INTERNATIONAL STANDARD

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Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives —

Part 1:
Chain-mail gloves and arm guards

Vêtements de protection — Gants et protège-bras contre les coupures et les coups de couteaux à main —

Partie 1: Gants en cotte de mailles et protège-bras

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

International Standard ISO 13999 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing.* It is based on EN 1082-1:1996.

ISO 13999 consists of the following parts, under the general title *Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives:*

— *Part 1: Chain-mail gloves and arm guards*

— *Part 2: Gloves and arm guards made of material other than chain-mail*

— *Part 3: Impact cut test for fabric, leather and other materials*

Annex A forms a normative part of this part of ISO 13999. Annexes B, C and D are for information only.

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Introduction

Chain-mail gloves and metal or plastic arm guards that offer some protection against stabs are used in those aspects of work where a knife is moved towards the user's hand and forearm, 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, game and poultry. Protective gloves and arm guards against stabs may also offer adequate protection for those working with hand knives in the plastics, leather, textile and paper industries, when laying flooring and similar tasks.

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 gloves and arm guards and associated straps and fasteners.

It should be noted that the tests specified in this part of ISO 13999 are designed to be severe, and in some cases destructive, in order to adequately test the products. The requirements in this part of ISO 13999 based on these tests do not imply that, in normal use, knives will penetrate gloves or arm guards by significant distances.

It has been assumed in the drafting of this part of ISO 13999 that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been prepared. The apparatus described should only be used by competent persons and requires safeguards to prevent, as far as is reasonably practicable, injury to the operator and other persons.

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Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives —

Part 1:
Chain-mail gloves and arm guards

1 Scope

This part of ISO 13999 specifies requirements for the design, penetration resistance, ergonomic characteristics, straps, weight, material, marking and instructions for use, of gloves and arm guards. It also specifies the appropriate test methods.

This part of ISO 13999 applies to protective chain-mail gloves and to metal and plastics arm guards for use with hand knives.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 13999. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this part of ISO 13999 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 13998, *Protective clothing — Aprons, trousers and vests protecting against cuts and stabs by hand knives.*

3 Terms and definitions

For the purposes of this part of ISO 13999, the following terms and definitions apply.

3.1 Anatomical terms

Defined terms and symbols are illustrated in Figure 1.

3.1.1
digit
one of the terminal divisions of the hand

NOTE These are numbered from (1) the thumb to (5) the little finger in Figure 1 and the numbers are used to denote the appropriate digits in this part of ISO 13999.

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3.1.2
wrist
radio-carpal joint

NOTE To obtain the surface marking of the wrist level, place the hand and forearm, fully relaxed, on a flat surface with the palm upwards. A finger tip is pressed firmly in the direction of the arrow in Figure 1, to palpate the styloid process of the ulna, which is located towards the dorsal surface of the hand. Mark the transverse level of the palpated ulnar styloid process. A plane 10 mm proximal to this level is the plane of the wrist. Note that skin creases are not an adequate guide to the level of the wrist.

3.2 Clothing

Defined terms and symbols are illustrated in Figure 2.

3.2.1
glove
hand covering for the whole hand that has protective material extending to the wrist and covers each digit separately

See Figure 2a).

3.2.2
short-cuff glove
glove with protective material continuous with it of length A proximal to the wrist

See Figure 2b).

3.2.3
long-cuff glove
glove with a permanently attached stiff but flexible cuff of length B, covering the forearm to a point which is at a distance C from the upper arm surface when the elbow is flexed at 90°

See Figure 2c).

NOTE The term "gauntlet" is deprecated. This is an inexact synonym of "long-cuff glove".

3.2.4
arm guard
protective device covering the forearm

NOTE It may be permanently attached to or held in place by a glove with a special short cuff of length D [see Figure 2c)] while both are used. It extends to a point which is at distance C from the upper arm surface when the elbow is flexed at 90°.

3.2.5
arm guard and glove assembly
arm guard correctly attached to or correctly worn with a compatible glove with a total length B from the wrist

See Figures 2c) and 2d).

3.2.6
long arm guard
protective device that covers the forearm and extends onto the upper arm

NOTE It may be secured to the body or to clothing so that it remains in place during use, see Figure 2e).

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4 Requirements

4.1 Dimensions of the protective surface areas of gloves and arm guards

4.1.1 General

The coverage provided by gloves shall be assessed in accordance with 6.1.4.

For details of dimensions, sizing and fitting of gloves and arm guards, see annexes A, B and D.

4.1.2 Gloves

A five-finger glove shall be designed to provide protection to all of the hand up to the wrist. The coverage shall be continuous except for a slit on the ulnar surface of the palm to aid putting on and taking off the glove. When the wrist strap is adjusted as in use the slit shall be closed by overlapping chain-mail.

4.1.3 Short-cuff gloves

Short-cuff gloves shall be designed to provide continuous protection from the finger tips to a length A [see Figure 2b)] at least 75 mm proximal to the wrist. The cuff shall either be stiffened so that it has a minimum compressed length of 75 mm and so that the difference between its compressed and extended length is less than 20 mm when measured in accordance with 6.2.2, or shall be attached to the upper body or arm or to clothing so that the minimum required coverage is maintained in use.

4.1.4 Long-cuff gloves

Long-cuff gloves shall be designed to provide continuous protection from the finger tips to the wrist and up the forearm. The proximal end of the protection should be at a distance C [see Figures 2c) and 2d)] of not more than 75 mm from the upper arm surface when the elbow is flexed at 90° (see annex B).

Long-cuff glove cuffs shall either be stiffened so that at least the minimum coverage is provided when the cuff is compressed and measured in accordance with 6.2.2, or shall be attached to the upper body or to the arm or to clothing so that the minimum required coverage is maintained in use.

4.1.5 Glove sizes

Gloves shall be marked with their size based on the hand size they are designed to fit, or with the colour-coded strap appropriate to the dimensions of the glove as given in annexes A and B.

4.1.6 Arm guard and glove assemblies

The coverage provided by arm guards and arm guard and glove assemblies shall be assessed in accordance with 6.1.4.

4.1.6.1 Coverage with rigid arm guards

Arm guards shall be designed to provide continuous protection to the hand and forearm: the arm guard covers the forearm from the cuff of a compatible glove. The proximal end of the protection shall be at a distance C [see Figures 2c) and 2d)] which should not be less than 45 mm or more than 75 mm from the upper arm surface when the elbow is flexed at 90° (see annex B). The arm guard shall be attached to, or held in place by, the cuff of the glove.

4.1.6.2 Coverage by chain-mail arm guards

Chain-mail arm guards shall either be stiffened so that at least the minimum coverage is provided when the guard is compressed and measured in accordance with 6.2.2, or shall be attached to the upper body or to the arm or to clothing so that the minimum required coverage is maintained in use.

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4.1.6.3 Coverage and attachment of long arm guards

Long arm guards shall be designed to provide continuous protection of the hand and forearm. The straps or fixing of the proximal end of the arm protector, when correctly adjusted, shall not allow it to slide down to expose the forearm.

4.1.6.4 Cuffs

The overlap of the protection provided by the cuff of the glove and the arm guard shall be at least 8 mm. The cuff of a compatible glove shall be of stiffened chain-mail with a compressed length D [see Figure 2d)] of not less than 30 mm. The difference in extended and compressed lengths of the cuff shall not be more than 20 mm when tested according to 6.2.2.

NOTE If the stiffening is only at the sides of the wrist, flexing of the wrist will not be impeded.

4.1.6.5 Shape of arm guards made of plastics or other rigid material

Arm guards made from plastics or other smooth materials shall be so designed at their proximal end to stop the knife blade. An example of the shape is given in Figure 3. The dimensions shall be:

$6 \text{ mm} < l_1 < 15 \text{ mm}$

$2 \text{ mm} < l_2 < 6 \text{ mm}$

$l_3 > 1{,}5 \text{ mm}$

The protection shall extend for at least 300° around the circumference of the arm guard. The arm guard shall be designed so that the arc without the protection can only be worn on the outside of the forearm directed towards the point of the elbow.

Arm guards formed of a rolled-up sheet of rigid material with an overlapping longitudinal junction shall have an overlap of their free edges of at least 30 mm for the whole length of the arm guard.

4.1.6.6 Arm guard and long cuff sizes

Arm guards sizes are their minimum or compressed length in millimetres (see 6.2.2).

See annex B for information on sizes of arms and of arm guards and long cuffs.

4.2 Construction

4.2.1 Chain-mail gloves

Chain-mail shall be made from rings with an internal diameter no greater than 3,2 mm. Chain-mail sheet shall have four rings passing through each ring.

4.2.2 Dimensions of interstices

The dimensions of interstices between chain-mail rings or any other components of the protective surface of gloves and arm guards shall be such that the 6,0 mm wide gauge number 1 described in 5.5 is unable to pass through them when applied as described in 6.3.

The dimensions of interstices between chain-mail rings or any other components of the protective surface of gloves and arm guards shall be such that the 4,0 mm wide gauge number 2 described in 5.5 is unable to pass through them when applied as described in 6.3 except at the positions listed below.

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Sites where the 4,0 mm gauge number 2 is permitted to pass through the protective material are:

a) at not more than three points in each crotch between digits two and three, three and four, and, four and five; probe number 2 shall not pass through at any point in the crotch between digits one and two;

b) at not more than eight points on the seam on the lateral and medial surfaces of each digit and over the tip of the digit.

Possible sites where the 4,0 mm probe penetrates the glove surface are shown in Figure 4.

4.2.3 Straps

Gloves shall have adjustable wrist straps at least 18 mm wide. The length of straps shall be continuously adjustable. They shall be secured by a quick release closure, for example a spring-loaded stud fastener. The fixed part of the closure shall be on the strap on the back of the wrist within 10 mm of the centre (i. e. in the centre of the dimension $l_{10} \pm 10$ mm, as in Table A.1 and Figure A.1). It shall not be possible to remove straps from gloves or arm guards when the straps are fastened. Straps shall be attached to cuffs or shall pass through loops. It shall not be possible to remove closures from straps except by intent.

Any straps on arm guards shall be of similar construction. See also advice in annex D about avoiding long free ends on the straps.

NOTE The force required to open the fastener should be greater than any accidental force that is likely to be applied during the work for which the glove is designed.

4.2.4 Mass

Gloves and arm guards shall be constructed of material with a mass per area of less than 4 kg/m^2. Testing shall be in accordance with 6.2.3.

4.3 Tensile strength

4.3.1 Chain-mail

When tested in accordance with 6.4.1, no ring, link or plate shall break or open when a force of 100 N is applied.

4.3.2 Attachment of arm guards

Arm guards shall be securely held in place when worn with a compatible glove. This attachment shall withstand a force of 150 N on the arm guard directed towards the elbow as described in 6.4.2.

If attachment is by studs or similar discrete fasteners, at least five shall be used. They shall be distributed approximately evenly around the circumference of the junction.

4.4 Penetration resistance

4.4.1 General

Penetration resistance of a glove or assembly shall be provided over the whole protective surface, including any junction between a glove and its cuff or attached arm guard.

4.4.2 Chain-mail gloves cuffs and chain-mail arm guards and those including metal plates

Protection shall be provided over the whole protective surface including any junction to another component or material. Testing shall be conducted in accordance with 6.5.1. The mean penetration shall not exceed 10 mm and no single penetration shall exceed 17 mm.

