INTERNATIONAL STANDARD

ISO 13999-2

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

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

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

Partie 2: Gants et protège-bras en matériaux autres que la cotte de mailles

Reference number
ISO 13999-2:2003(E)

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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 2.

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

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

ISO 13999-2 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*. It is based on European Standard EN 1082-2:2000.

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*

Introduction

Chain-mail gloves and chain-mail or rigid-plastic or metal arm guards are used in work particularly in the meat industry where a sharp pointed knife is drawn towards the user's hand holding the meat. In work where the knife is generally used to cut away from the hand, or the knives are not finely pointed, it may be appropriate for ergonomic reasons to use gloves and arm guards that are more comfortable though providing less protection than that provided by products fulfilling the requirements of ISO 13999-1. This part of ISO 13999 gives the requirements for such less protective products. The products provide significant protection against slashing cuts but only limited stab protection. It is important that a risk assessment exercise is carried out before these products are accepted as suitable for use in a particular job.

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 use of the of the gloves or arm guards, and these could have implications for the acceptability of particular construction, construction materials and the cleaning methods for protective gloves and arm guards and associated straps and fasteners.

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 whom guidance 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.

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

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

1 Scope

This part of ISO 13999 specifies requirements for the design, cut resistance, penetration resistance, and ergonomic characteristics of cut-resistant gloves, arm guards and protective sleeves made of materials other than chain mail and rigid metal and plastics. They provide less cut and stab protection than the products specified in ISO 13999-1 and are intended to be used only in work where the knife is not finely pointed or it is used only to cut away from the hand and arm.

2 Normative references

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

ISO 3175-2:1998, *Textiles — Professional care, drycleaning and wetcleaning of fabrics and garments — Part 2: Procedure for testing performance when cleaning and finishing using tetrachloroethene*

ISO 3758, *Textiles — Care labelling code using symbols*

ISO 6330:2000, *Textiles — Domestic washing and drying procedures for textile testing*

ISO 13997, *Protective clothing — Mechanical properties — Determination of resistance to cutting by sharp objects*

ISO 13999-1:1999, *Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives — Part 1: Chain-mail gloves and arm guards*

ISO 13999-3, *Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives — Part 3: Impact cut test for fabric, leather and other materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13999-1 and the following apply.

3.1
protective sleeve
flexible garment covering the arm from the wrist to above the elbow

NOTE 1 It may be self-supporting because of its elasticity or held in place by straps or other systems.

NOTE 2 Protective sleeves are normally worn inside the cuff of a glove and lightly grip the wrist.

4 Requirements

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

4.1.1 General

The requirements for fabric, leather, soft plastic or composite gloves and arm guards shall be the same as those for chain-mail gloves and chain-mail or rigid arm guards given in ISO 13999-1, except as listed below. Sizes and coverage shall be assessed in accordance with 6.8 and Annex A.

4.1.2 Gloves

The coverage provided by gloves shall be continuous and without a slit on the ulnar side of the palm.

4.1.3 Short cuff gloves

Short cuff gloves shall be designed to provide continuous protection from the fingertips to a distance at least 75 mm proximal to the wrist. The cuff shall retain this coverage when tested in accordance with Annex A.

4.1.4 Long cuff gloves

Long cuff gloves shall be designed to provide continuous protection from the finger tips to a distance less than 75 mm from the upper arm surface when the elbow is flexed at 90°, see ISO 13999-1:1999, Annex B. The cuff shall retain this coverage when tested in accordance with Annex A.

4.1.5 Glove sizes

Gloves shall be marked with their size based on the hand size that they were designed to fit, in accordance with ISO 13999-1:1999, Table B.1. Sizing shall be verified in accordance with Annex A.

4.1.6 Flexible protective sleeves

Flexible protective sleeves shall provide continuous coverage from the wrist, as defined in ISO 13999-1:1999, 3.1.2, to above the elbow.

4.1.7 Arm guard, or protective sleeve and glove assemblies

4.1.7.1 General

The coverage provided by arm guards, protective sleeves, and arm guard, or protective sleeve and glove assemblies shall be continuous. The coverage and absence of gaps shall be assessed in accordance with 6.4 and Annex A.

