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# Protective clothing for use in snowboarding — Wrist protectors — Requirements and test methods

*Habillement de protection destiné à la pratique du surf des neiges — Protecteurs de poignets — Exigences et méthodes d'essai*



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# Foreword

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This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.



# Introduction

Snowboarding are all the pastimes and competitions in which a snowboard is used. The users range from small children to adults of all ages.

The wrist is the most frequently injured body region among snowboarders. The majority of wrist injuries are consequences of falls. The most common injury mechanism is described as a compressive load applied to a hyperextended wrist. Beginners and children have a high incidence of wrist injuries due to snowboarding. One third of injuries among beginner snowboarders are to the wrist.

Studies have shown that the risk of sustaining a wrist injury can be reduced by wearing wrist protection. Wrist protectors in snowboarding are intended to protect the wearer against fractures as well as contusions and sprains.

Wrist protectors will not prevent all wrist, forearm, hand, elbow and shoulder injuries in snowboard accidents.

A wide variety of wrist protectors is commercially available. Consumers can choose between different principal design concepts. One is the “integrated protection concept” in which the protective elements are integrated within a glove. Another one is the “separated protection concept” where the protective elements are individual components (similar to a brace or orthosis) that can be worn with or without a glove. If worn with a glove it can be foreseen to place them underneath or on top of the glove[3][4][5][6].

# Protective clothing for use in snowboarding — Wrist protectors — Requirements and test methods

## 1 Scope

This document specifies the requirements and test methods for ergonomics, innocuousness, comfort/sizing, restraint, ability to limit wrist extension and attenuate impact force on the palm as well as provisions for marking and instructions supplied by the manufacturer for wrist protectors for all users of snowboard equipment.

It does not apply to protectors used in roller sports, alpine skiing, or other sports. This document does not address protection for the forearm due to axial forces caused by an impact on the fingers or fist. Moreover, this document does not address protection against palmar flexion (terminal flexion) caused by an impact on the dorsal side of the hand.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 21420:2020, *Protective gloves — General requirements and test methods*

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*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

**3.1**
**wrist**
radio-carpal joint

**3.2**
**dorsal**
pertaining to upper side or back of the hand and wrist

**3.3**
**palmar**
pertaining to the palm side of the hand and wrist

**3.4**
**wrist protector**
wrist guard
device worn on the wrist and extending onto the forearm and the hand, that is intended to reduce the risk of wrist injuries by mechanical impact

**3.5**
**concepts of wrist protectors**

**3.5.1**
**integrated protection concept**
glove and protection elements forming one unit and used as one product

**3.5.2**
**standalone protection concept**
protection elements forming a wrist protector which can be worn with a glove, where the suitable type of glove will be specified by the manufacturer

Note 1 to entry: The manufacturer specifies how the protector is to be worn, including, whether the protector is to be worn underneath or on top of the glove.

**3.7**
**stiffness element**
design element that limits wrist extension

**3.8**
**splint**
type of stiffness element that uses semi-rigid support on either the dorsal and/or palmar area of the protector

**3.9**
**fastener**
strap or connector attaching wrist protector to the wrist

**3.10**
**extension**
movement of the hand in the dorsal direction

Note 1 to entry: Dorsal pertains to the back of the hand, palmar to the palm.

**3.11**
**flexion**
movement of the hand in the palmar direction

## 4 Requirements

### 4.1 General

Performance requirements shall be based on 3 ranges (A, B, C) as defined in Table 1.

The size of the wrist protector shall be defined according to the hand size in ISO 21420.

**Table 1 — Correlation range to size**

| | Range | | |
|---|---|---|---|
| | **A** | **B** | **C** |
| Size | ≤6 | 7 to 8 | ≥9 |

Requirements are fulfilled, if ergonomic-, innocuousness - and restraint- tests are fulfilled at room temperature (20 °C) and impact- and limitation of wrist extension-tests are fulfilled at room temperature and in cold condition (–10 °C)

However, additional impact- and limitation of wrist extension-tests at lower temperature might be performed and specified in the information supplied by the manufacturer (see Clause 7).

## 4.2 Splints

Wrist protectors may have splints on either the dorsal and/or palmar area of the protector. If splints are used, their dimensions must be appropriate to ensure sufficient pressure distribution on the surface of the hand and forearm. The dimension shall conform to the measures as given in Table 2. The reference point for measurements shall be the plane of the wrist of an appropriate size of assessor (see Table 1), who has put on the protector in straight position. The position of the plane of the wrist of the assessor shall be determined according to ISO 13999-1:1999, Figure 1.

