Moving handle of torque wrench
3 Bolt on which the torque mechanism pivots
4 Part of the torque wrench that applies the test force
5 Metal rods for insertion into rings
6 Rubber return spring
7 Fixed handle

a) Torque wrench pliers



b) Chain mail showing the positions of the metal rods prior to a force being applied

Figure B.1 — Torque wrench pliers

Annex ZZ
(normative)

Corresponding International and European Standards for which equivalents are not given in the text

At the time of publication of this International Standard ISO 13998, the editions of the following documents were valid. Members of ISO and IEC maintain registers of currently valid International Standards.

EN 340:1993	ISO 13688:1998, *Protective clothing — General requirements.*
EN 1082-1:1996	ISO 13999-1:1999, *Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives — Part 1: Chain-mail gloves and arm guards.*
EN 20811:1992	ISO 811:1981, *Textile fabrics — Determination of resistance to water penetration — Hydrostatic pressure test.*

Bibliography

ISO 7000, *Graphical symbols for use on equipment — Index and synopsis.*

ICS 13.340.10

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