4.1.7.2 Coverage by fabric, leather or other flexible arm guards or protective sleeves, and by long arm guards

Flexible arm guards and protective sleeves shall be provided with a means of holding them in place such that the minimum required coverage is maintained when tested in accordance with Annex A. They shall not move more than 40 mm upwards from the wrist when subjected to pulls of 25 N as described in 6.5.

4.1.7.3 Overlap between cuffs and protective sleeves

The overlap of the protection provided by the cuff of a glove and a compatible protective sleeve or arm guard shall be at least 50 mm if there is not a continuous circumferential connection between them. The protective sleeve shall be inside the cuff of the glove. Examination shall be made according to Annex A. The protective sleeve shall resist pulls of 25 N as described in 6.5 and shall not be pulled out of the cuff of the glove.

4.1.7.4 Arm guard and protective sleeve sizes

Arm guards and protective sleeves shall be marked with their minimum length, and where appropriate with the range of stature of persons they are designed to fit and the sizes of compatible gloves (see Clause 7 and Clause 8). Products are examined in accordance with 6.8 and Annex A.

4.2 Construction

4.2.1 Dimensions of interstices

The maximum dimensions of interstices in rigid parts of the products, or between hard components, or through the structure of a knit, in gloves, arm guards and protective sleeves shall be such that the 4 mm wide gauge number 2 described in ISO 13999-1:1999, 5.5, is unable to pass through them when applied as described in 6.9.

4.2.2 Attachment of arm guards and protective sleeves

Arm guards or protective sleeves that are attached to gloves shall withstand a pull of 150 N directed up the arm if worn outside the cuff of the glove, or 25 N if worn inside the glove, when tested, as described in 5.2 and 6.5. No gap in coverage shall occur during the test. Gaps shall be assessed as specified in 6.4.

4.2.3 Knife penetration and cut resistance

4.2.3.1 General

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

4.2.3.2 Fabric, leather, plastic of composite gloves, arm guards and protective sleeves

When tested in accordance with 6.6 and the method given in ISO 13999-3 with an impact energy of 0,65 J, the mean penetration shall not exceed 8 mm and no single penetration shall exceed 14 mm.

4.2.3.3 Cut resistance

All gloves, arm guards and protective sleeves shall require a cutting force of more than 20 N when the cut resistance is measured in accordance with 6.7 in all of the prescribed orientations.

4.3 Properties of materials

4.3.1 General

The protective gloves, arm guards and protective sleeves shall not be constructed of materials that are known to cause short- or long-term injury. The names and concentrations of all substances contained in the product, which are generally known to cause allergies or cause sensitization (see Clause 8) shall be listed in the

information supplied by the manufacturer. Gloves and arm guards shall not have injurious rough or sharp surfaces or edges or sharp protruding wire ends.

The materials from which they are made shall not lose their protective properties during the normal service life of gloves, arm guards or protective sleeves when cleaned and sterilized according to the manufacturer's instructions.

Products shall be examined in accordance with Annex A.

4.3.2 Cleaning temperature stability

Cleaning temperature stability shall be as specified in ISO 13999-1:1999, 4.5.2 and 6.6.

4.4 Ergonomic requirements

When tested and examined in accordance with Annex A, the glove and arm guard or protective sleeve shall be found satisfactory for the use intended as indicated in the manufacturer's instructions in the information supplied by the manufacturer.

5 Test apparatus

5.1 General test apparatus, as specified in ISO 13999-1:1999, 5.1 to 5.7, if appropriate for the materials used in the construction of the gloves, arm guards or protective sleeves.

5.2 Test apparatus for assessing the attachment of arm guards and protective sleeves to gloves.

A hand held electronic force gauge, spring balance or similar device shall be used. Small clamps or clips shall be provided to attach the gauge to the test item. A flexible connection shall be made between the clamp and the gauge. The gauge shall have a range of 0 N to 200 N or two gauges of 0 N to 30 N and 100 N to 200 N shall be provided. The gauges shall be accurate to $\pm$ 3 N at 25 N and to $\pm$ 10 N at 150 N.

5.3 Impact-cut test apparatus, as specified in ISO 13999-3.

5.4 Cut-resistance test apparatus, meeting the requirements specified in ISO 13997.

6 Test methods

6.1 General

For each of the required sequences of measurements performed in accordance with this part of ISO 13999, make an estimate of the uncertainty of the final result. In the test report, record this uncertainty (U_{m}) in the form $U_{\mathrm{m}} = \pm X$. It shall be used in determining whether a “Pass” performance has been achieved. For example, if the final result plus U_{m} exceeds the required pass level value, the sample shall be considered to have failed.