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4.4.3 Rigid arm guards made of plastics or metal

Testing shall be conducted in accordance with 6.5.2. The mean penetration shall not exceed 12 mm and no single penetration shall exceed 15 mm.

4.4.4 Rigid arm guard attachment

Testing of the region of attachment of the cuff of a compatible glove to the arm guard shall be in accordance with the principles in 6.5.2. The mean penetration shall not exceed 12 mm and no single penetration shall exceed 15 mm.

4.5 Properties of materials

4.5.1 General

The protective clothing shall not be constructed of materials that are known to cause short- or long-term injury to normal users. The protective clothing shall not have injurious rough or sharp surfaces. It shall not lose its protective properties during its normal service life when cleaned and sterilised according to the manufacturer's instructions.

4.5.2 Cleaning temperature stability

The maximum cleaning temperature that does not harm the item shall be supplied with it. If this temperature is below 82 °C it shall be marked on the item. The testing of the stability of plastic arm guards is described in 6.6. No dimension shall have changed by more than 10 %, nor shall any dimension fall outside the range given in 4.1.6.5 after testing.

5 Test apparatus

5.1 Visual examination

Visual examinations should be made by a competent person with such light sources and magnification aids as are necessary.

5.2 Tolerances

Unless specified, all dimensions are centre values with a tolerance of $\pm$ 2 %.

5.3 Tensile strength testing apparatus

Tensile strength testing apparatus shall be as described ISO 13998, except that the metal rods to be placed in the rings shall be (1,2 $\pm$ 0,1) mm unless narrower rods are required to pass through the rings, and the force to be exerted shall be up to 100 N.

5.4 Penetration testing apparatus

5.4.1 General

Penetration testing apparatus shall be as described in ISO 13998 with the addition of components to support small chain-mail samples and rigid arm guards as given in 5.4.2 and 5.4.3.

5.4.2 Chain-mail samples

Rectangular samples of glove chain-mail or arm guard chain-mail shall be cut (120 $\pm$ 10) mm $\times$ (120 $\pm$ 10) mm. Rigid steel rods are passed through the rings on each side of the sample, leaving approximately 10 mm (three or four rings) unsupported at the ends of each side.

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The sample placed on the flesh simulant is tensioned by four 400 g weights. One is attached to the centre of each side by clips and string which is arranged to fall approximately 30° to the horizontal and pass over a hoop of internal diameter not less than 800 mm, to the weight. The outer surface of the glove or arm guard material shall be placed upwards.

Samples of the following types representing all the construction features of the test item are to be tested:

a) four-ring interlock flat chain-mail;

b) samples of four-ring interlock flat chain-mail joined by a seam across the middle of the sample; samples of every seam type present in the glove or arm guard shall be tested; the seams shall not include points at which the 4,0 mm probe is able to pass through the chain-mail;

c) samples of chain-mail in which the rings are coated or surrounded by a plastics matrix that impedes their independent movement.

5.4.3 Support for rigid arm guards

Plastics or other rigid arm guards shall be filled with uncooked long-grain polished rice in polythene bags. The rice shall be shaken and vibrated into place. The bags shall be taped into place and the guards shall be taped tightly around the bags, so that no movement occurs during testing. The filled arm guard shall be pressed into the flesh simulant so that its lower surface is fully supported. It shall be taped down by adhesive tape across the tray as shown in Figure 5.

If the rice is not sufficiently tightly packed, the impact energy is absorbed elastically in deformation of the whole guard. The knife and block may even rebound as the arm guard returns to its resting shape. It is important that the rice be tightly packed to avoid this happening.

5.5 Gauges for interstices

The gauges for interstices shall be made of steel ($1 \pm 0,05$) mm thick. Gauge number 1 shall be ($6 \pm 0,1$) mm wide over a length of not less than 50 mm. The end of a gauge shall taper with (60 ± 5)° included angle as shown in Figure 6. Gauge number 2 shall be the same as gauge number 1 except that its width shall be ($4 \pm 0,05$) mm. The gauges shall be supported in handles or otherwise so that the force that can be exerted along the long axis of the gauge is limited to ($10 \pm 0,5$) N.

5.6 Blunt probe

The blunt probe for checking the coverage provided by test items in 6.1.4 shall have a smooth approximately hemispherical end on a ($6 \pm 0,5$) mm diameter metal shaft.

5.7 Test arms for measuring the compressed length of cuffs and forearm guards

The test arms shall be made of hard polished material such as varnished wood, metal or hard plastic. The dimensions shall be according to Table 1. The shape is shown in Figure 7.

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Table 1 — Test arm dimensions

Dimensions in millimetres

Dimensions[a]	Test arm number			
	1	2	3	4
l_1	Dimension to be measured			
l_2	60	60	60	60
l_3	100	100	100	100
l_4	60	60	60	60
l_5	20	20	20	20
l_6	15	15	15	15
d_1	80	85	92	100
d_2	80	85	92	100
d_3	50	56	63	70
d_4	45	50	55	60
d_5	45	50	55	60
d_6	75	80	85	90

Tolerances shall be ± 2 % on diameter, ± 5 % on length.

[a] Dimensions are shown on Figure 7.

6 Procedures

6.1 Visual examination

6.1.1 Chain-mail

Examine the entire surface of the mail for missing rings, unclosed rings and rough welds which could abrade a user's skin. Examine all seams and the interlocking of rings within them. Test by hand to determine whether fittings have sharp edges, that the fasteners are easy to use and secure, and that there are no long free ends of straps when the glove is worn. Where chain-mail is possibly joined within an opaque strap or fitting, expose the chain-mail and examine as above. Report findings.

6.1.2 Rigid arm guards

Examine the whole surface, edges and fittings. Determine whether there are sharp edges, surface crazing or small cracks at edges and around fitment holes. Determine if the whole shape is appropriate. Report findings.

6.1.3 Assembly

Examine the attachment of the arm guard to a compatible glove. Determine the orientation of any openings between them and the compatibility of the assembly. Determine whether unexpected detachment could occur in use. Report findings.

6.1.4 Examination of coverage

The test item shall be put on and correctly adjusted on a subject of the appropriate dimensions determined from the manufacturer´s information for users. The relevant requirements in 4.1.2, 4.1.3, 4.1.4, 4.1.6.1, 4.1.6.2, 4.1.6.3 and 4.1.6.4 for coverage of the hand, wrist and forearm shall be tested by inspection, measurement and the attempted insertion of a non-injurious blunt probe described in 5.6.

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The probe shall be applied to every slit, opening or overlap found. The probe shall be angled at 0° to 45° with the underlying skin at any angle between directly up the arm and 90° across the arm from the medial to the lateral side. The probe shall be gently moved around with a maximum force of 4 N. Varying its angle of approach to ascertain whether it can pass through the test item. Every penetration shall be recorded as a gap in the coverage. Report findings.

6.2 Dimensions and mass determination

6.2.1 Measurement of glove dimensions

Lay the glove flat and insert appropriate gauges (see annex A) into the digits to measure their length. Measure the remaining dimensions specified. Make allowances where the glove is curved (see annex A). Check the correspondence of the results to the claimed size and marking. Report findings.

6.2.2 Measurement of compressed and extended lengths of cuffs, cuffs and arm guards, and arm guards

Measure the maximum length (extended length) of a cuff and arm guard, or arm guard, when it is suspended by its distal end and hanging freely under its own weight. The dimensions to be measured shall correspond to the appropriate dimensions A, B or D shown in Figure 2. The measurement shall be made five times. Between measurements, the test item shall be lifted from below to compress it, and it shall be gently released to hang freely again before the next measurement is made.

Measure the compressed length of the same item on a test arm as described in 5.7. Choose the appropriate test arm according to the manufacturer's size marked on the test item. The test item should fit loosely about the test arm. A smaller size test arm should be used if the fit is not loose, and a larger one should be used it the looseness is far in excess of what would be acceptable in the normal use of the test item. Table 2 is a guide to the selection of test arms.

Table 2 — Selection of appropriate test arms

Test arm number	Glove size range that would normally be tested with an appropriate arm guard, on the test arm
1	Up to size 6½
2	6½ to 8½
3	8½ to 10
4	Above size 10
NOTE Arm guards are supplied in different sizes to fit the same glove. There is not a recognized arm guard sizing scheme so this table is based on glove sizes. This is only a guide, as arm guard diameters that are necessary depend on the muscularity of the users. Muscularity of the forearm is not reflected in the glove sizes needed.	

The test item shall be fitted to the test arm and the straps adjusted. The wrist strap should rest vertically on the expanded section of the test arm as shown in Figure 7a). The test arm shall be suspended vertically. A ring of mass (500 ± 10) g shall be placed on the upper end of the test item (proximal when worn) as shown in Figure 7a). The compressed length of the test item corresponding to the appropriate dimension A, B or D shown in Figure 2 shall be measured. The measurement shall be made five times. Between measurements the test arm should be turned upside down to allow the test item to fully extend. The test item should be allowed to fall naturally into place when the test arm is returned to its upright orientation before the ring is placed on it.

Report the mean of the extended length and the mean of the compressed length of the test item.

6.2.3 Determination of the mass per unit area of arm guards, cuffs and extended cuffs, and gloves

Measure the linear dimensions of samples of the protective materials from which the test items are made. Weigh the samples and calculate the mass per unit area of each material.

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6.3 Testing the dimensions of interstices

Use the gauges described in 5.5 to probe the interstices between metal or plastics components of the glove or arm guard. Push the gauge against the interstice with a force up to (10 ± 0,5) N. Permit the material under test to fold if the gauge enters further as this happens. Test five examples of each interstice type associated with each combination of ring interlocking or plate combination. Test such combinations whether they are covered or filled with a plastics, rubber, viscoelastic or other material.

Test first with gauge number 2. If it passes through any type of interstice locate and mark all such interstices. Record their positions. Test each of these with gauge number 1.

Report all instances and positions where the gauges pass through the protective material.

6.4 Tensile strength testing

6.4.1 Chain-mail

Check the calibration of the apparatus to be used or the force that it exerts. Fix the metal rods into a pair of interlocked rings or into a pair of rings on opposite sides of a plate or into similar links. Smoothly and progressively apply a force that pulls the rings apart as it rises from 0 N to 100 N over a period of 2 s to 10 s. Carry out 50 trials on an undamaged glove or chain-mail arm guard at random sites. Carry out 25 trials on pairs of rings in seams. Report all instances of rings or plates opening or breaking at a force below 100 N. Note that it is not required to report the force applied when breaking occurs.

6.4.2 Arm guard attachment

Place the arm guard attached to a compatible glove on a suitable surrogate forearm and fist. Apply a force of 150 N over a period of 30 s to 60 s pulling the arm guard from the glove along the forearm axis. Report findings.

6.5 Penetration testing

6.5.1 Chain-mail and combinations of chain-mail and metal plate

Penetration testing is carried out as described in ISO 13998, except that the nominal dropping height is 250 mm and tests are only carried out with the sample in the horizontal plane. Test pieces including seams shall be tested with knife impacts at the various orientations along the seam. Test pieces including coated or surrounded chain-mail shall be tested in the coated or embedded area. Report all results, calculate the mean penetration and note the largest penetration.

6.5.2 Rigid arm guards

Condition the apparatus and rice-filled arm guards at (20 ± 2) °C for 24 h before use except as specified below. Condition the tray filled with flesh simulant as necessary (see ISO 13998).