**Table 2 — Minimum dimensions of splints in wrist protectors**

Dimensions in millimetres

| Location of splints | Range | | |
|---|---|---|---|
| | A | B | C |
| Length from the wrist up the arm towards the elbow | 45 ± 2 | 50 ± 2 | 55 ± 2 |
| Length from the wrist up the hand towards the finger tip | 40 ± 2 | 45 ± 2 | 50 ± 2 |
| Width at each end of the splints | 25 ± 2 | 25 ± 2 | 30 ± 2 |
| NOTE Differences between A, B and C are based on Reference [9]. | | | |

## 4.3 Ergonomics

When tested in accordance with 5.4, the assessor shall be able put on and take off the two wrist protectors by themselves without any discomfort, significant problem or hazard being encountered.

When tested in accordance with 5.4, the accessor shall be able to close and open the binding system by themselves while wearing wrist protectors.

## 4.4 Innocuousness

The product shall comply with the requirements in ISO 21420:2020, 4.2.

The tested sample shall not show permanently deformed nor broken parts, when tested according to 5.7 and 5.8.

Straps and closures of the tested samples shall not open during the tests according to 5.6 and 5.8.

The handling of the wrist protector during tests according to 5.4 and 5.5 shall not show roughness, sharp edges, projections and the like which could cause excessive irritation or injuries.

If splints are used for limitation of the wrist extension, their dimensions must fulfil the requirements of 4.2.

## 4.5 Restraint

When tested in accordance with 5.5, the displacement $\Delta l$ (see Figure 2: $l_2 - l_1$) of each test shall not exceed 20 mm.

## 4.6 Impact strength

When tested in accordance with 5.6 all components of the wrist protector shall not break or split.

## 4.7 Impact performance

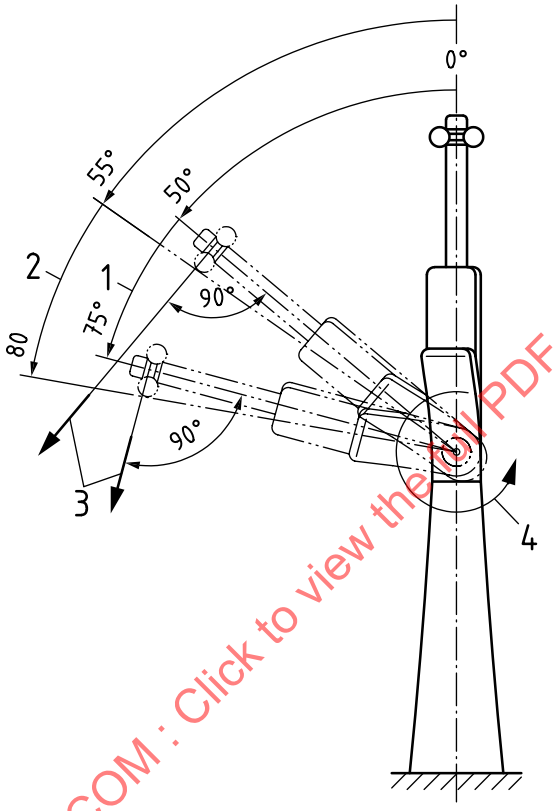
Wrist protectors can have protection elements that protect the palm against impact.

When tested in accordance with 5.7 all measured impact forces shall not exceed 3 kN.

### 4.8 Limitation of wrist extension

Wrist protectors shall be sufficiently stiff that when tested according to 5.8 and loaded with torque 1 according to Table 8 all resulting angles of the artificial wrist joint (extension 1) shall be within 50° to 75° (extension 1 = 50° ... 75° ± 1°). When tested according to 5.8 and loaded with torque 2 according to Table 8, all resulting angles of the artificial wrist joint (extension 2) shall be within 55° to 80° (extension 2 = 55° ... 80° ± 1°).

When torque 2 according to Table 8 is applied, extension 2 shall be at least 5° greater than extension 1 at torque 1 (extension 2 – extension 1 ≥ 5° ± 1°).