6.2 Pre-treatment

Wash and dry all test specimens of products five times before examination or testing in accordance with manufacturer's instructions in the information supplied by the manufacturer. In the absence of such details, wash and dry them in accordance with Procedure 2A specified in ISO 6330:2000. Then tumble dry the test specimens at a temperature not exceeding 70 °C (Procedure E). Products marked as additionally suitable for dry cleaning shall be dry-cleaned five times before the washing cycles, as specified for normal materials in ISO 3175-2:1998, 8.1.

6.3 Conditioning

Condition test specimens at (20 ± 2) °C and a relative humidity of (65 ± 5) %, for at least 24 h before testing. Carry out testing in the conditioning environment or within 5 min of withdrawing the specimens from the conditioning environment.

6.4 Examination of coverage

Have an appropriate subject put on the test specimens as indicated by the marking and adjusted according to the manufacturer's instructions in the information supplied by the manufacturer. Test the coverage provided for the hand, wrist and forearm by inspection, measurement and the attempted insertion of a non-injurious blunt probe as described in ISO 13999-1:1999, 5.6.

As a general rule, try to get the probe through any apparent opening. Apply the probe to every slit, opening, or overlap found. Apply the probe at an angle of 0° to 45° with respect to the underlying skin, and at any angle between directly up the arm and directly across the arm. Within this envelope of approach angles, move the probe around on any opening or potential opening, with a force of up to 4 N to ascertain whether it can pass through the test item. Record every penetration as a gap in coverage.

Include the findings of the examination and test in the test report.

6.5 Strength of attachment of arm guards and protective sleeves to gloves and the resistance to displacement of protective sleeves from within cuffs and on arms

Have an appropriate subject put on the test specimen as indicated by the marking, and adjusted according to the manufacturer's instructions in the information supplied by the manufacturer. Attach the clamp (see 5.2) in turn to four points approximately evenly spaced around the circumference of the arm guard or protective sleeve (40 ± 5) mm above its attachment to the glove or (75 ± 10) mm above the subject's wrist for unattached products. Attach the force gauge or similar device to the clamp in each position and apply the test force progressively over a period of 5 s to 10 s. Direct the force as nearly as possible up the arm parallel to the skin. Observe the movement of the arm guard or protective sleeve and measure the displacement immediately once the required force has been reached. Reposition the arm guard or protective sleeve before each trial.

Record the results of the test in the test report.

6.6 Impact cut testing

6.6.1 General

Carry out the impact cut testing as specified in ISO 13999-3.

6.6.2 Samples and test positions

Test gloves intact, if possible. Place the glove on the specimen support so that six impact cuts can be made on the back of the glove. Make two cuts along the long axis of the glove, two cuts at 90° to these, and two at 45° to them. Make impact points at least 15 mm apart and on undamaged material.

If the fingers of the glove are of apparently weaker construction, prepare and subject test-finger samples to impact cuts as specified in ISO 13999-3. Make a total of six impact cuts.

Test arm guards and protective sleeves for each type of construction of protective material present. If necessary, cut them transversely into short tubes to fit them on the apparatus. Make a total of six impact cuts.

Report the individual test results and their arithmetic means, any observations related to the protective quality of the product, and details of any hazardous edges, fragments, or sharp wire ends, that were produced by the knife impact in the test report.

6.7 Cut resistance testing

6.7.1 General

Carry out testing to cut resistance in accordance with ISO 13997.

6.7.2 Samples

Cut samples from the backs, palms, fingers and cuffs of gloves. Orient finger and palm samples so as to make the cut across the finger and palm. Orient back samples so as to make the cut at 45° to the long axis of the glove. Orient cuff samples so as to make the cut parallel to the long axis of the glove. Determine the cutting force for each orientation.

Cut samples from arm guards and protective sleeves so as to determine the cutting force along and across the product and at 45° to these directions. Subject each type of construction of protective material to the test.

6.7.3 Tests

Perform the cut test as specified in ISO 13997. Pre-treat samples as whole products as specified in 6.2. Determine the cutting force in each orientation specified in 6.7.2 and include the results in the test report.