The nominal dropping height for testing plastics arm guards shall be 500 mm, and for metal arm guards 250 mm. The distance shall be measured from the knife tip to the point of impact. Adjust the height of the electromagnetic release mechanism appropriately. Make ten penetration trials with sharp oiled test blades at sites along the centre top line of the arm guard. The arm guard shall be progressively horizontally rotated approximately 35° relative to the blade between impacts. Impact sites shall not interact nor be on the outer 90° of the circumference of the arm guard (outside of the forearm in use and often a region of overlap of the free edges of the guard). The impacts shall be situated in two rows along the arm guard which is rotated about its long axis between the two series of impacts so that the impacts are always along the centre top line. The distance between the rows shall be at least 50 mm. Measure the length of the back of the blade exposed inside the arm guard to an accuracy of ±1 mm.

It is permitted to make this measurement by marking the blade above the guard after impact, measuring the length of the blade back from the mark to the tip, and subtracting the thickness of the guard at the impact site after impact.

The guard thickness at impact sites shall be measured after the rice has been removed. Report all results, calculate the mean penetration and note the largest penetration.

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If the guard is made of plastics repeat the test of ten impacts on a fresh arm guard filled with rice. The filled arm guard shall be conditioned at (0 ± 2) °C for 24 h. Each impact shall be made within 30 s of moving the arm guard to laboratory temperature unless the whole environment is controlled to (0 ± 2) °C. If the laboratory temperature is not 0°C, the filled arm guard shall be reconditioned at 0 °C after each impact. The reconditioning time shall be 60 min for each minute of exposure to the laboratory temperature. Report all results, calculate the mean penetration and note the largest penetration.

6.5.3 Rigid arm guard attachments

Fit the arm guard to a compatible glove and fill the palm area, wrist and arm guard as in 5.4.2. Test the attachment region and the wrist strap area if this is not part of the attachment, in accordance with 6.5.2. Make ten penetration trials. Report all results, calculate the mean penetration and note the largest penetration.

6.6 Testing the physical stability of plastics arm guards at cleaning temperatures

Condition two plastics arm guards, which are as nearly as possible identical, at (20 ± 2) °C for at least 24 h.

Immerse one arm guard in water at the maximum cleaning temperature specified by the manufacturer ± 2 °C, or in boiling water if the specified temperature is above 100°C for (300 ± 5) s. Hang the arm guard by a single attachment point in air at (20 ± 2) °C with a relative humidity of (65 ± 5) % for at least 24 h.

Leave the second arm guard hanging in air at (20 ± 2) °C with a relative humidity of (65 ± 5) % while the other is being immersed.

Compare the two arm guards. Report any changes in the dimensions or the shape of the immersed guard. Report all changes observed and the temperature of the test immersion.

7 Marking

Protective gloves and arm guards for use with hand knives shall be permanently and conspicuously marked with at least the following:

— the name or identification of the manufacturer or importer;

— the manufacturer's type designation or style number;

— the size designation;

— the maximum permissible cleaning temperature if this is below 82 °C.

8 Information for users and instructions for use

Gloves and arm guards 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 product:

— the information required in clause 7;

— the address of the manufacturer or importer;

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

— storage instructions;

— instructions on how to select the correct size of glove and arm guards for the user;

— instructions on how to position and adjust the glove and arm guard on the body;

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

— a warning only to use the equipment in the form supplied, apart from an instruction to shorten free ends of straps to 25 mm or less;

— instructions for cleaning appropriate to different types of use, including a warning about any treatments known to damage the item and the effect of repeated cleaning cycles;

— instructions for sterilization appropriate to different types of use, including a warning about any treatment known to damage the item;

— a warning about any effects on the level of protection due to ageing, wear, environmental factors or chemicals including oils and solvents (see annex C for information);

— a warning about any classes of work in which the equipment could place the user at risk of injury. In particular state the hazards of powered tools and machines with moving parts, and that a chain-mail glove conducts electricity;

— instructions on the examination, tests and action required when a ring or rings are lost from chain-mail;

— instructions on how to recognize plastics degradation;

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

9 Pictograms

Products fulfilling the requirements of this part of ISO 13999 shall be marked with the pictograms shown in Figure 8. The pictograms are to be placed on the product or on the package in which it is supplied.

The width of the shield shall be at least 30 mm.

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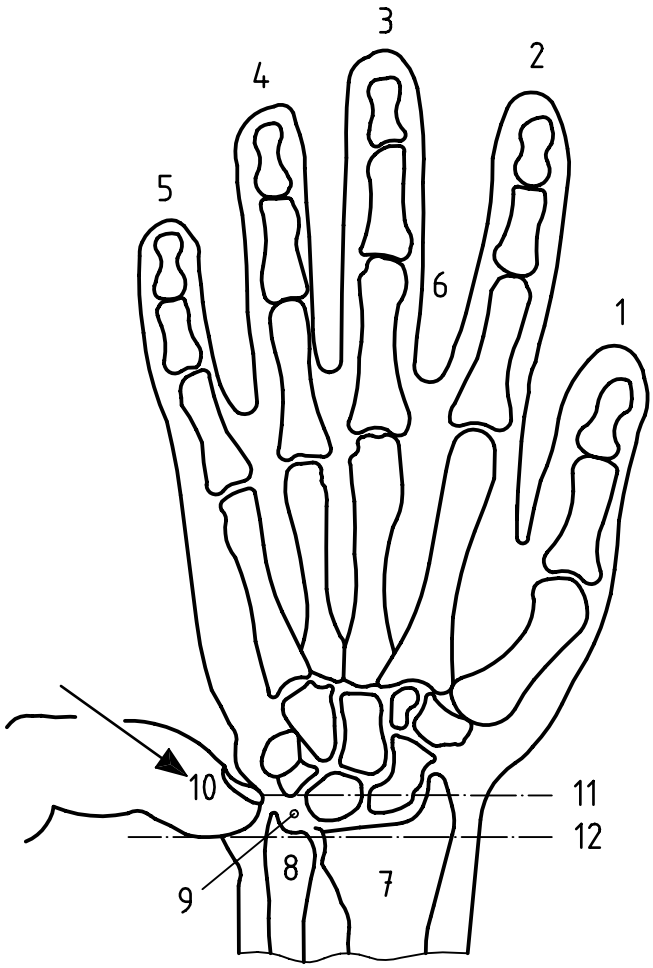

Key

1 to 5	Digits one to five
6	Crotch between digits two and three
7	Radius bone
8	Ulnar bone
9	Styloid process of the ulna
10	Direction of finger pressure
11	The determined level of the tip of the styloid process
12	The wrist level 10 mm proximal to 11

Figure 1 — Definition of anatomical points on the hand (right-hand ventral surface upwards)

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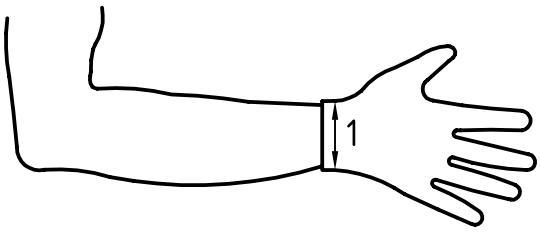
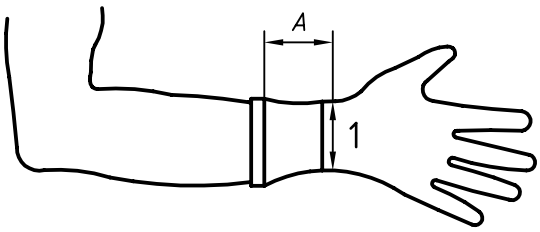
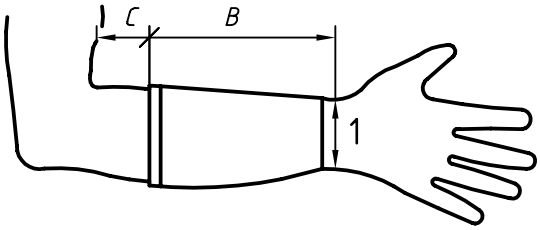
a) Glove



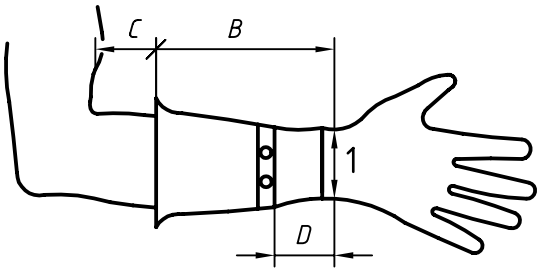
b) Short-cuff glove



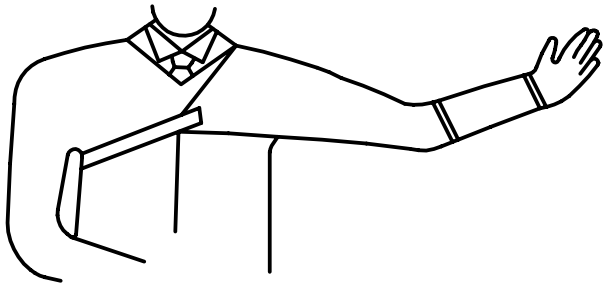
c) Long-cuff glove



d) Assembly of a rigid arm guard and a compatible glove



e) Long arm guard and a compatible glove



Key

1 Level of the wrist

A Length of the protection afforded by a short cuff

B Length of the protection afforded by a long cuff

C Length of the clearance between the top of a long cuff or arm guard and the upper arm

D Length of the cuff on a glove that is attached to an arm guard

Figure 2 — Types of gloves and arm guards

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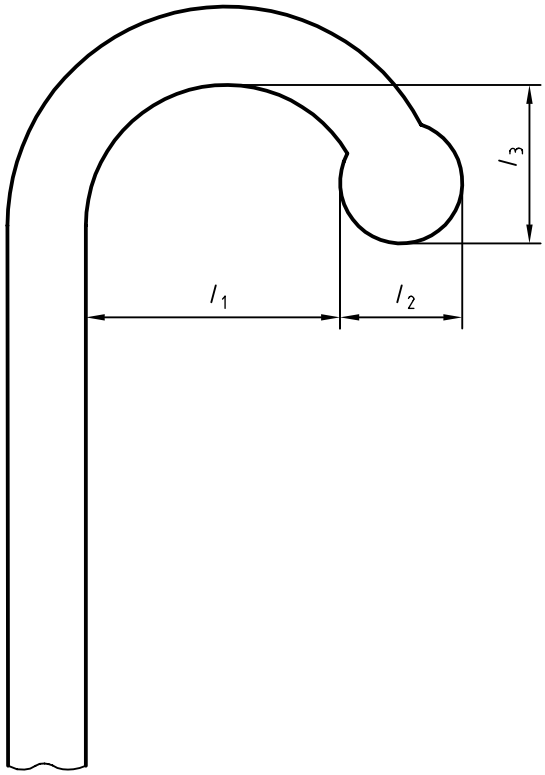

6 mm < l_1 < 15 mm

2 mm < l_2 < 6 mm

l_3 > 1,5 mm

Figure 3 — Example of profile of the proximal end of a smooth and rigid arm guard