**Key**

| | | | |
|---|---|---|---|
| 1 | extension 1 | 3 | force |
| 2 | extension 2 | 4 | torque 1/2 |

**Figure 1 — Extension angle**



## 5 Testing

### 5.1 General

If no specific methods are specified, compliance with the requirements of this document shall be examined by measurement, visual inspection and tactile examination.

Only wrist protectors, as offered for sale shall be tested.

One size is tested per range (see Table 1) and the results are valid for all sizes within the range. Manufacturers do not need to supply a size for each range but test results are not transferable between ranges.

According to the two main types of design concept, the testing samples for all performance tests are as follows:

— If the wrist protector is built as an integrated protection concept, the complete product (protector and glove) has to be tested.

— If the wrist protector is built as a standalone protection concept, the product is to be tested in the configuration as specified in the information supplied by the manufacturer. If one or more types of gloves are foreseen, the protector shall be tested in combination with all type of gloves specified in the information supplied by the manufacturer. The protector shall be mounted as specified in the information supplied by the manufacturer (e.g. underneath or on top of the glove).

The sequence of tests shall be as shown in Table 3.

**Table 3 — Sequence of tests and number of test sample (to be done for each range)**

| Performance Test | Sequence of tests | Sample number/Conditioning | |
|---|---|---|---|
| Ergonomics | 1st | No. 1 (L+R) | - |
| Restraint | 2nd | — | No. 2 (L)/Room Condition |
| Limitation of extension | 3rd | No. 1 (R)/Room Condition | No. 2 (R)/Cold Condition |
| Impact strength | 4th | No. 2 (L)/Room Condition | No. 2 (R)/Cold Condition |
| Impact performance | 5th | No. 3 (R)/Room Condition | No. 3 (L)/Cold Condition |

## 5.2 Sampling

For each range to be tested, two pairs of wrist protectors shall be provided (Sample No. 1 and No. 2). For standalone wrist protectors, manufacturers shall provide all type of gloves specified in the information supplied by the manufacturer and for all ranges to be tested

If the wrist protector according to the information supplied by the manufacturer (see Clause 7) protects the palm against impact (4.7), a third pair of wrist protectors (No. 3) shall be provided.

The test samples shall be supplied with the information supplied by the manufacturer according to Clause 7.

## 5.3 Conditioning

### 5.3.1 General

All samples shall be conditioned before testing impact strength (5.6), impact performance (5.7) and limitation of extension (5.8), where samples shall be mounted to the prosthesis before conditioning. For standalone wrist protectors, gloves shall be conditioned too.

### 5.3.2 Room temperature conditioning

The mounted samples shall be exposed to a temperature of (20 ± 2) °C for not less than 4 h. Testing shall be completed in the conditioning environment or within 2 min of removal from the environment.

### 5.3.3 Cold temperature conditioning

The samples shall be exposed to a temperature of (–10 ± 2) °C for not less than 4 h. Testing shall be completed in the conditioning environment or within 2 min of removal from the environment.

## 5.4 Ergonomics

An assessor of suitable hand size shall put on, tighten and take off both wrist protectors (left and right) by themselves (without external support) as specified in the information supplied by the manufacturer, including gloves for wrist protectors, provided to be worn with gloves.

An assessor shall fix and then unfix themselves to a snowboard by closing and then opening the binding of the snowboard (left and right) while wearing wrist protectors and gloves on both hands (right and left).

## 5.5 Restraint

The wrist protector shall be put on by an assessor with the appropriate hand sizing (see Table 1) in the way specified in the information supplied by the manufacturer.

Standalone protection concept to be worn over the glove shall be tested with the type of gloves specified in the information supplied by the manufacturer.

Fasten the wrist protector as specified in the information supplied by the manufacturer. A reference line square to the long axis of the fingers, which best represents the mean approach to the positions of the marks showing the joint position [Line 2 of Figure 2 a)] shall be drawn onto the upper surface of the wrist protector. A mark shall be drawn onto the skin of the forearm within 1 cm from the end of the wrist protector [Line 1 of Figure 2 a)].

The assessor shall flex the wrist in palmar and dorsal directions 10 times to the full range of motion.