6.8 Measurement of arm guard and protective sleeve length

Measure the length of the product on an appropriate subject where a product is marked with its linear length, or this is given in the information supplied by the manufacturer. Have the subject put on the product and adjust it. Measure the product's length with the arm held out horizontally in front of the subject. Report the marked or claimed length and the measured length in the test report.

6.9 Testing the dimensions of interstices

Use gauge number 2 described in ISO 13999-1:1999, 5.5, to probe the interstices between metal or plastic components of the glove, arm guard or protective sleeve or their joins to each other. Push the gauge against the interstice with a force of up to 10 N. Permit the material under test to fold if the gauge enters further as this happens. Test five examples of each interstice type. Test the main areas of knitted products and seams between panels.

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

7 Test report

The test report shall include the following information:

a) reference to this part of ISO 13999 (ISO 13999-2:2003);

b) test sample description, identification by name or code, source, sizes supplied, batch numbers or equivalent, and dates of manufacture;

c) list and details of all other items of protective clothing used with the test samples in testing where another compatible item is required, such as a glove meeting this part of ISO 13999 for use with a protective sleeve that is under test;

d) dates of testing and a list of the tests performed;

e) details of the test panel members;

f) results of the following tests and for each one, where appropriate, the estimate of the uncertainty of the final result and a statement as to whether the test specimen complies with the requirements in this part of ISO 13999:

1) whether coverage is provided in compliance with 4.1.2 to 4.1.6 when the test in 6.4 is performed;
2) results of temperature stability testing of plastic arm guards as specified in ISO 13999-1, 4.5.2 and 6.6;
3) result of testing attachment of arm guards and protective sleeves as specified in 5.2, 6.4 and 6.5;
4) whether flexible arm guards are adequately held in place during the procedure described in A.5, and do not move more than 40 mm upwards from the wrist during the test in 6.5;
5) individual impact cut test results in tests made as specified in 6.6.2 and for each series their arithmetic mean, a note of any observations related to the protective quality of the product, and details of any hazardous edges, fragments, or sharp wire ends, that are produced by the knife impact;
6) cutting force determined in each test orientation as specified in 6.7;
7) whether the minimum length marking on arm guards and protective sleeves are confirmed as correct in the tests in 6.8 and A.5;
8) result of testing interstices as specified in 6.9;
9) results of the innocuousness examination as specified in A.3;
10) results of the glove size verification as specified in A.4;
11) results of the arm guard and protective sleeve size verification as specified in A.5;
12) numerical and descriptive results of the grip and pull test as specified in A.6 as well as the calculation of the score for the glove and a statement of the acceptability of the glove;

g) statement as to whether the sample(s) have met all the requirements of this part of ISO 13999;
h) all authorizing signatures.

8 Marking

Gloves, arm guards and protective sleeves conforming to this part of ISO 13999 shall be permanently and conspicuously marked with at least the following:

a) the name or trademark of the manufacturer or importer;
b) the manufacturer's designation of the product type, commercial name or code that uniquely identifies it;
c) the size of the product;
d) the maximum permissible cleaning temperature if this is below 82 °C;
e) the pictograms as specified in Clause 9.

The following information should be given on the product whenever practical or on the packaging:

f) the types of use for which the product is or is not specifically intended;
g) the hazards against which some protection is given;
h) the textile and material types present in the product;
i) the international care label symbols in accordance with ISO 3758 (negative labels are important).

9 Information for users and instructions for use

Gloves, arm guards and protective sleeves 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:

a) the information required in Clause 8;
b) the full address of the manufacturer or the legally responsible company;
c) a statement of the types of work for which the product is suitable;

d) an explanation of the differences in protection offered by the product conforming to this part of ISO 13999 and another product conforming to ISO 13999-1 as well as any advice on how to choose between the products;

e) any advice on how to select the correct size of product and how to check its fit;

f) any advice on how to position and adjust the product;

g) any advice on wearing other personal protective equipment (PPE) to obtain the protection desired;

h) a warning that protection is limited to slash protection by knives and sharp edges and to stab protection by knives with wide blades;

i) a warning that the product is not suitable for use where strong cuts are made towards the hand and arm;

j) a warning to use the products only as supplied, apart from an instruction to shorten free ends of straps;

k) a warning about any environmental conditions, or misuse that would seriously reduce the protection provided;

l) a warning about any effects of chemicals, oils, solvents, ageing or wear that would seriously reduce the protection provided;

m) a warning about any classes of work in which the product could place the user at risk of injury and, in particular, state the hazards of powered tools and machines with moving parts;

n) a warning about any materials used in the product that may cause allergic responses or are carcinogenic;

o) any instructions for cleaning the product appropriately for different types of use including a warning about any treatments known to damage the product, and the effects of repeated cleaning cycles;

p) any instructions on storage of the product;

q) any instructions on how to examine the product for wear and degradation;

