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Protective gloves against cold

F : Gants de protection contre le froid

D : Schutzhandschuhe gegen Kälte

French standard approved

by decision of the Director General of AFNOR on May 20, 2006 taking effect on June 20, 2006.

Replaces the approved standard NF EN 511 dated January 1995.

Correspondence

The European standard EN 511:2006 has the status of French standard.

Analysis

This document forms part of a series of standards set up by the CEN within the scope of the implementation of the European Directive relating to Personal Protective Equipment. It sets out the characteristics of gloves which protect against convective and conductive cold down to $-50\text{ }^{\circ}\text{C}$.

Descriptors

Technical International Thesaurus: work clothing, protective clothing, accident prevention, gloves, thermal protection, water-tightness, tests, bend tests, testing conditions, marking, graphic symbols.

Modifications

With respect to document replaced, revision of the standard.

Corrections



National foreword

References to French standards

The correspondence between the standards figuring in the clause "Normative references" and the identical French standards is as follows:

<i>EN 388</i>	<i>: NF EN 388 (classification index: S 75-502)</i>
<i>EN 420</i>	<i>: NF EN 420 (classification index: S 75-504)</i>
<i>EN ISO 7854</i>	<i>: NF EN ISO 7854 (classification index: G 37-133)</i>
<i>ISO 7000</i>	<i>: FD ISO 7000 (classification index: X 05-005-01)</i>

The other standards mentioned in the clause "Normative references" that do not have any correspondence in the collection of French standards are as follows (they may be obtained from AFNOR):

ISO 4675
ISO 5085-1
ISO 15383

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 511

April 2006

ICS 13.340.40

Supersedes EN 511:1994

English Version

Protective gloves against cold

Gants de protection contre le froid

Schutzhandschuhe gegen Kälte

This European Standard was approved by CEN on 9 March 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



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Foreword

This European Standard (EN 511:2006) has been prepared by Technical Committee CEN/TC 162 “Protective clothing including hand and arm protection and lifejackets”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2006, and conflicting national standards shall be withdrawn at the latest by October 2006.

This European Standard supersedes EN 511:1994.

Annex D provides details of significant technical changes between this European Standard and the previous edition EN 511:1994.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 89/686/EEC.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this European Standard.

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

1 Scope

This European Standard specifies the requirements and test methods for gloves which protect against convective and conductive cold down to $-50\text{ }^{\circ}\text{C}$. This cold can be linked to the climatic conditions or an industrial activity. The specific values of the different performance levels are decided by the special requirements for each class of risk or the special areas of application. Product tests may only give performance levels and not levels of protection.

2 Normative references

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

EN 388, *Protective gloves against mechanical risks*

EN 420, *Protective gloves — General requirements and test methods*

EN ISO 7854:1997, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing (ISO 7854:1995)*

ISO 4675, *Rubber- or plastics-coated fabrics — Low- temperature bend test*

ISO 5085-1, *Textiles — Determination of thermal resistance — Part 1: Low thermal resistance*

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

ISO 15383, *Protective gloves for firefighters — Laboratory test methods and performance requirements*

3 General requirements

These gloves shall meet all the applicable requirements of EN 420.

4 Performance requirements

4.1 Mechanical requirements

The gloves shall at least comply with performance level 1 of EN 388 in abrasion and tear resistance. This minimum requirement can be different according to the levels of protection against cold (see 4.5 and 4.6).

4.2 Flexibility behaviour

When tested in accordance with 5.2 there shall not be any cracks. This test is not necessary for uncoated materials.

4.3 Water penetration

The gloves shall be tested according to 5.3.

A level of performance of 1 shall be indicated when no leakage is seen at the end of the testing period. If this requirement is not passed, then a performance level of 0 shall be indicated, and a warning stating that the

glove may lose its insulative properties when wet shall be added in the information supplied by the manufacturer (see Clause 7).

4.4 Extreme cold flexibility test

When tested in accordance with 5.4 no crack shall appear at the fold. This test shall be performed on gloves designed to protect at temperatures below $-30\text{ }^{\circ}\text{C}$.

4.5 Convective cold

When tested in accordance with 5.5, the thermal insulation properties of the glove shall comply with the values given in Table 1.

Table 1 — Thermal insulation values

Performance level	Thermal insulation I_{TR} in $\text{m}^2\text{ K/W}$
1	$0,10 \leq I_{TR} < 0,15$
2	$0,15 \leq I_{TR} < 0,22$
3	$0,22 \leq I_{TR} < 0,30$
4	$0,30 \leq I_{TR}$

For a convective cold performance level of 2 to 4, the product shall record at least level 2 in abrasion and tear resistance according to EN 388, otherwise the maximum convective cold performance that shall be reported is level 1.