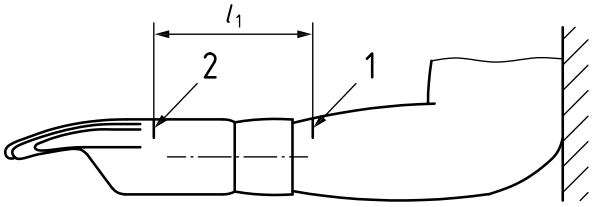
The assessor shall sit or stand with the trunk in a vertical position, the rear side of the upper arm pressed against a vertical support or wall and the forearm with the protector or protector and glove to be tested oriented approximately horizontal. The hand and finger joints shall be maintained in a stretched position during the test.

The distance between the reference line and the mark on the forearm shall be measured [Distance $l_1$ of Figure 2 a)].

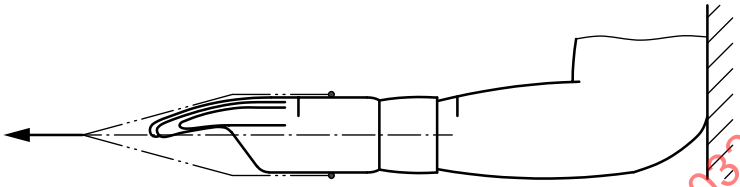
The force shall be applied at a rate of <200 mm/s in a direction parallel to the (longitudinal) axis of the forearm, by using a spring balance or similar device with a measuring range of at least 30 N. Forces shall be attached to the inner and to the outer side of the protector [medio-lateral direction, see Figure 2 b)]. Apply the force of (15 ± 1,5) N and maintain for (10 ± 1) s in a direction parallel to the forearm axis. Then release the forces. Measure the distance between the reference line (line 1) and line 2 with an accuracy of ± 2 mm within 5 seconds after release of the applied force [Distance $l_2$ see Figure 2 c)].

Displacement $\Delta l = l_2 - l_1$

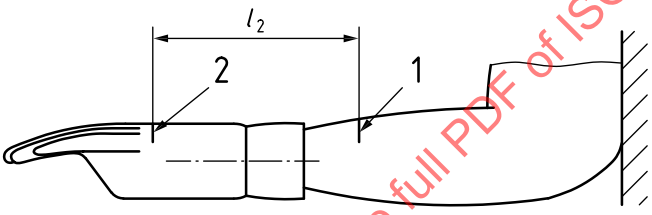
Three tests shall be made using the same sample. Reposition and adjust the wrist protector as necessary between the tests.




**a) Before application of the force**



**b) Application of the force (only for standalone wrist protectors)**




**c) After application of the force**

**Key**

1 mark on the skin of the forearm
2 reference line
$l_1$ distance between mark and reference line before force application
$l_2$ distance between mark and reference line after force application

**Figure 2 — Maximum displacement of the wrist protector**



## 5.6 Impact strength

### 5.6.1 Apparatus

Impact strength shall be tested in impacts with a mass of (5 000 ± 25) g.

The apparatus shall consist of the following:

a) pendulum test rig or a free fall guided-mass test rig.

b) steel anvil shall have a flat surface that is larger than the protector.

c) striking face on the impact mass that is circular with a diameter of (80 ± 2) mm. The corner of the striking face with its vertical side shall have a radius of curvature of (0,5 ± 0,1) mm. The striker and the impact mass shall be made of steel.

### 5.6.2 Procedure

The apparatus shall be adjusted so that the impact energy is in accordance with Table 4.

**Table 4 — Impact energy**

Dimensions in Joules

| Range | | |
|---|---|---|
| A | B | C |
| 30 ± 0,2 | 40 ± 0,2 | 50 ± 0,2 |

Samples as specified in 5.2 shall be tested once.

## 5.7 Impact performance

### 5.7.1 Test area

The test area shall be marked on the protector using a template in accordance with Table 5.

**Table 5 — Diameter of the test area template**

Dimensions in millimetres

| Range | | |
|---|---|---|
| A | B | C |
| 30 ± 0,5 | 40 ± 0,5 | 50 ± 0,5 |

Templates shall be centred on the points marked on the wrist protectors as follows.

On a person of an appropriate size for the protector, establish the position of the plane of their wrist joint according to ISO 13999-1:1999, Figure 1.

Draw a transverse line on their palm 30 mm, 40 mm or 50 mm from this plane for ranges A, B or C wrist protectors respectively.

Draw a longitudinal line down the centre of their palm. Fit the protector with the palm protection element to the person according to the information supplied by the manufacturer.

Place the template on the palm protection element so that its centre lies above the intersection of the two lines. Draw a line on the protector around the template.