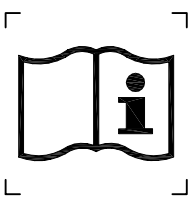
r) any instructions on the criteria to use when deciding whether to repair or to replace the product.

10 Pictogram

Products fulfilling the requirements in this part of ISO 13999 shall be marked with the pictograms ISO 7000-2619[1)] and ISO 7000-1641 shown in Figure 1. The pictograms are to be placed on the product or on the package in which it is supplied, together with the number of this part of ISO 13999, i.e. ISO 13999-2.

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

a) ISO 7000-2619
“Protection against cuts”



b) ISO 7000-1641
“Operation instruction”

Figure 1 — Pictograms

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

Annex A
(normative)

Ergonomic testing

A.1 Principles

The sizes of gloves are verified by examining the fit of gloves and arm guards on a test panel of subjects with appropriate hand and arm sizes. The ergonomic properties of the products are evaluated by the test panel of subjects performing a number of prescribed actions and answering a number of questions.

A.2 Test panel

The test panel shall be selected to have physiques and manual dexterity that would be expected in workers performing moderately strenuous hand and arm work. They do not have to be habitual users of such protective equipment. Their hand circumferences and lengths as defined in ISO 13999-1 shall be measured, and their hand sizes shall be determined by reference to ISO 13999-1:1999, Table B.1. A panel of at least five members shall be selected who have hands of sizes marked on the gloves to be tested. Men and women shall be selected as appropriate for the glove sizes. If sufficient glove sizes are included in the manufacturer's range, each panel member shall have a different hand size. The length of digit 1 (thumb) is not highly correlated with other hand dimensions and care should be taken not to select panel members with extreme digit 1 dimensions. The stature of the panel members shall be measured and used to select appropriate arm guards and protective sleeves, if these are sized against the stature of users.

A.3 Examination of products

Before gloves, arm guards or protective sleeves are worn they shall be examined visually and by hand for sharp edges or surfaces, rough hard areas, protruding wire ends or any other feature that might cause harm to a user. If serious faults are found, no ergonomic testing shall be carried out.

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

A.4 Procedure for glove size verification

Gloves shall be considered to be correctly marked if they are neither too tight nor too loose on the appropriate hands. Glove fit shall be determined by five panel members and an examiner.

The gloves shall be pulled on firmly to the hands and any closures securely fastened. The panel member shall then grasp a horizontal bar 30 mm to 40 mm in diameter that is fixed at about waist height and is orientated parallel to their coronal plane; that is it runs across in front of them.

The glove shall be considered too small if any of the following criteria are met:

— the wearer reports strain in gripping the bar, or a feeling of constriction across the palm or the back of the hand while doing so;

— the wearer reports continuous muscular effort is required to keep the fingers and thumb curled around the bar;

— the wearer reports the glove is tight against the tip of any digit and the examiner cannot pinch together material of the glove at the end of the digit while the wearer grips the bar.

The glove shall be considered too large if any of the following criteria are met:

— the wearer reports the glove is loose on the hand holding the bar and the hand moves easily inside the glove when the grip is slightly relaxed;

— the examiner can pinch together material at the sides of the palm to form a total fold depth on the two sides of the palm of more than 15 mm;

— the examiner can pinch together material at the end of any one digit to form a fold longer than 20 mm, or the mean fold length on the five digits is greater than 15 mm.

If a glove is found to be too large or too small in a relatively minor way on one panel member, two further members with the same nominal hand size shall wear the glove and its fit shall be assessed. The glove is acceptably marked if it fits both the additional subjects.

Record the results of the assessments in the test report.

A.5 Procedure for arm guard and protective sleeve size verification

Examine the manufacturer's information for use and the markings on the products. Select five panel members of the appropriate sizes to assess the products. Select appropriate compatible gloves to wear with the products.