4.6 Contact cold

When tested in accordance with 5.6, the thermal resistance properties of the material shall comply with the values given in Table 2.

Table 2 — Thermal resistance values

Performance level	Thermal resistance R in $\text{m}^2\text{ K/W}$
1	$0,025 \leq R < 0,050$
2	$0,050 \leq R < 0,100$
3	$0,100 \leq R < 0,150$
4	$0,150 \leq R$

For a contact cold performance level of 2 to 4, the product shall record at least level 2 in abrasion and tear resistance according to EN 388, otherwise the maximum contact cold performance that shall be reported is level 1.

5 Test methods

5.1 Conditioning

Except for the convective cold test, before testing, the samples shall be stored for a minimum of 48 h in the following standard atmosphere:

temperature (23 ± 2) °C;

relative humidity (50 ± 5) %.

The test shall be preferably carried out in this atmosphere. If the test is carried out under different climatic conditions then it should be started within 3 min of the time the samples were removed from the standard atmosphere.

For protective gloves with a multi-layer construction the test shall be carried out on all layers simultaneously, even if these, when removed, are not connected to one another (see 5.5).

5.2 Flexibility behaviour

The test shall be carried out in accordance with Method A of EN ISO 7854:1997 at a test temperature of (-20 ± 2) °C or an alternative temperature as specified by the glove's manufacturer.

- The number of cycles shall be 10 000.
- From each palm of a pair of protective gloves two samples shall be taken (four samples in total).
- If the direction of manufacture of the material is recognizable then one sample shall be so taken that the longitudinal axis lies in the direction of the manufacture and one in the direction at right angles to it.
- If the direction of manufacture is not given and one cannot be established then the two samples are taken in two directions at right angles to one another.
- The samples are taken without seams. If this is not possible then the sample is taken in such a way that the seams lie, during the test, in the area of the clip and do not influence the bending.

5.3 Water penetration

The test shall be carried out according to the whole glove integrity test described in ISO 15383, with complete immersion of the glove up to the wrist line only.

5.4 Extreme cold flexibility

The test shall be carried out in accordance with ISO 4675 with a test temperature of (-50 ± 2) °C.

- From each palm and back of a pair of gloves a sample will be taken (four samples in total).
- If the direction of manufacture of the material is recognizable then one sample shall be taken so that the longitudinal axis lies in the direction of manufacture and one in the direction at right angles to it.
- If the direction of manufacture is not given and one cannot be established then the two samples are taken in two directions at right angles to one another.

5.5 Convective cold

5.5.1 Principle

The thermal insulation of a handwear is determined by measuring the power required to maintain a constant temperature gradient between the surface of a heated, full-scale hand model and the ambient atmosphere.

Design and construction of the hand shall achieve the same constant temperature over the whole hand surface (maximum deviation as specified in A.4).

The gloves shall be stored at test temperature for at least 24 h prior to testing.

The heat input to the hand shall be sufficient to maintain a mean hand temperature in each zone in the range 30 °C to 35 °C at an ambient temperature, which is at least 20 °C lower.

5.5.2 Apparatus

The test apparatus consists of:

- hand model;
- climatic room;
- measuring equipment.

See Annex A.

5.5.3 Test sample

The test sample shall be of size 9 (see EN 420).

5.5.4 Procedure

The hand model is dressed with the test glove and placed vertically, fingers down in the test zone of the climatic room.

The ambient temperature (T_A) is set sufficiently low to meet the requirements of Annex A. The air velocity is kept at $(4 \pm 0,5)$ m/s and relative humidity (50 ± 5) %. Alternative conditions may be used provided correlation between the results obtained is demonstrated.

When the temperature of the hand (T_{Hand}) and power consumption (Q_{Hand}) have reached a steady state, the measurements are taken of their average values for a period of 10 min.

The resultant thermal insulation is calculated by:

$$I_{\text{TR}} = \frac{T_{\text{Hand}} - T_A}{Q_{\text{Hand}}}$$

I_{TR} is the resistance to dry heat loss from the hand, which includes the resistance provided by the handwear and the air layer around the dressed model;

T_{Hand} is the mean surface temperature of the measuring zone of the hand, in °C;

T_A is the mean temperature of the air in the climatic room, in °C;

Q_{Hand} is the measured power supply to the measuring zone of the hand during steady state, in W/m².