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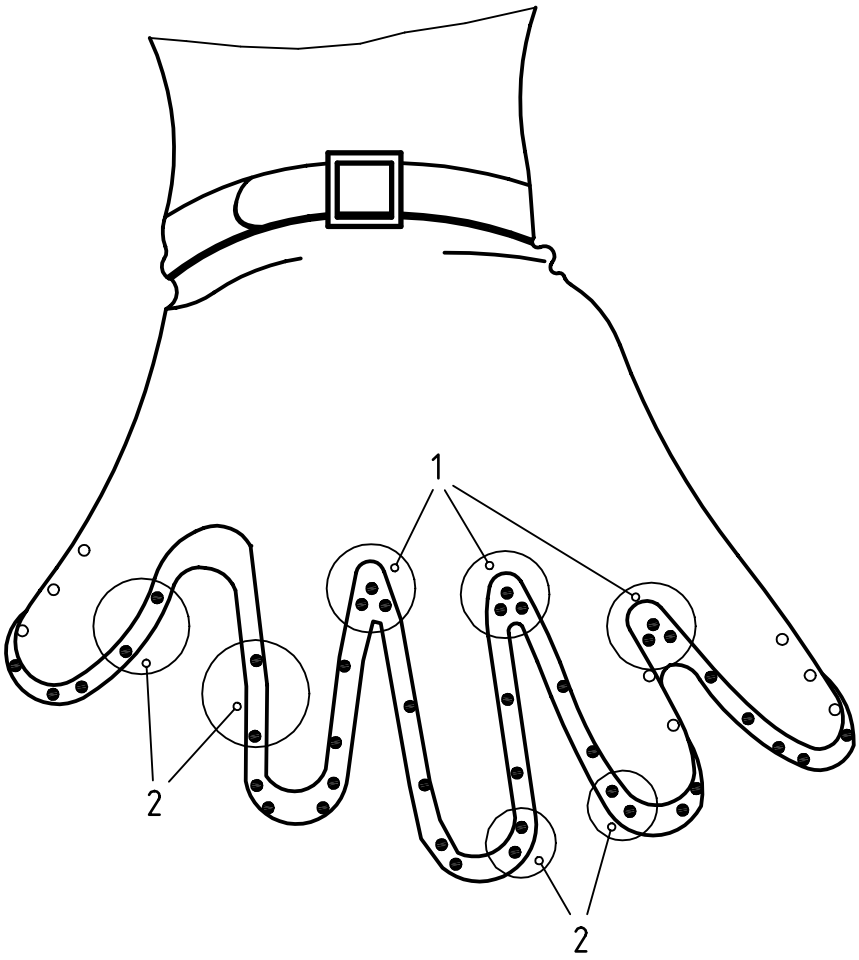

Key

1 Points in the crotches between digits two and three, three and four, and four and five

2 Points on the lateral and medial seams on digits, and on the tips of digits

Figure 4 — Diagrams illustrating the possible points on gloves at which the 4,0 mm wide probe is permitted to penetrate the chain-mail

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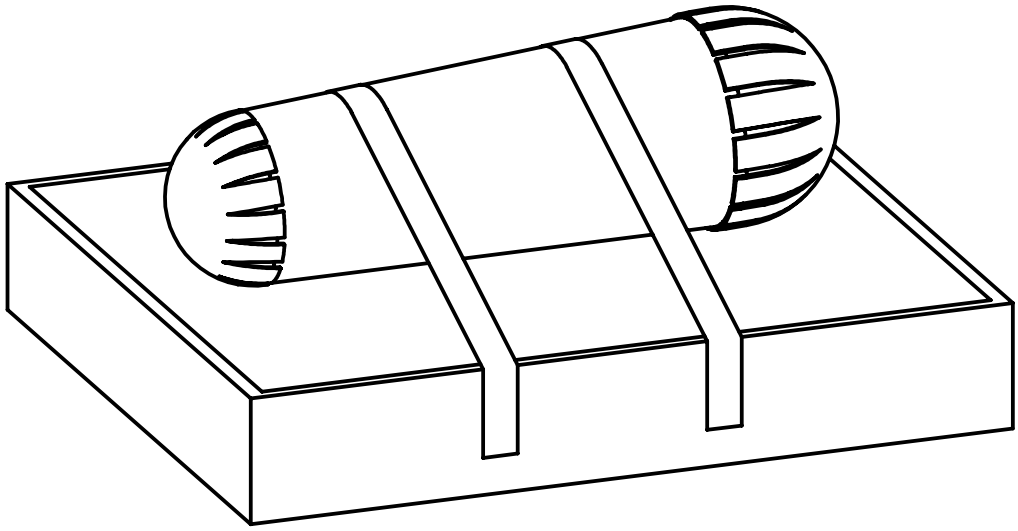

NOTE It has been filled with rice and fixed to the flesh simulant by tapes across the tray.

Figure 5 — An arm guard prepared for testing

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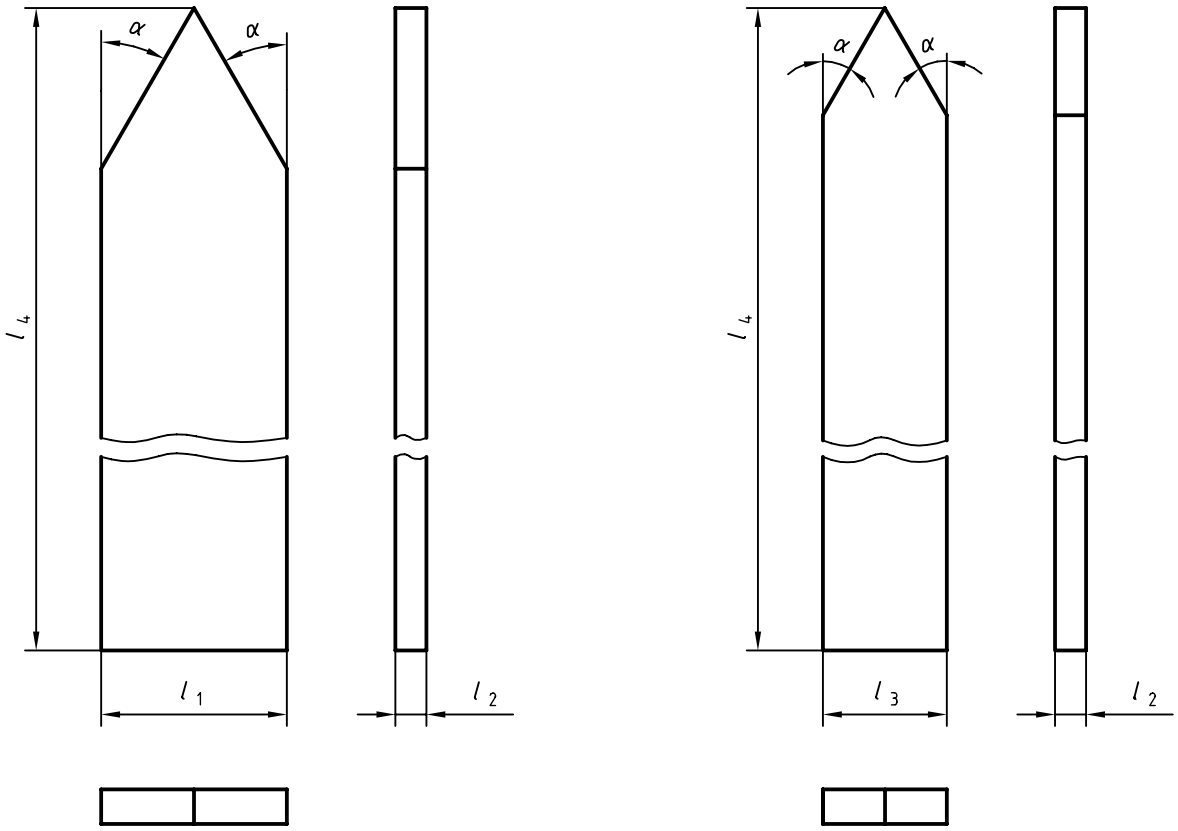

a) Gauge No. 1 **b) Gauge No. 2**

l_1 = (6 ± 0,1) mm l_3 = (4 ± 0,05) mm α = (30 ± 2,5)°

l_2 = (1 ± 0,05) mm l_4 is more than 50,0 mm

Figure 6 — Interstice gauges

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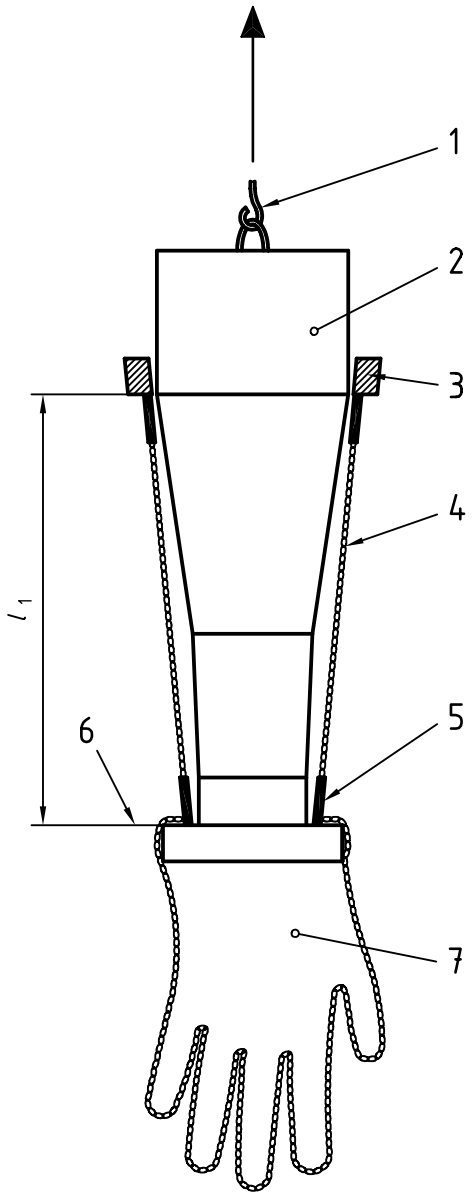

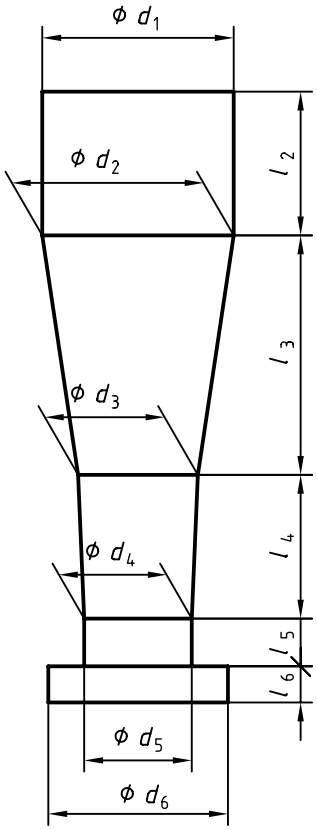

Key

1 Suspension point of the test forearm
2 Test arm
3 Compression ring of mass (500 ± 10) g
4 Cuff or arm guard under compression
5 Wrist strap of the glove correctly adjusted on the test arm
6 Horizontal reference and support surface
7 Glove

NOTE l_1 is the compressed length to be measured.

l_2 to l_6 and d_1 to d_6 are the dimensions of the test arm that are listed in Table 1.

a) Sketch of glove and arm guard on test arm (not to scale)

b) Shape and dimensions of test arms

Figure 7 — Test arm for measuring the compressed lengths of cuffs, cuffs and arm guards, and arm guards

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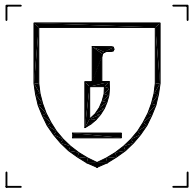
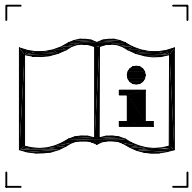


ISO 7000-2483
"Protection against cuts and stabs"



ISO 7000-1641
"Operation Instruction"

Figure 8 — Pictograms

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Annex A
(normative)

Colour codes of selected glove sizes

A.1 Gloves

A.1.1 General

Gloves shall be marked with their size based on the hand size they are designed to fit, or with the colour-coded strap appropriate to the dimensions of the glove in Table A.1. Table A.2 gives the traditional glove sizes that correspond to the colour of coded gloves in Table A.1. Gloves that do not correspond to the dimensions in Table A.1 shall not be fitted with straps of these colours.