The clothing to be worn with the products shall be as specified in the information supplied by the manufacturer, or the products shall be tested by the panel members wearing first a lightweight short-sleeved industrial coverall or jacket, and then a long-sleeved industrial coverall or jacket.

The products shall be put on and adjusted according to the manufacturer's information for use. Compatible gloves shall be put on and adjusted. The wearers, who should be standing, shall then raise their arms to a vertical position and stretch upwards. They shall then lower their arms to their sides and maximally flex their elbows with their fists close to their chests. They shall then relax with their arms hanging down at their sides. They shall then grasp the horizontal bar in front of them as specified in A.4.

The examiner shall verify that the coverage provided by the arm guard or protective sleeve conforms to the requirements in ISO 13999-1:1999, 4.1.5.1 to 4.1.5.3, and in 4.1.6 and 4.1.7.

The wearer shall then repeat the stretching, flexing and relaxing movements ten times without adjusting the arm guards, protective sleeves or gloves. They shall then grasp the horizontal bar and the examiner shall verify the coverage provided by the arm guard or protective sleeve and the glove. In particular, the examiner shall note whether the products have remained in place and that the required overlap at the wrist has been maintained.

The wearer shall report any excessive tightness or constraint experienced during the test, and any undue looseness or movement of the products.

Record the results of the assessments in the test report together with a statement of the acceptability of the arm guard or protective sleeve.

A.6 Grip-and-pull test

A.6.1 Principle

It is an important safety characteristic of gloves used, for example, in meat cutting that the work piece can be held securely and that it does not slip when large forces are applied to it by the knife. Measurements of the forces involved in boning out show peak forces of over 300 N and steady forces of 100 N. Gloves of the type covered by this part of ISO 13999 are expected to be only used in lighter work. Test forces have been specified accordingly in Table A.4.

This test requires four panel members to pull a metal cylinder towards themselves. This simulates the action of holding the work piece while cutting away from the body. The panel members report on the subjective strain of performing the task with and without the test glove, and with and without grease on the test cylinder.

A.6.2 Apparatus

A.6.2.1 Rigid work bench, with a top surface whose height can be adjusted and with room for the subject's feet beneath it.

A.6.2.2 Horizontal stainless steel cylinder, (30 ± 1) mm in diameter, mounted (120 ± 10) mm above the working surface.

The cylinder shall be orientated at (90 ± 10)° to the front edge of the work surface. The cylinder shall have a gripping region at least 150 mm long at its end, which is smooth and polished.

It shall have a rounded end facing the front edge of the work surface with a radius of at least 5 mm at the junction of the curved and flat faces. The cylinder shall end (150 ± 10) mm back from the front edge of the work surface. See Figure A.1.

The cylinder shall be supported so that it can only move in the direction of its long axis.

A.6.2.3 Force measuring system, with a direct read-out meter, ranging from at least 0 N to 400 N, showing the pull (force) exerted on the cylinder.

The meter shall be connected to the end of the cylinder (A.6.2.2) distant from the subject. A pull of 400 N shall not require a movement of the cylinder greater than 50 mm. The system shall have an accuracy better than ± 10 N.

A.6.2.4 Hand rests, mounted to the left and right of the gripping cylinder system against which the subject can brace their “knife” hand.

The rests shall be (120 ± 10) mm high and be mounted with the front face (300 ± 20) mm back from the front edge of the work surface. The rests shall have a length of at least 300 mm and a thickness of at least 80 mm. The corners shall have a radius of curvature greater than 5 mm.

A.6.3 Procedure

At least four panel members shall take part in the test. Each member shall, if possible, wear a different size of glove. If they are naturally right-handed, the glove to be worn shall be the left one, and the converse for left-handed members.

Adjust the apparatus so that the gripping cylinder is approximately at the panel member's waist height. The angle between the panel member's forearm and upper arm shall be approximately 120°. Each panel member shall perform a series of four test units, which have been divided into two test sets, i.e. either bare-handed or gloved, as described in Table A.1.

Table A.1 — Panel test set-up

Test cylinder conditions	Test set	
	A Bare handed	B Gloved
Dry	Test unit 1: bare-handed, dry cylinder	Test unit 3: gloved, dry cylinder
Greased cylinder	Test unit 2: bare-handed, greased cylinder	Test unit 4: gloved, greased cylinder

Each panel member shall carry out a panel test of the test units in the sequence given in Table A.2.