### 5.7.2 Apparatus

Testing shall be carried out in an apparatus in which a guided mass falls onto a test specimen on an anvil. The centre of gravity of the falling mass shall be above the centre of the anvil.

The falling mass shall have a mass of (2,5 ± 0,025) kg and a striking face of 40 mm ± 2 mm × 40 mm ± 2 mm. It shall be made of polished steel, edges rounded with radius 1 mm ± 0,5 mm.

A means of measuring the velocity of the falling mass 5 mm to 15 mm before impact shall be provided to enable the impact energy to be verified.

The anvil shall be made of steel and shall have a radius of 100 mm and a hemispherical surface with a radius of curvature of 100 mm.

The anvil shall be attached through a piezoelectric load cell to a mass of at least 1 000 kg. The load cell shall be preloaded in accordance with the information supplied by the manufacturer.

The anvil shall be so mounted that during the impact test the total force between the anvil and the solid base of the device is conducted through the sensitive axis of a load cell. The recording system shall show a continuous force with time or shall have a peak force detection capability. Digital sampling systems shall have a minimum rate of 10 kHz. The complete system shall be able to measure forces up to 50 kN with an accuracy of 0,1 kN between 1 kN and 10 kN.

### 5.7.3 Procedure

The apparatus shall be adjusted so that the impact energy is in accordance with Table 6.

**Table 6 — Impact energy**

Dimensions in Joules

| Range | | |
|---|---|---|
| **A** | **B** | **C** |
| 3 ± 0,2 | 4 ± 0,2 | 5 ± 0,2 |

The protector shall be placed on the anvil and held down with a force between 5 N to 10 N.

NOTE A system of elastic straps has been found suitable.

The protector shall be moved on the anvil so that each chosen test position is impacted. Test positions shall be at least 15 mm apart. Test positions shall include points within the marked test area that it is anticipated will be particularly weak.

Four impacts shall be made with at least 30 s between each impact.