The average of two independent measurements is used as the mean value for the test glove.

5.6 Contact cold

The test shall be carried out in accordance with ISO 5085-1 using a pressure of 6,9 kPa and expressing the results in m² K/W.

Two representative samples of the material used to construct the palm side of the fingers of the glove shall be tested. If this is not possible, then sufficient samples shall be taken from the palm side of a number of gloves. If the palm side of the glove is not uniform, then samples of the different parts of the glove shall be tested and the lowest mean value quoted.

NOTE an alternative test method may be used provided it has been cross-validated against the method described above.

6 Marking

The marking shall comply with the appropriate clause of EN 420.

In addition, the pictogram ISO 7000-2412 for the cold protective gloves shall be included with reference of the standard and the performance levels indicated as shown in the example hereunder:

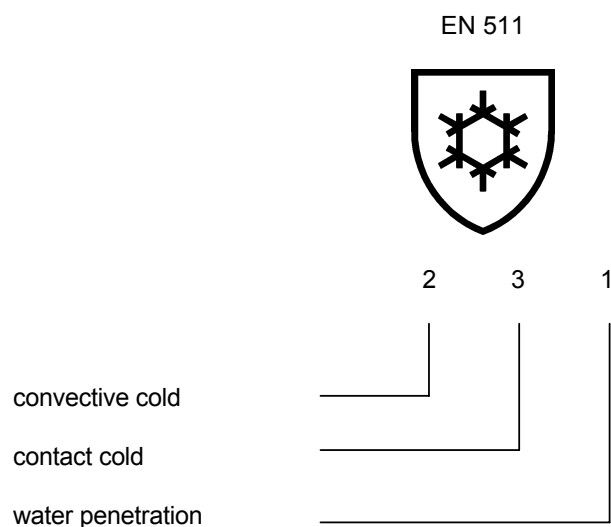


Figure 1

The pictogram shall be used only if a minimum level of 1 is obtained for convective cold according to 4.5 or contact cold according to 4.6.

The sign X, instead of a number, means that the glove is not designed for the use covered by the corresponding test.

7 Information supplied by the manufacturer

The information supplied by the manufacturer shall be according to the appropriate clause of EN 420.

If the glove consists of separate parts which are not permanently interconnected, the manufacturer shall indicate that the performance levels and the protection only apply to the complete assembly.

The manufacturer shall provide information or indicate where information can be obtained on the maximum permissible user exposure, e.g. temperature, duration. Annex B may be used as a help.

If the glove is not reaching a level of performance of 1 according to the water penetration test, then a warning stating that the glove may lose its insulative properties when wet shall be added (see 4.3).

Annex A (normative)

Convective cold — Description of test apparatus

A.1 General

In principle thermal insulation can be determined with any apparatus, which can measure and control the temperature of the surface of the hand and the heat loss from the hand.

Selection of temperature sensors and heating elements and their application and integration into the hand model is not critical as long as the performance of the apparatus complies with A.2 to A.5.

A more detailed description of the size, form and shape of the hand is given below. These factors significantly contribute to the variation in measured values.

A.2 Hand model

The hand is heated so as to provide a uniform surface temperature similar to the surface of a human hand.

The hand (fingers, palm and back) forms one measuring zone. The hand is separated from the forearm by a guarding zone, which is heated similarly to the hand. The hand model is cast in a mould, prepared from a standard porcelain hand model ¹⁾ used for manufacturing gloves as shown in Figure A.1. Dimensions are given in Figure A.2. Fingers are flexed with thumb in opposition.

The hand is made of solid plastic. It may also be made from another material e.g. copper, aluminium. The forearm serves as a stand for positioning of the hand in the climatic room.