Annex B contains information on hand sizes and the glove dimensions that fit different sizes of hand.

A.1.2 Flat pattern gloves

Six sizes of flat pattern type of glove have been designated by the use of colour-coded wrist straps. Figure A.1 shows the dimensions l_0 to l_{12} associated with each of these sizes. Table A.1 gives the value and tolerance for each dimension for each size of glove.

The dimensions of gloves are measured with the aid of digit gauges. Glove digit gauges are parallel sided with a rounded end as shown in Figure A.2 for insertion into the digit of the glove. They are sheet material 1 mm thick with widths corresponding to b_1 to b_5 as shown in Table A.3. The gauges are used by pushing them gently up the appropriate digit and measuring the length of inserted gauge against the relevant feature shown in Figure A.1.

Table A.1 — Dimensions of colour-coded gloves

Strap colour	**Dimensions ± tolerance** mm												
	l_0 ± 5	l_1 ± 3	l_2 ± 3	l_3 ± 3	l_4 ± 3	l_5 ± 3	l_6 ± 3	l_7 ± 3	l_8 ± 3	l_9 ± 5	l_{10} ± 5	l_{11} ± 5	l_{12} ± 3
Brown	188	110	46	95	69	79	71	55	8	35	95	40	10
Green	200	114	48	100	72	82	74	58	8	35	95	40	10
White	212	118	50	105	75	85	77	61	9	40	100	45	10
Red	225	122	52	110	78	88	80	64	10	45	105	50	10
Blue	237	127	55	118	81	91	83	67	11	50	110	55	10
Orange	250	132	58	125	84	94	86	70	12	55	115	60	10

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Table A.2 — Colour codes corresponding traditional glove sizes

Colour	Glove size
Brown	5 to 5.5
Green	6 to 6.5
White	7 to 7.5
Red	8 to 8.5
Blue	9 to 9.5
Orange	10

Table A.3 — Dimensions of gauges used in measuring the dimensions of colour-coded gloves

Colour	Gauges for sizing mm				
	b_1	b_2	b_3	b_4	b_5
Brown	28	27	27	25	22
Green	30	29	29	27	24
White	32	31	31	29	26
Red	35	33	33	31	28
Blue	38	35	36	33	30
Orange	41	37	38	35	32

A.1.3 Curved gloves

NOTE This type of glove is made with more rings on the back than the front. The gloves require smaller excess length and width to provide a good fit. The amount of excess will depend on the degree of built in curvature. Measurements of curved gloves on a flat surface are not directly comparable with those of flat gloves.

Determine the equivalent flat length of a curved glove by laying it on a flat surface as in Figure A.3b) and measuring its length (l_1). The glove is then to be worn by the appropriate size of subject. The glove on the hand is placed on the surface of a cone and slid up and down until the glove is in its natural curvature on the hand. The angle a subtended by the glove is measured in degrees. The equivalent flat length of the curved glove is given by the approximate formula:

$$\text{Equivalent flat length} = l_1 + 0{,}2\ \alpha$$

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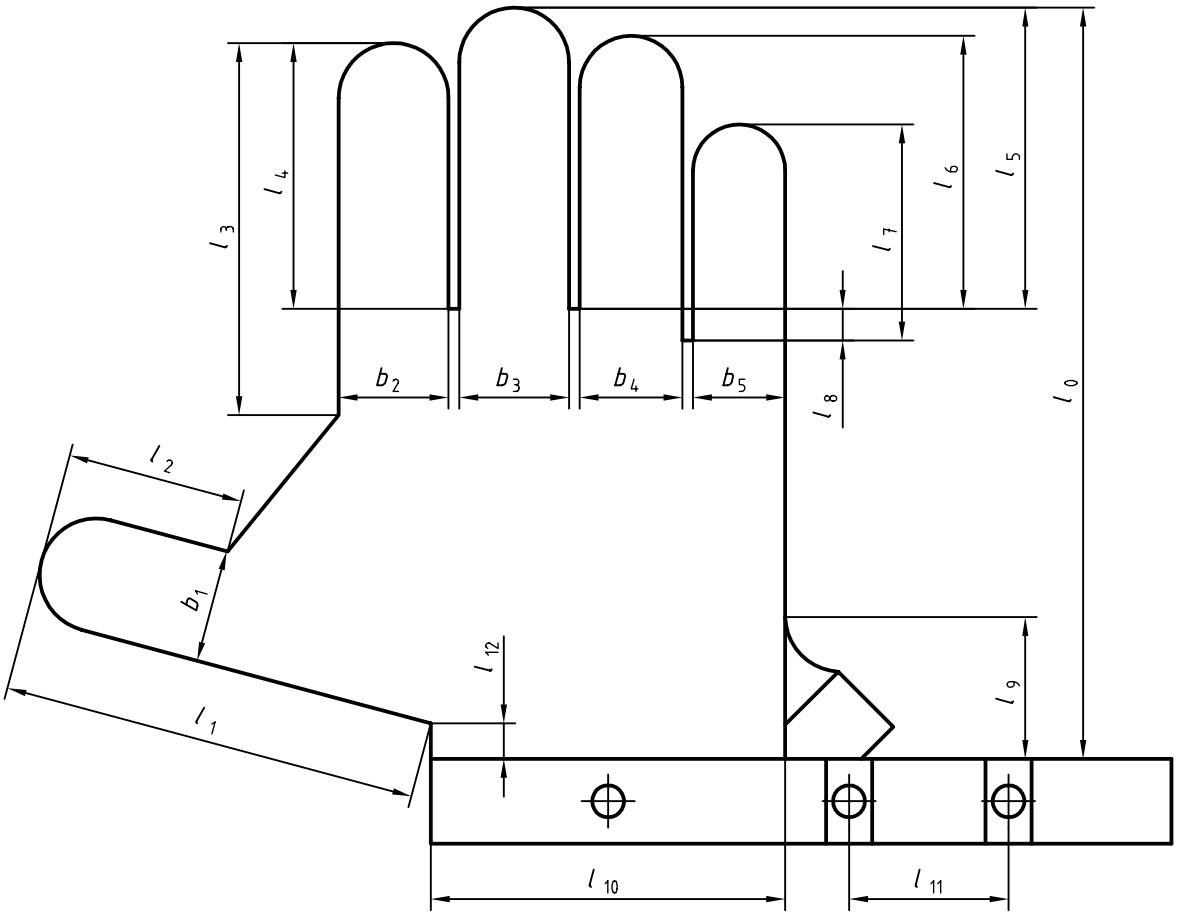

NOTE As measured by a scale using gauges b_1 to b_5 as given in Table A.3 with reference to gloves bearing colour-coded wrist straps indicating their size.

Figure A.1 — Flat pattern glove dimensions l_0 to l_{12} given in Table A.1

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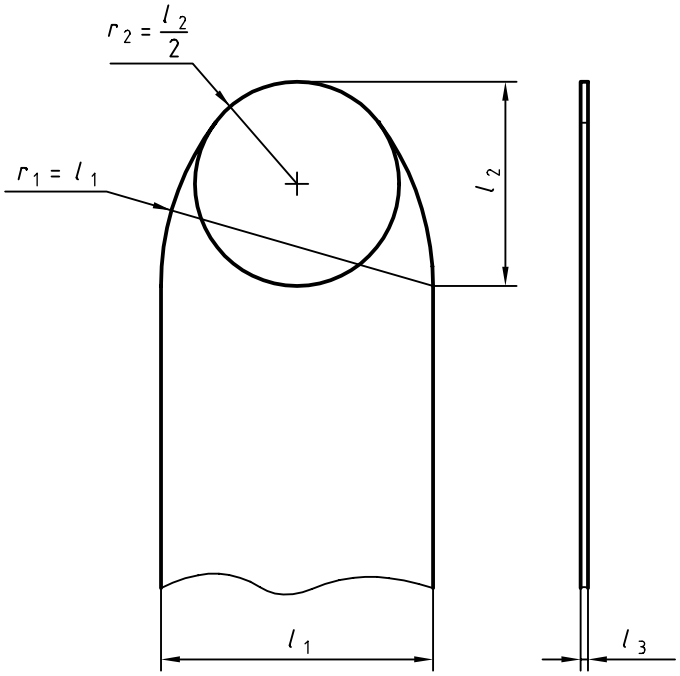

l_1 is dimension b (as given in Table A.3) ± 0,2 mm

l_2 = (l_1 × 0,75) mm ± 0,2 mm

l_3 = (1 ± 0,2) mm

Figure A.2 — Finger-length gauge made of flat sheet material

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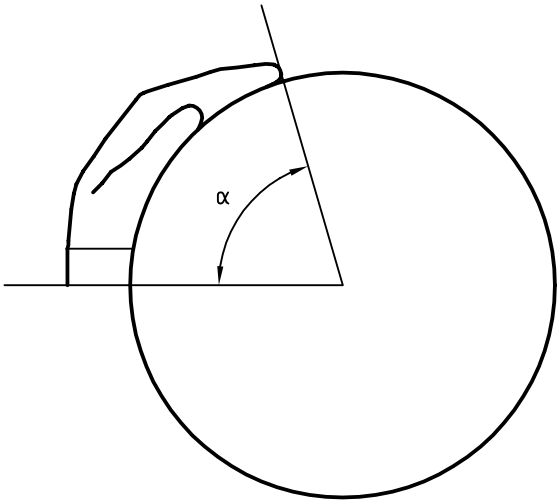
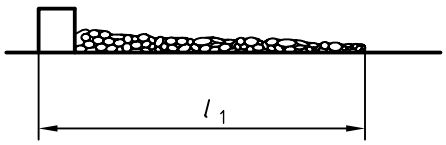
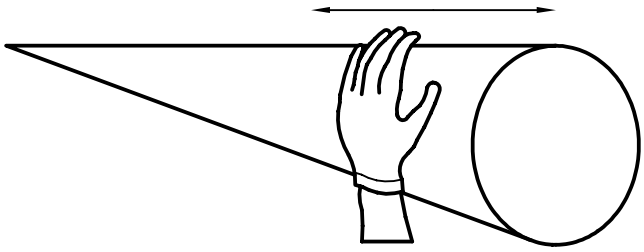


a) Determination of angle (α)
(The glove on a hand at a cone diameter that permits the glove to be fully relaxed)



b) Determination of the flat length of a glove (l_1)



c) Sliding a gloved hand on a cone to determine the glove's curvature when it is fully relaxed

Figure A.3 — Measurement of the equivalent flat length of a curved glove

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Annex B
(informative)

Hand and arm sizes, protective glove and arm guard sizes

B.1 Introduction

The information in this annex is provided to assist users, employers and manufacturers.