Table A.2 — Test unit sequence for each test panel

Test panel	Test unit sequence order			
	First test	Second test	Third test	Fourth test
Member 1	Test unit 1	Test unit 3	Test unit 2	Test unit 4
Member 2	Test unit 3	Test unit 1	Test unit 4	Test unit 2
Member 3	Test unit 1	Test unit 3	Test unit 4	Test unit 2
Member 4	Test unit 3	Test unit 1	Test unit 2	Test unit 4

Panel members shall be allocated randomly to the test sequences. If a panel member fails to complete the test, the sequence they were following shall be used by their replacement.

For the dry cylinder units, the cylinder shall be free of grease and moisture. For the greased cylinder units, the gripping region shall be liberally coated in petroleum jelly or similar innocuous grease.

For each test unit, the panel members shall follow the procedure given in Table A.3.

Table A.3 — Procedure for each test unit

Stage	Task
1	Stand comfortably at the bench, “knife” hand on a rest, “glove” hand lightly closed on the gripping cylinder.
2	Apply a peak force (see Table A.4), within less than 5 s, by pulling on the cylinder.
3	Decrease the pulling force to a level corresponding to the maintained force, specified in Table A.4, and maintain this level for at least 10 s.
4	Stop pulling and relax the grip, remove the hand from the cylinder, rest for (30 ± 5) s.
5	Repeat Stages 1 to 4 five times for a total of six pulls.

The forces in Table A.4 shall be applied by panel members with different hand sizes.

Table A.4 — Test forces to be applied

Hand and glove size	Peak force N	Maintained force N
Size 6 and below	150	60
Size 7 and 7 1/2	200	80
Size 8 and 8 1/2	250	100
Size 9 and above	300	120

After each test unit, each panel member shall immediately declare a single “test unit score” for the subjective effort they exerted as specified in Table A.5.

Table A.5 — Scoring criteria for each test unit

Test unit score	Criteria for scoring
1	No problems encountered. No strain or fatigue. Hand or glove did not slip.
2	Slight strain or sense of effort. Fatigue noticed by the end of the fifth or sixth repeat of Stages 1 to 5, or slight glove or hand slip.
3	Significant strain in completing the task. Fatigue noticed during the third or fourth repeat of Stages 1 to 5, or significant glove or hand slip.
4	Severe strain completing the task, or the sixth repeat not completed. Stage 4 noted to be too short for recovery, or uncontrollable hand or glove slip occurs.

After each set of tests with a dry or greased cylinder, each panel member shall immediately declare a “comparative score” (see Table A.6) for the test unit for the bare-handed test compared with the gloved-handed test under the same conditions (either dry or greased). The examiner shall record any comments on comfort or problems found by the panel member.

Table A.6 — Scoring criteria for each comparative test set score

Comparative score	Criteria for scoring
0	When the two conditions are perceived as equal for bare-handed and glove-handed tests under the same conditions (e.g. 2 and 2) or when the second test set (gloved hand) requires *less* effort than the first (bare-handed) (e.g. 2 and 1 or 3 and 2).
2	When the second test set (gloved hand) requires significantly more effort than the first (bare-handed) (e.g. 1 and 2 or 1 and 3).
4	When the second condition (gloved hand) requires much more effort and results in more fatigue than the first (bare-handed) (e.g. 1 and 4).

The "comparative" test set score shall be added to the single "test unit scores" for each test set and each panel member, and the total determined for each test set of gloves determined for all four panel members. The total score for the glove is the difference between the test sets (B minus A — see Table A.7).

Table A.7 — Example for calculating the total score for a hypothetical glove

Test set	Test unit: cylinder condition	Scores								Total for each test set
		Panel member 1		Panel member 2		Panel member 3		Panel member 4		
		S[a]	C[b]	S[a]	C[b]	S[a]	C[b]	S[a]	C[b]	
A: bare-handed	Test unit 1: dry	1	2	2	0	1	4	2	0	23
	Test unit 2: greased	3		2		4		2		
B: gloved	Test unit 3: dry	2	2	3	2	1	4	1	4	35
	Test unit 4: greased	4		4		4		4		
Total glove score (B–A)										**12**

[a] S = single test unit score.

[b] C = comparative test set score.

A total glove score of 8 or below indicates that the glove has very good ergonomic characteristics as evaluated in this test.

