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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**

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

*Partie 1: Gants en cote de mailles et protège-bras*

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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.

## 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.

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### 2 Normative reference

[ISO 13999-1:1999](#)

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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.

### 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  $90^\circ$

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  $90^\circ$ .

### 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.

#### 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.

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<sup>2</sup>. Testing shall be in accordance with 6.2.3.

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### 4.3 Tensile strength

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#### 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.

#### 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.

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### 5 Test apparatus

#### 5.1 Visual examination <https://standards.iteh.ai/catalog/standards/sist/761879eb-dab9-456f-b3d3-2dd9cd22c378/iso-13999-1-1999>

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.

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 ( $60 \pm 5$ )° 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.