This annex contains information on the measurement of hands and forearms, the distribution of sizes in the population, the anatomical areas that should be covered, and advice on selecting appropriate gloves and arm guards to fit individuals.

B.2 Measurements

B.2.1 Anatomical landmarks

Figure 1 shows the anatomical landmarks referred to in this annex. Measurements are defined using these landmarks in order to allow the accurate communication of hand and arm sizes between purchasers and manufacturers.

B.2.2 Hands

Length measurements should be made with the hand on a flat surface. Four reference lines, as shown in Figure B.1, should be established:

a) wrist line (**a**) as defined in Figure 1;

b) a line (**b**) joining crotch 3 to crotch 2 and projected to the edge of the palm in crotch 1;

c) a line (**c**) joining crotch 3 to crotch 4 projected to the ulnar edge of the palm;

d) a line (**d**) joining crotch 2 to crotch 4.

Measurements 1 to 6 are made perpendicular to the wrist line with the digits straight and close together. Measurements 7 to 10 are made along the mid-line of each digit. Measurements 11 to 17 are made with the hand held up, the digits straight and maximally spread out.

The following measurements are made.

1 **Hand length:** tip of longest digit to wrist.

2 **Digit 1 (thumb) height:** tip of digit 1 to wrist.

3 **Crotch 1 height:** crotch 1 to wrist.

4 **Crotch 2 height:** crotch 2 to wrist.

5 **Crotch 3 height:** crotch 3 to wrist.

6 **Crotch 4 height:** crotch 4 to wrist.

7 **Digit 2 length:** tip of digit 2 to crotch line **b**.

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8 **Digit 3 length:** tip of digit 3 to crotch line (**b**).

9 **Digit 4 length:** tip of digit 4 to crotch line (**c**).

10 **Digit 5 length:** tip of digit 5 to crotch line (**c**).

11 **Wrist circumference:** circumference at the wrist level.

12 **Palm circumference:** circumference of the palm parallel to crotch line **d** at a level equidistant between crotch 1 and crotch 2.

13 **Digit 1 circumference:** circumference of the interphalangeal joint of digit 1.

14 **Digit 2 circumference:** circumference of the proximal interphalangeal joint of digit 2.

15 **Digit 3 circumference:** circumference of the proximal interphalangeal joint of digit 3.

16 **Digit 4 circumference:** circumference of the proximal interphalangeal joint of digit 4.

17 **Digit 5 circumference.** circumference of the proximal interphalangeal joint of digit 5.

B.2.3 Forearms

Measurements should be made with the upper arm against the side of the thorax, the elbow flexed at 90°, the palm vertical with digit one uppermost and the fist clenched (see Figure B.2). Three reference lines should be established:

a) wrist line (**a**) as defined in Figure 1;

b) a straight line (**e**) from the top of the wrist touching the forearm and projected to the anterior surface of the upper arm;

c) a vertical line (**f**) from the contact of line **e** with the upper arm.

The following measurements are made:

18 **Forearm length:** horizontal distance from the wrist to the upper arm.

19 **Forearm length to the point of maximum circumference:** horizontal distance from the wrist to the position of the maximum circumference of the forearm.

20 **"Forearm taper":** horizontal line from the wrist to the point at which line **e** touches the forearm.

21 **Circumference of the forearm at a distance of 45 mm from the upper arm** (see Figure B.2): as defined by line **f**.

22 **Maximum circumference of the forearm**: determined by taking measurements.

23 **Circumference of the forearm at a distance of 50 mm from the wrist line a** (see Figure B.2).

24 **Circumference of the forearm at the distance (20) from the wrist line a**. (This is shown as the same as 22 in Figure B.2 for clarity. The positions of 22 and 24 may be the same or 24 may be much closer to the wrist if muscle development is high).

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B.3 Sizes and proportions of hands and forearms

B.3.1 Hands

The data in this section are based, where possible, on surveys of the hand sizes of various European populations. Additional information from non-European sources has been used to make estimates of European dimensions where this has been found to be necessary. It should be noted that users of chain-mail gloves and arm guards may not be typical of the European population as a whole and sizing should be determined by the dimensions of the user population wherever possible.

Traditionally glove sizes are based on the circumference of the palm in inches (25,4 mm) e.g. size 7, 8 or 8½, etc. There is no similar system to express hand length.

Measurements show the following.

a) Hand length is highly correlated with digit length.

   Hand length is highly correlated with crotch height.

   Hand length is not correlated with hand circumference.

   Hand length is not correlated with digit circumferences.

b) Digit height is very highly correlated with crotch height with the exception of digit 1.

c) Palm circumference is correlated with digit circumference.

   Palm circumference is not correlated with digit length.

   Palm circumference is not correlated with crotch height.

d) Wrist circumference is very highly correlated with digit circumference.

   Wrist circumference is highly correlated with palm circumference.

These facts imply that hand length and palm circumference are reasonable predictors of the other dimensions of a hand with the exception of thumb length. Hands with long palms and short fingers or the reverse are very rare. However, because hand length and palm circumference are not correlated, it should be expected that a sizing scheme based on a single length for each width will not accommodate a good proportion of hands comfortably.

Figure B.3 shows the distribution of hand widths and lengths of individual hands from a single population. The overall European population has a similar distribution, but the overlap between the male and female hand sizes is greater, because of the mix of populations of different genetic composition. The elliptical envelopes are the boundaries within which 90 % of the European male and female hand sizes will be found. These have been estimated from data from several single population surveys.

Table B.1 gives a sizing tariff to accommodate approximately 90 % of the adult population, this is based on providing three different hand length (A to C) for each whole and half hand size (designated 6 to 10 in the traditional way).

Distributors and retailers should be able to supply manufacturers with information about the range of hand sizes in a particular local population.

This will ensure the availability of the appropriate glove sizes to allow at least 90% of that population to be adequately fitted. It is to be expected that around 5 % of the population will require specially made gloves in order to achieve optimum fitting. This will often be due to problems with digit 1 and crotch 1 heights.

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Table B.1 — Nominal sizes of gloves

Dimensions in millimetres

Hand size	6	6½	7	7½	8	8½	9	9½	10
Circumference	152	165	178	191	203	216	229	241	254
Length size A	151	159	167	175	183	191	199	207	215
Length size B	166	174	182	189	197	205	213	221	229
Length size C	179	186	194	202	210	218	226	236	241

B.3.2 Forearms

There is little data available on the dimensions of adult forearms. It is estimated from limited data that the 5 % to 95 % range of dimension 18 in Figure B.2 for European females is 160 mm to 210 mm and for European males is 190 mm to 240 mm. The dimensions of the test arms in Table 1 is based on a population of young adult UK males. The majority have arms with dimensions between test arm numbers 2 and 3. Fit individuals in a high state of athletic training approximate to test arm number 4. Length and diameter of arms are not strongly correlated.

B.4 Coverage provided by gloves and arm guards

This part of ISO 13999 specifies requirements for gloves and arm guards which provide a level of protection against injury from hand knives. Jobs which involve moving the knife towards the user's hand or forearm will mainly require this type of protection. The part of ISO 13999 is particularly directed towards the needs of the meat-cutting industry although other industries need protection of the same type.

The clothing in this part of ISO 13999 will only provide protection to a limited area of the body. Selection of the degree of coverage necessary for a particular job must be done carefully, bearing in mind the types of hazard and the likely probability of each occurring. Where only hand cuts are a problem, then a protective glove should be used. The glove should extend to at least the wrist. However if there is a risk that the palmar surface of the wrist could receive a cut then a glove with a cuff should be used. It should be noted that cuts in the wrist area can produce particularly disabling injuries because of the risk of damaging nerves. In the meat-cutting industry it is advised that knife users should have at least hand and wrist protection to 75 mm proximal to the wrist. Coverage for the complete forearm is indicated where there is a foreseeable risk of injury in this region. It is advised that work practices and techniques may change after the introduction of this type of protective equipment. Such changes may mean that a body area not previously at risk is now likely to receive a knife cut and further protective coverage is required.

It is important that there are no weak areas in the protective coverage. Hidden weak areas can occur at the join between gloves and their cuffs, between gloves and arm guards, and in areas where protective material overlaps. Correct selection, adjusting and wearing can minimize such problems, but purchasers are advised that when selecting protective equipment its design should be evaluated by taking into account the direction of knife movements and the possibility of hidden weak areas being struck.

B.5 Size and fit

B.5.1 Gloves

Hand sizes are discussed in B.3.1. An ideal glove fits the hand closely and provides no resistance to movement of the hand. A chain-mail glove is inelastic and so gloves are usually chosen by users so that they are big enough to prevent any dimension becoming too tight during use.

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Both the width and the length have to fit properly because the chain-mail allows little dimensional change to compensate for inadequate length or width. To ensure that the glove does not restrict the hand movements associated with the work, some allowances to these dimensions will be necessary.

B.5.2 Flat pattern gloves

These gloves are made such that their back and front dimensions are the same: they can be laid out smoothly on a flat surface. To obtain a good fit and provide comfort in use, the dimensions of such gloves should exceed the hand dimensions by 10 mm to 15 mm in length and 15 mm in width when the measurements are made with the glove laid flat.

Six sizes of this type of glove have been designated by the use of colour-coded wrist straps. The dimensions of such gloves are given in annex A.

B.5.3 Curved gloves

This type of glove is made with more rings on the back than the front. The gloves require smaller excess length and width to provide a good fit. The amount of excess will depend on the degree of built-in curvature.

B.5.4 Size marking of gloves in width and length ranges

As described in B.3.1, by making gloves available in both width and length ranges a high percentage of users will be able to obtain a good fit. Table B.1 gives the hand dimensions which gloves should be expected to fit. These gloves should be marked with the nominal size of hand they are designed to fit (e.g. 7B or 9A). This applies to both flat and curved gloves. The dimensions of particular user populations may need to be taken into account when selecting ranges of sizes for purchase. The colour of the straps on these gloves should not conflict with the colour coding scheme given in annex A.

B.5.5 Made-to-measure gloves

At least 5 % of hands will not be adequately fitted by gloves of the dimensions in annex A or by gloves made for the hand sizes in Table B.1. Special gloves should be made to fit such individuals, but they should not have wrist strap colours from annex A or size markings from Table B.1. A label to identify the individual for whom the glove was made should be affixed.

B.5.6 Arm guard sizes

B.5.6.1 General

Users of arm guards may, on average, be expected to have more muscular arms than the general adult population because of the largely manual work they do. This needs to be reflected in the diameters of the proximal end of arm guards. The more muscular an arm is, the shorter an arm guard will need to be, due to the increased diameter of the upper arm.

Rigid arm guards are likely to be available in fixed sizes. In some cases it may be possible to shorten them after purchase, but usually the design fixes their length. Chain-mail arm guards can be made to order in any length or shape.

B.5.6.2 Rigid arm guard length

The required length of a rigid arm guard is the forearm length (457 mm in B.2.3) minus the compressed glove cuff length (= 30 mm, see 4.1.6.4), and minus the clearance required to avoid digging into the upper arm (distance C = 45 mm to 75 mm, see 4.1.6.1) and Figure 2. Figure B.4 shows the range of forearm guard sizes, and the estimated population spread of forearm lengths.