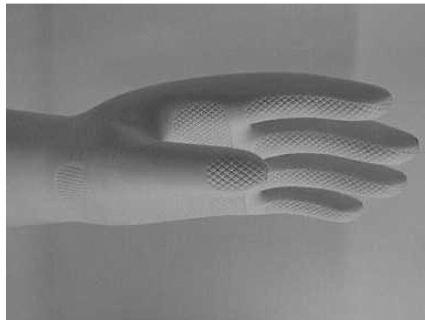
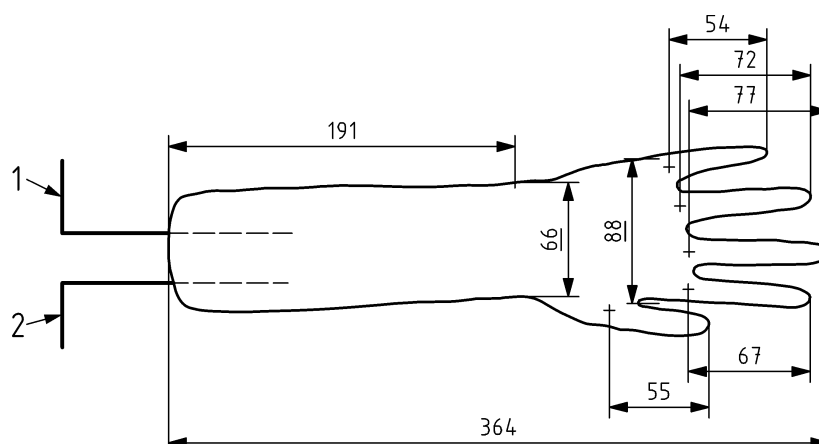


Figure A.1 — Picture of a porcelain model (hand area)

1) Information concerning sources of supply for standard porcelain hand models may be given by CEN/TC 162, the secretariat of which is held by DIN.

Dimensions in millimetres

**Key**

- 1 cables from temperature sensors
- 2 cables from heating elements

NOTE The hand model is shown reduced proportionally.

Figure A.2 — Hand model

A.3 Power supply system

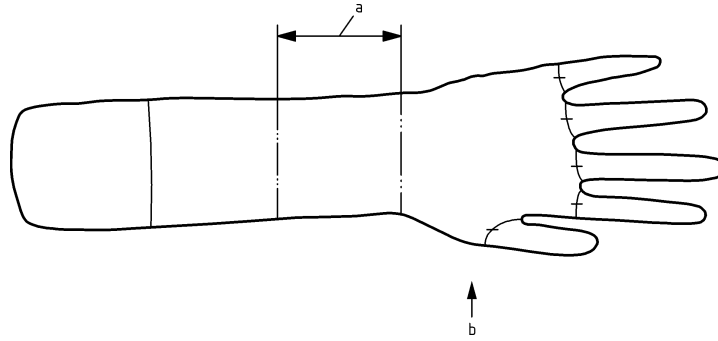
The surface of the hand is covered by densely wired resistance wires. The layer of wires is coated by plastics, approximately 0,2 mm thick.

Power supply including the heating elements shall be sufficient to enable to maintain a stable heat flow through the hand model of up to 200 W/m².

Power to the hand shall be measured so as to give an accurate average over the period of the test. The accuracy of the power measurement shall be within 2 % of the reading for the average power for the test period.

The hand is heated by a low voltage DC-power supply. Power supply shall be stabilised. Voltage fluctuation shall not exceed ± 1 %.

Figure A.3 shows the heated guard zone, preventing axial heat flow to the elbow.



Key

- a heated guard zone
- b heated hand and fingers

Figure A.3 — Position of the heated zones of the hand model

A.4 Surface temperature

Temperature distribution over the hand surface shall be constant, with no local cold or hot spots. The recommended setpoint for mean hand surface temperature is in the range 30 °C to 35 °C. Local deviations from the controlled mean hand surface temperature shall not exceed ± 1 °C. Temperature uniformity shall be repeatedly (every year, after repair etc.) checked with an infrared imaging system or equivalent method.

Temperature sensors shall be imbedded in the surface layer, not to interfere with the fitting of the test glove.

Temperature of the hand surface is measured by resistance wires. The sensor wire is taped to the surface in a manner that allows for a representative measure of mean hand surface temperature including all significant areas (fingers, palm and back of the hand).

A.5 Climatic room

The hand shall be placed in a room that can provide uniform climatic conditions. Spatial and temporal temperature deviations shall be within ± 1 °C and humidity within ± 5 %.

Mean radiant temperature shall not be more than 0,5 °C different from mean air temperature. Mean air velocity in the test zone shall be controlled at $(4,0 \pm 0,5)$ m/s. Turbulence intensity shall be less than 30 % (one standard deviation of mean air velocity).