## 5.8 Limitation of wrist extension

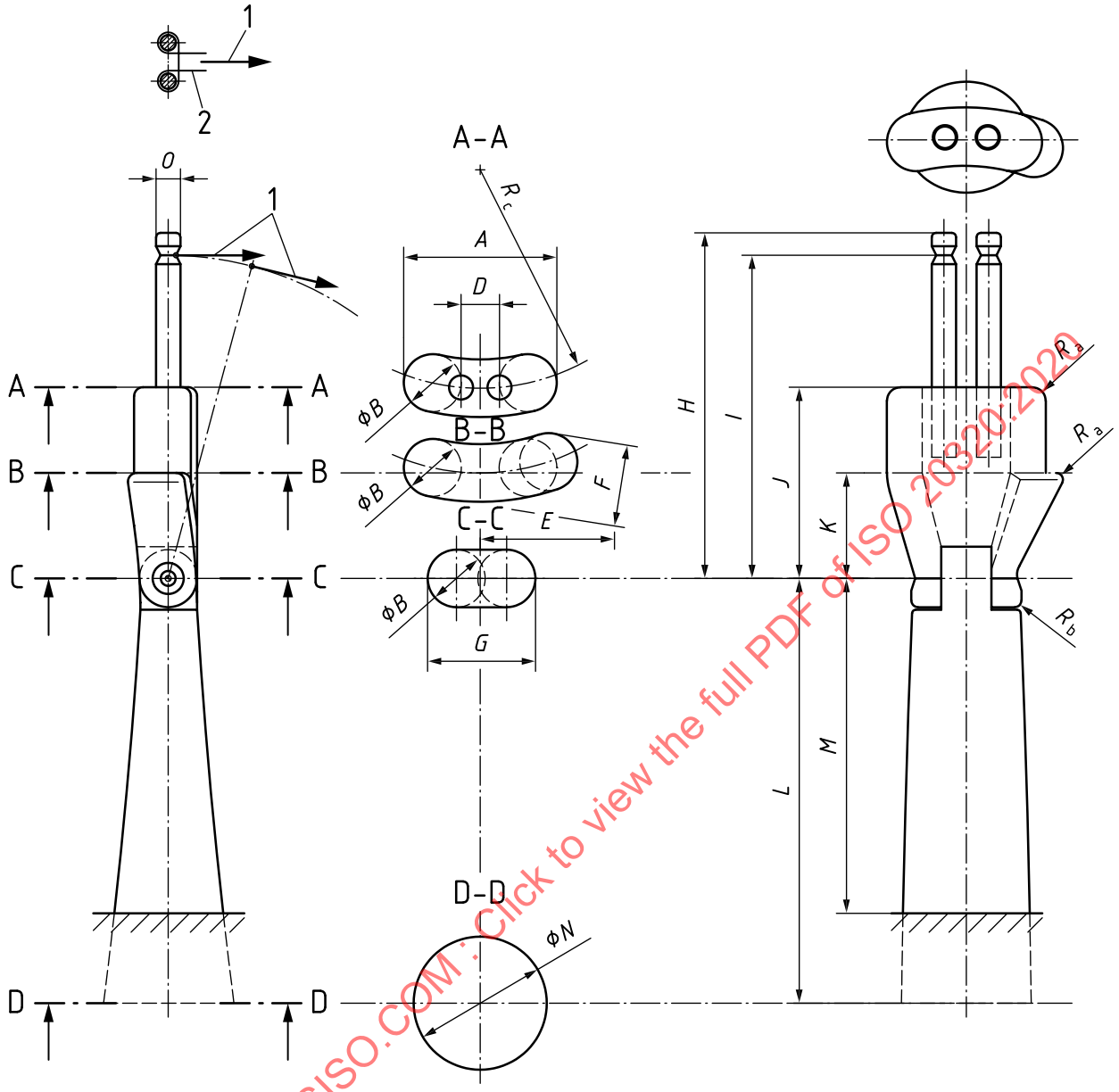
### 5.8.1 Principle

Wrist protectors shall be fitted to appropriate sizes of wrist and hand prosthesis. A specific torque (Torque 1 of Table 8) initiated into the wrist by applying a force perpendicular to the fingers and the angle of the wrist of the prosthesis is measured (Extension 1 of Figure 1). A second higher torque is applied and the angle of the wrist of the prosthesis is measured again (Extension 2 of Figure 1).

### 5.8.2 Apparatus

The hand, wrist and joint dimensions for a right hand prosthesis are given in Figure 3 and Table 7. Hand and wrist parts shall be made of polyamide or similar material. The hand shall be connected to the wrist using a metal bolt or screw tightened to hold the hand in place without resisting flexion and extension. The two rods extending from the hand intended for the load application shall be made from steel. The mass of the complete hand of the prostheses shall not exceed 0,600 kg. For the test, the forearm shall be fixed in a vertical position.

The force shall be applied via a cable (e.g. gear changing cable for bicycles) or a cord (e.g. string) around the fingers according to Figure 3. No other additional mass shall be applied to the fingers such as a clamp to hold the cable or cord. When testing integrated protection designs or wrist protectors designated to be worn over gloves, the load application shall be mounted over the glove fingers 3 and 4 (see ISO 13999-1:1999, Figure 1.). The direction of the force shall be 90° to the fingers (Figures 1 and 3).




**Key**

1 force

2 cable or cord

**Figure 3 — Hand prosthesis (right hand)**

**Table 7 — Dimensions of the hand prosthesis**

Dimensions in millimetres, Tolerances ±0,5 mm

| Prosthesis size | Range | Dimensions of the hand prosthesis | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *A* | ⌀*B* | $R_G$ | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* | *M* | ⌀*N* | *O* | *X* |
| **S** | **A** | 69 | 24 | 120 | 19 | 43,5 | 39 | 50 | 160 | 148 | 91 | 52 | 245 | 180 | 54 | 12 | 165 |
| **M** | **B** | 85 | 28 | 115 | 22 | 51,5 | 47 | 57 | 182 | 170 | 100 | 56 | 273 | 180 | 69 | 12 | 202 |
| **L** | **C** | 95 | 32 | 110 | 24 | 56,5 | 58 | 66 | 204 | 192 | 111 | 62 | 312 | 180 | 88 | 12 | 226 |

Dimension X: resulting circumference of the hand.

Chamfer: $R_a$ 2 mm.

Chamfer $R_b$ 10 mm.

Prosthesis dimensions are based on anthropometric data[7][8][9].

Hand length (Dimension *H*) of the three prostheses correspond to hand length of ISO 21420:

— Prosthesis size S corresponds to size 6,5;

— Prosthesis size M corresponds to size 8;

— Prosthesis size L corresponds to size 9.