Arm guards should be marked with their length. The relationship between their size and the forearm lengths for which they are designed should be marked on the guard as in Table B.2.

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Table B.2 — Arm guard sizes

Dimensions in millimetres

Arm guard length	Minimum protective length when attached to a glove	Should fit forearms of lengths between the limits
90	120	165 and 195
110	140	185 and 215
130	160	205 and 235
150	180	225 and 255
170	200	245 and 275

Rigid arm guards are usually supplied so that they only fit particular sizes of gloves. When fitted to such gloves, they provide total lengths of forearm coverage such as those shown below:

— 120 mm of coverage is provided by arm guards designed to fit 'Brown', 'Green' and 'White' gloves when used with the gloves;

— 160 mm of coverage is provided by arm guards designed to fit 'Red' and 'Blue' gloves when used with the gloves;

— 180 mm of coverage is provided by arm guards designed to fit 'Orange' gloves when used with the gloves.

Other sizes of arm guards may be provided through increments of no more than 20 mm between sizes should be available.

B.5.6.3 Arm guard diameter

The following ranges of dimensions are recommended.

a) For the distal end, the largest diameter of the opening with the glove attached should be 65 to 90 mm. The dimension from the back to the front of the wrist may be 10 mm less than the width.

b) For the proximal end, the opening should be 85 mm to 125 mm.

c) These ranges may be combined with the length range as in Table B.3.

Table B.3 — Arm guard lengths and diameters

Dimensions in millimetres

Length	Maximum internal distal diameter	Internal proximal diameter
90	65	85
110	71	95
130	77	105
150	83	115
170	90	125

It should be noted that some people will require shorter and wider arm guards than those shown in Table B.3. It may be possible to cut down long arm guards to provide this.

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B.6 Long-cuff and chain-mail arm guard lengths

The selection of a glove with an appropriate length of long-cuff or chain-mail arm guard should be guided by the information on forearm sizes in B.3.2. The distance between the proximal end of the cuff of arm guard and the upper arm when the elbow is flexed at 90° (distance C in 4.1.4 and 4.1.6.4 and Figure 2) should not be more than 75 mm. This distance can be less than the 45 mm length recommended for rigid arm guards on which the turned-out lip tends to dig into the upper arm. The lengths commonly manufactured are given in Table B.4.

Table B.4 — Long-cuff lengths

Dimensions in millimetres

Long-cuff length	Compressed length	Should fit forearms of length between the limits
200	180	225 and 255
220	200	245 and 275
240	220	265 and 295

Long cuffs are usually supplied so that particular glove sizes have a single long cuff length. For example:

— 200 mm long cuffs may only be supplied on 'Green' and 'White' gloves;

— 220 mm long cuffs may only be supplied on 'Red' gloves;

— 240 mm long cuffs may only be supplied on 'Blue' and 'Orange' gloves.

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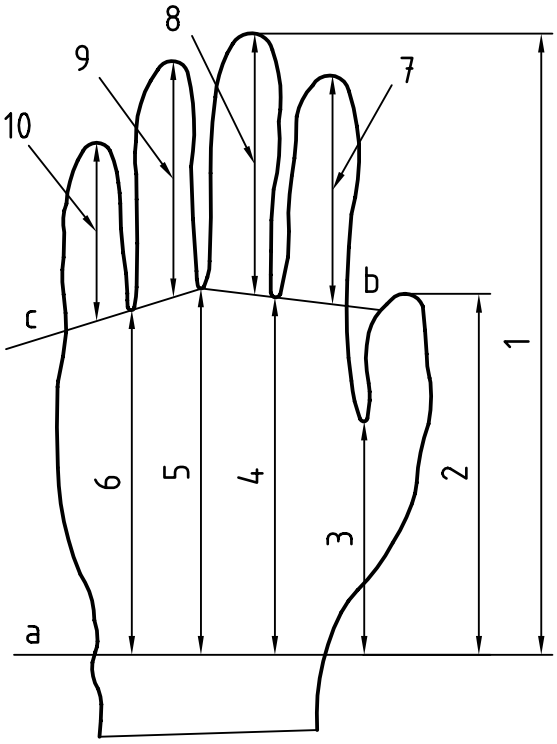
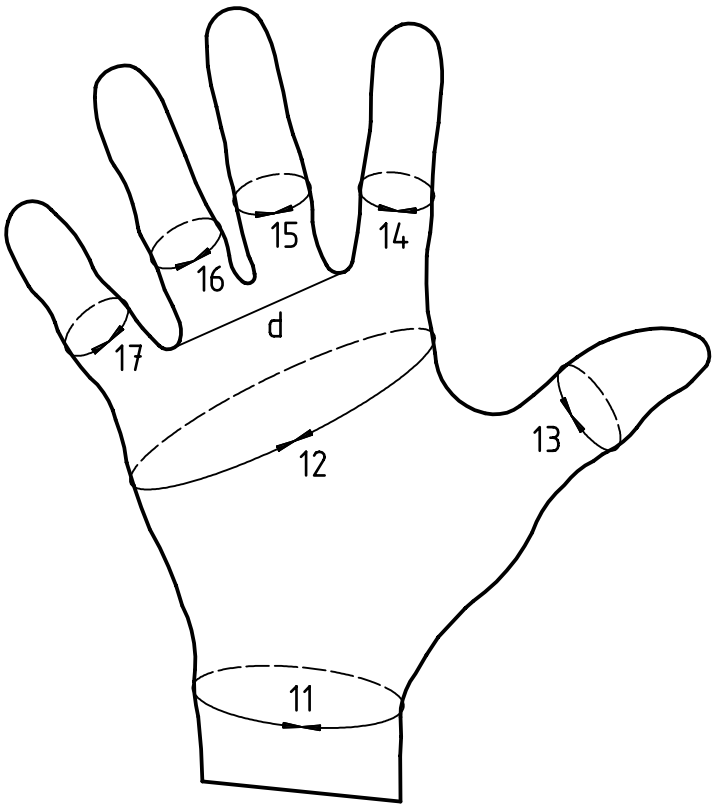


a) Linear measurements



b) Circumference measurements

Key

1 to **17** are measurements described in B.2.2.

a to **d** are reference lines described in B.2.2.

Figure B.1 — Reference lines and specified dimensions for measurement on hands

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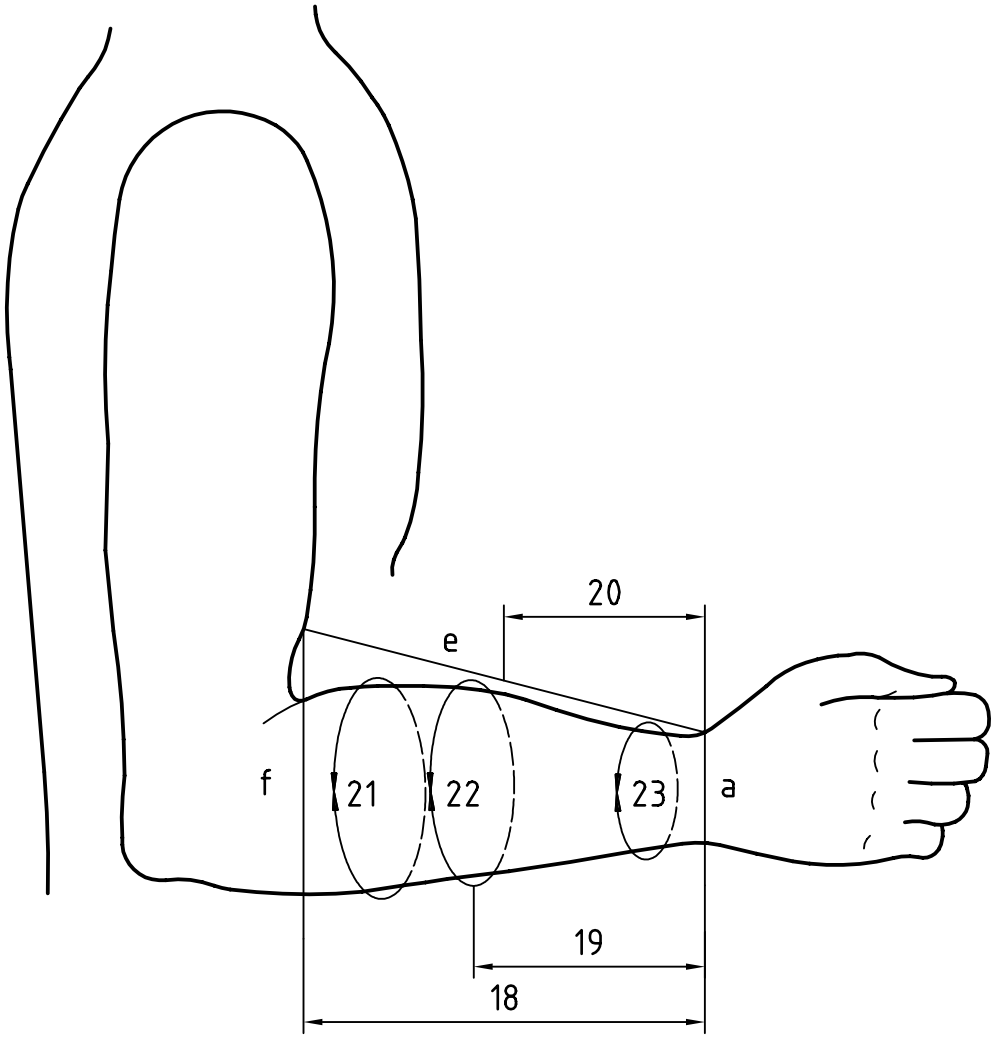

Key

18 to **23** are measurements described in B.2.3.

a, **e** and **f** are reference lines described in B.2.3.