Annex B (informative)

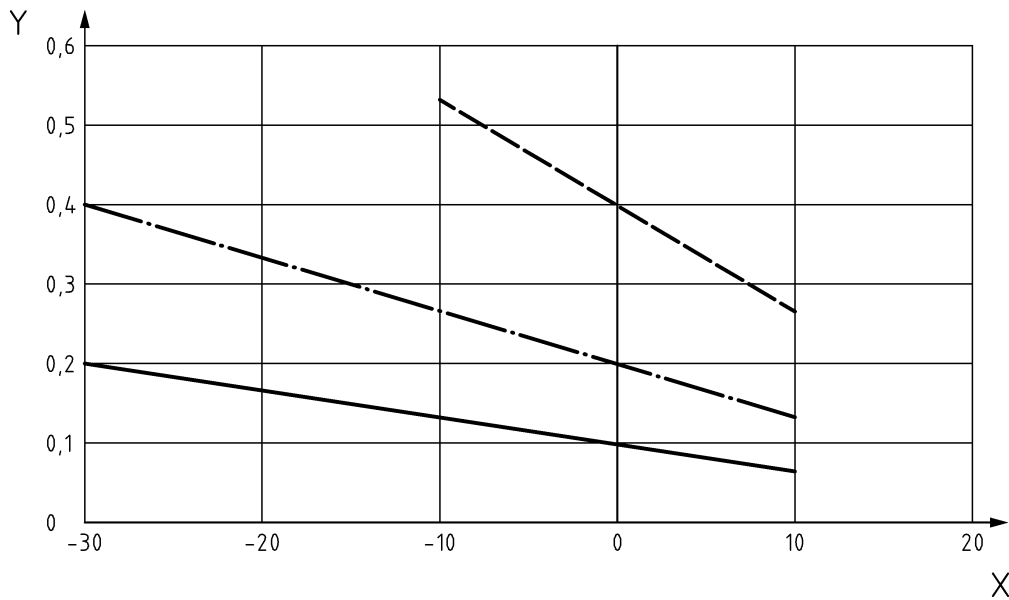
Protection against cold according to the application

Several parameters should be considered in the selection process of a glove that protects against cold, such as those shown in Table B.1.

Table B.1 — Parameters relevant in selection process

Environment	Environmental temperature Atmospheric conditions (relative humidity...) Wind speed
Individual conditions	Health and well-being of the person Effect of other protective clothing worn by the person
Occupation	Time of exposure Activity level Dexterity requirements Contact with cold items Contact with wet or dry objects

Studies have established certain correlations between these parameters and the level of thermal insulation required to protect in cold conditions. The table given in Annex B of EN 342:2004 is an example of such data. Figure B.1 shows the thermal insulation level required for three activity levels as a function of ambient air temperature at a wind speed below 0,5 m/s (source: Goldman 1994).



Key

X temperature in °C

Y insulation in m²K/W

----- low activity

- . - . - medium activity

———— high activity

Figure B.1 — Glove insulation requirements at three levels of physical activity

NOTE The parameters considered in the study (air velocity etc.) may differ from these of the convective cold test method specified in 5.4.

Annex C

(informative)

Uncertainties of measurement and results interpretation

For each of the required measurements performed in accordance with this European Standard, a corresponding estimate of the uncertainty of measurement should be evaluated. This estimate of uncertainty should 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.

Annex D
(informative)

Significant technical changes between this European Standard and the previous edition

This European Standard includes the following significant technical changes compared to the previous edition:

- a) requirements on extreme cold flexibility test also applicable to uncoated gloves were excluded from the test in the 1994 edition;
- b) conditioning atmosphere modified;
- c) contact cold test modified;
- d) requirements on mechanical levels modified;
- e) requirement on water penetration modified;
- f) informative Annex B for the selection of protective gloves against cold including relevant parameters added;
- g) informative Annex C for uncertainties of measurement added;
- h) informative Annex ZA for the correspondence between this EN and essential requirements of Directive 98/686/EEC added.

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 89/686/EEC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 89/686/EEC on the approximation of the laws of the Member States relating to personal protective equipment.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 89/686/EEC

Clause(s)/subclauses of this standard	Essential requirements (Ers) of Directive 89/686/EEC, Annex II
4.1	3.3 Protection against physical injury (abrasion, perforation, cuts, bites)
4.2	3.7.1 PPE constituent materials and other components
4.3	3.7.2 Complete PPE ready for use
4.4	3.7.1 PPE constituent materials and other components
4.5	1.1.2.2 Classes of protection appropriate to different levels of risk
4.5	3.7.2 Complete PPE ready for use
4.6	1.1.2.2 Classes of protection appropriate to different levels of risk
4.6	3.7.1 PPE constituent materials and other components
6	2.12 PPE bearing one or more identification or recognition marks directly or indirectly relating to health and safety
7	1.4 Information supplied by the manufacturer

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] EN 342:2004, *Protective clothing — Ensembles and garments for protection against cold*