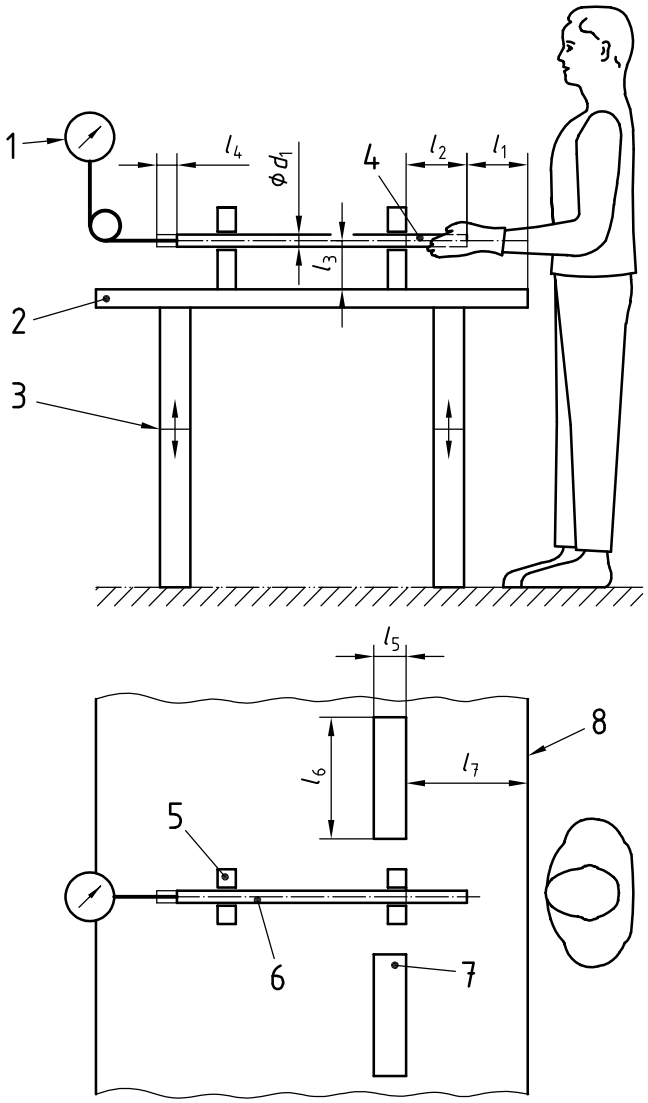
A total glove score of 9 to 13 indicates there is a slight ergonomic hindrance of using the glove. The glove may be accepted if the notes made by the examiner do not show the panel members had significant problems with the comfort or fit of the glove.

A total glove score of 14 to 19 indicates a significant ergonomic hindrance of using the glove. Such a glove is only acceptable if no panel member reported any comfort or other problem.

Gloves scoring 20 and above do not pass this test.

Other members shall replace panel members who withdraw from the test. They shall preferably have the same hand size. The test shall be halted if features of the gloves appear to be likely to harm the panel members.

The numerical and descriptive results of the test shall be included in the test report together with a statement of the acceptability of the glove.



Key

1 force of pull display
2 working surface
3 height adjustment
4 gripping region of cylinder
5 gripping cylinder supports
6 gripping cylinder
7 “knife” hand rest
8 front edge of working surface

l_1 distance of cylinder end from working surface front edge, (150 $\pm$ 10) mm
l_2 length of gripping region on cylinder, $\geqslant$ 150 mm
l_3 height of cylinder centre above working surface, (120 $\pm$ 10) mm
l_4 maximum movement of cylinder for 0 N to 400 N, pull, $\leqslant$ 50 mm
l_5 depth of hand rest, $\geqslant$ 80 mm
l_6 length of hand rest, $\geqslant$ 300 mm
l_7 distance of hand rest from working surface front edge, (300 $\pm$ 20) mm
d_1 diameter of cylinder, (30 $\pm$ 1) mm

Figure A.1 — Grip-and-pull test apparatus

Annex A
(normative)

Test results — Uncertainty of measurement

For each of the required measurements performed in accordance with this part of ISO 13999, a corresponding estimate of the uncertainty of measurement shall be evaluated.

This estimate of uncertainty shall be applied and stated when reporting test results, in order to enable the user of the test report to assess the reliability of the data.

ICS 13.340.40; 13.340.99

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