Figure B.2 — Reference lines and specified dimensions for measurement on forearms

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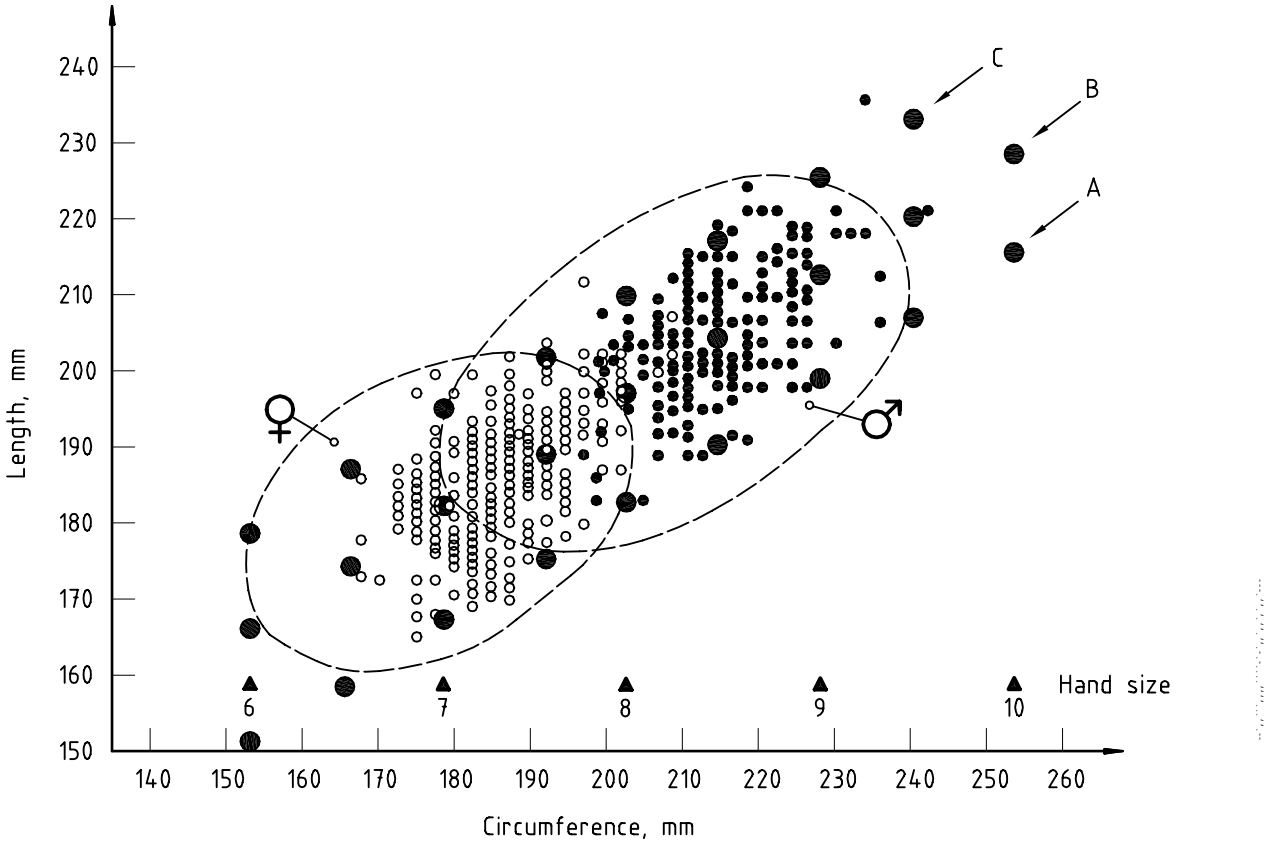

NOTE 1 The graph shows the individual widths and lengths of male (•) and female (o) hands in a single population. The elliptical envelopes are the boundaries within which 90 % of the adult European male and female hand sizes are estimated will be found.

NOTE 2 The hand sizes in Table B.1 are shown superimposed on the graph (●). These hand sizes are estimated to include 97 % of the European population between the ages of 15 and 65 years.

Figure B.3 — Distribution of hand widths and hand lengths

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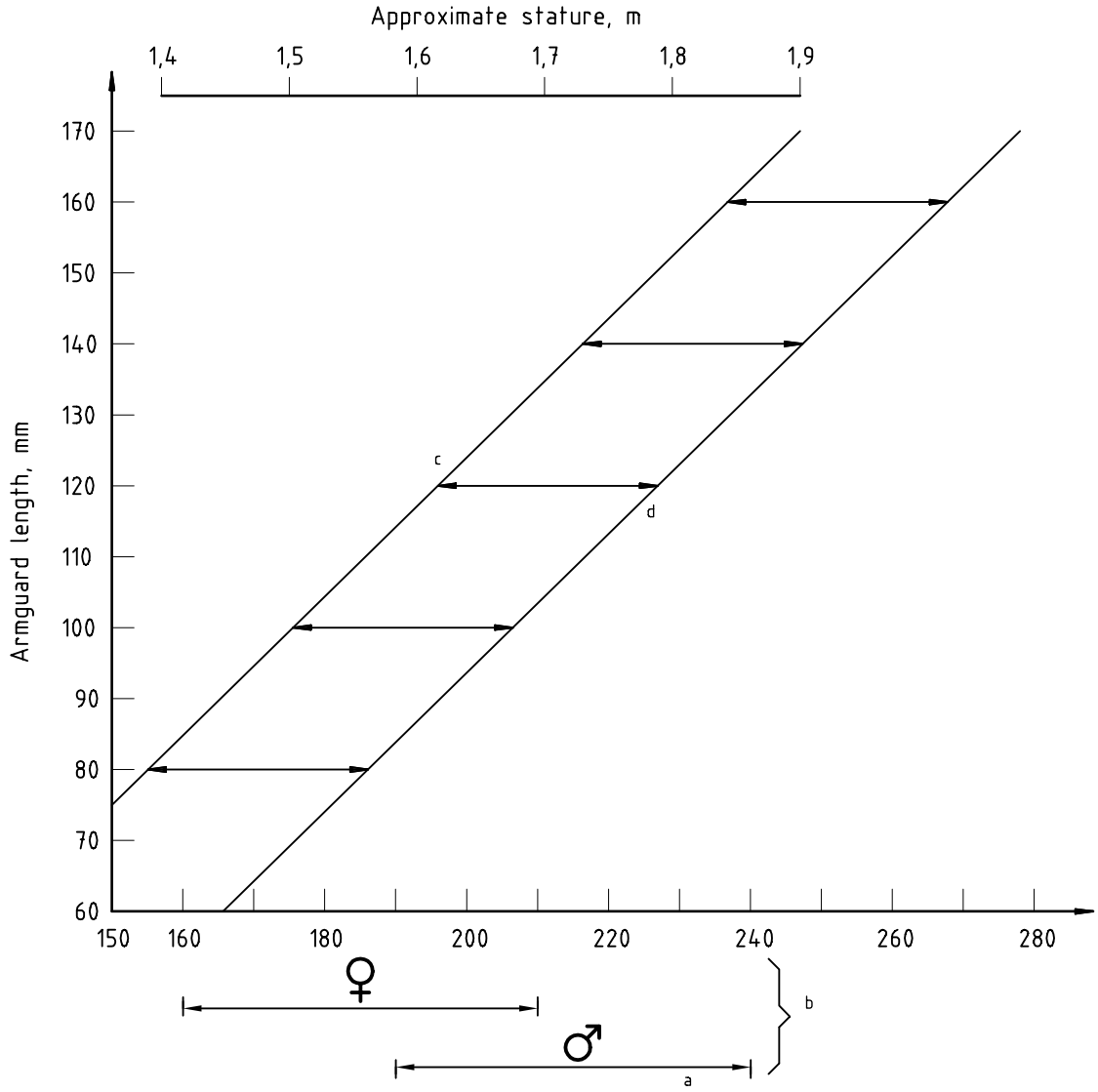

[a] Forearm length, in millimetres

[b] 5 to 95 percentile of predicted populations

[c] Minimum upper arm clearance

[d] Maximum upper arm clearance

NOTE The predicted 5 to 95 percentile values of the male and female adult European populations are also shown with the approximate relationship between forearm length and stature.

Figure B.4 — Relationship between forearm length and the required arm guard length

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Annex C
(informative)

Advice on the selection of plastics for use in arm guards

C.1 Introduction

The information in this annex is provided to assist users, employers and manufacturers.

This annex contains information on the degradation of plastics and how it may be recognized. Attention is drawn to the need in the food industry for sterilization of equipment. Information should be provided to guide users in the selection of safe and effective sterilisation procedures for plastics.

C.2 Degradation of plastics

Plastics such as those used to make arm guards degrade in a number of ways. The following may occur:

a) chemical changes in the plastic altering the bonding of its constituent molecules; this may occur as a function of time and temperature;

b) loss of plasticizer rendering the plastic brittle;

c) uptake of oils, fats, waxes and organic solvents altering the action of any plasticiser and altering chemical bonding; the plastic may get harder or softer, tougher or more brittle, it may crumble or become sticky; the type of plastic and the contaminant will determine the changes that occur;

d) changes due to the action of ultraviolet light; most plastics get harder and more brittle; the presence of inhibitors may reduce the rate of change of properties;

e) mechanical fatigue from the flexing of the guard in use and when putting on and taking off;

f) biological attack;

g) attack by cleaning agents, detergents, acids or alkalis.

It is rarely possible to predict the response of a plastics material to a combination or cycle of these forms of attack. Manufacturers are therefore advised to test their plastics by simulating the service conditions their products are likely to encounter and ensure that adequate warnings about the effects of damaging conditions are given in the instructions supplied with them. Items collected from users after a certain period of service can also provide very useful data.

C.3 Simulation of degradation in use

C.3.1 General

In the absence of material collected from users, the most likely contaminants should be tested on new items.

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C.3.2 Fats and oils

A new clean arm guard should be coated with pork lard, fish oil or other appropriate material. It should by kept at (20 ± 2)°C for 7 days. The guard should be cleaned with detergent and water and should be left to dry. The process should be repeated four times before testing according to 6.5.2.

C.3.3 Temperature cycles

A new clean arm guard should be placed in an environment at (–10 ± 2)°C for at least 6 h. It should be transferred to (+60 ± 2)°C for at least 6 h. The cycle should be repeated 30 times. The arm guard should be conditioned for 24 h before testing according to 6.5.2.

C.3.4 Interpretation of results

If a plastics material shows less than a 10 % loss of performance after the tests in C.3.2 or C.3.3 or in similar tests designed to simulate the service condition of the product, it is reasonable to assume that it will not fail prematurely in service in conditions where the tested contaminants are present. A 25 % loss of performance would suggest that the manufacturer should specify a maximum service life for the product.

C.3.5 Mineral oils and solvents

Plastics materials vary widely in their responses to contact with mineral oils and solvents. A rough assessment of the resistance of a plastics may be made by bending a sample of the material 200 mm × 200 mm into a U shape with a force of 100 N and moistening the outside of the curve with toluene and keeping it wet for one minute while maintaining the force on the plastic. Low resistance plastics will crack or crumble. High resistance plastics will show no change.

Products made of low-resistance plastics should be marked with a suitable warning.

C.4 Recognition of degradation in plastics

There are signs of changes in plastics that are visible. Manufacturers are recommended to include in their instructions with plastics products the specific changes in their product that should lead to its being withdrawn from service. These changes may include some of the following:

a) surface crazing with fine cracks in stressed areas such as around stud fixing holes and along edges;

b) short full-depth cracks in stress areas as above;

c) changes to the surface of the plastic such as stickiness, a powdery layer or a cloudy or opaque layer;

d) colour changes: these may not be significant;

e) changes in flexibility: these may be due to degradation or mechanical flexing.

It is important that manufacturers provide sufficient information for employers and users to recognize deterioration in the product before its performance falls below that required in this part of ISO 13999.

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Annex D
(informative)

Selection and fitting of gloves and armguards to provide comfort and protection

The correct fitting of gloves and arm guards is essential if adequate protection is to be afforded by these devices. Gloves that are too small are uncomfortable and may cause damage to the hands. Arm guards that are too small may restrict movements as well as being uncomfortable. Equipment that is too large may impede safe working and in some cases actually cause a hazard.

The choice of types of protection should be made bearing in mind the information in annex B and the coverage required in 4.1.

It is often desirable to wear some additional type of protection with an arm guard or glove. This may be for hygiene reasons or to give some thermal insulation. The use of other types of gloves, such as vinyl or vinyl and cotton, inside the chain-mail glove will affect the fit characteristics and appropriate allowances must be made. Similarly fabric sleeves inside arm guards may need to be allowed for.

After a glove or arm guard has been fitted to a user and the straps correctly adjusted, then the free strap ends should be cut off to a maximum length of 25 mm and sealed or oversewn in a suitable manner.

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