DRAFT FOR DEVELOPMENT

DD ENV 342:1998

Protective clothing — Ensembles for protection against cold

ICS 13.340.10

National foreword

This Draft for Development is the English language version of ENV 342:1998.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the European organization responsible for its conversion into a European Standard. A review of this publication will be initiated 2 years after its publication by the European organization so that a decision can be taken on its status at the end of this three-year life. The commencement of the review period will be notified by an announcement in *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into a European Standard, to extend the life of the prestandard or to withdraw it. Comments should be sent in writing to the Secretary of BSI Technical Committee PH/3, Protective clothing, at 389 Chiswick High Road, London W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ENV title page, pages 2 to 15 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This Draft for Development, having been prepared under the direction of the Health and Environment Sector Board, was published under the authority of the Standards Board and comes into effect on 15 April 1998

ISBN 0 580 29718 7

Amendments issued since publication

Amd. No.	Date	Comments

Contents

blank

EUROPEAN PRESTANDARD

PRÉNORME EUROPÉENNE

EUROPÄISCHE VORNORM

ENV 342

February 1998

ICS 13.340.10

Descriptors: Personal protective equipment, protective clothing, thermal resistance, specifications, thermal insulation, air permeability, water vapor tests, low temperature tests

English version

Protective clothing — Ensembles for protection against cold

Vêtements de protection — Ensembles de protection contre le froid

Schutzkleidung — Kleidungssysteme zum Schutz gegen Kälte

This European Prestandard (ENV) was approved by CEN on 22 January 1998 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. ENV 342:1998 E

Foreword

This European Prestandard 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 Prestandard 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(s).

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

Introduction

This prestandard as a prospective standard for provisional application is published to achieve at least a common basis in Europe for requirements and test methods for protective clothing ensembles against cold in the interest of especially manufacturers, test institutes and end-users. The measured properties and their subsequent classification are intended to ensure an adequate protection level under different user conditions: Thermal insulation of the whole ensemble and the air permeability are the essential properties to be tested and marked on the label.

Thermal insulation is the most important property and it is measured on the complete clothing ensemble with a full-sized thermal manikin in order to account for the effect of layers, fit, drape, coverage and shape. In this respect this prestandard differs from many other standards specifying only material properties. The insulation is tested with new ensembles. It should be recognized that ensembles in frequent use may loose significant insulation capacity due to laundry and wear. In general high quality products and well maintained clothing are less affected in this respect.

Wind may considerably increase convective heat losses. Therefore, the air permeability of the outer garment material is an important factor to be taken into account in relation to the protection of the wearer against cold. The insulation requirements and air effects for given conditions can be assessed by methods given in ISO/TR 11079.

Sweating must be avoided in continuous cold exposure, since moisture absorption will progressively reduce insulation. This is best controlled by selecting optimal rather than maximal insulation and flexible, adjustable garments rather than fixed and closed ensembles. It is more efficient to get rid of heat and moisture by ventilation of clothing through adjustable openings and button-up, than by passive diffusion through layers of garments. In the very cold, very little, if any, water vapour escapes through the material because of condensation and, eventually, is freezing in clothing. In some conditions with intermittent exposures (e.g. cold store work) or in conditions close to and above 0 °C the water vapour resistance value of fabrics become increasingly important and fabrics with a low value may contribute to improved heat balance and thermal comfort.

Because this prestandard only deals with ensembles, it is intended to draft a standard with requirements and test methods for garments against local cooling of the body.

1 Scope

This European Prestandard specifies requirements and test methods for performance of clothing ensembles (i.e. two piece suits and coveralls) for protection against cold environment.

It does not include specific requirements for head wear, footwear and gloves intended to prevent local cooling.

2 Normative references

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed herafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 340, *Protective clothing — General requirements.*

EN 511, *Protective gloves against cold.*

ENV 343, *Protective clothing — Protection against foul weather.*

EN 23758*, Textiles — Care labelling code using symbols. (ISO 3758:1991)*

EN 31092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test). (ISO 11092:1993)*

EN ISO 9237, *Textiles — Determination of permeability of fabrics to air.*

ISO/TR 11079*, Evaluation of cold environments — Determination of required clothing insulation (IREQ).*

ISO 4674, *Fabrics coated with rubber or plastics — Determination of tear resistance.*

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

3 Definitions

For the purposes of this prestandard, the following definitions apply:

3.1
cold environment

environment characterized by the combination of a low temperature, humidity, wind and thermal radiation (see ISO/TR 11079)

3.2
ensemble

clothing consisting of a two-piece suit or one-piece suit (coverall)

3.3
outer shell material

the outermost material of which the protective clothing is made

3.4
liner

an insert with a watertight property

3.5
thermal lining

a non-watertight layer providing thermal insulation

3.6
thermal liner

a layer with a watertight property providing additional thermal insulation

3.7
lining

an innermost material without watertight property and thermal insulation

3.8 properties of clothing materials or material combinations (composites)

3.8.1
thermal resistance (insulation) R_{ct} $\left[\frac{m^2 \cdot K}{W}\right]$

temperature difference between the two faces of a material divided by the resultant heat flux per unit area in the direction of the gradient. The dry heat flux may consist of one or more conductive, convective and radiant components. Thermal resistance R_{ct}, expressed in square metres kelvin per watt, is a quantity specific to textile materials or composites which determines the dry heat flux across a given area in response to a steady applied temperature gradient

3.8.2
water vapour resistance R_{et} $\left[\frac{m^2 \cdot Pa}{W}\right]$

water vapour pressure difference between the two faces of a material divided by the resultant evaporative heat flux per unit area in the direction of the gradient. The evaporative heat flux may consist of both diffusive and convective components

water vapour resistance R_{et}, expressed in square metres pascal per watt, is a quantity specific to textile materials or composites which determines the "latent" evaporative heat flux across a given area in response to a steady applied water vapour pressure gradient

3.8.3
water vapour permeability index i_{mt} (dimensionless)

ratio of thermal and water vapour resistances in accordance with equation

$$i_{mt} = \frac{S \cdot R_{ct}}{R_{et}} \quad (1)$$

where S equals 60 Pa/K.

i_{mt} is dimensionless, and has values between 0 and 1. A value of 0 implies that the material is water vapour impermeable, that is, it has infinite water vapour resistance, and a material with a value of 1 has both the thermal resistance and water vapour resistance of an air layer of the same thickness

3.9 thermal insulation of the protective clothing ensemble

3.9.1
resultant basic thermal insulation, $I_{cl,r}$

thermal insulation from skin to outer clothing surface under defined conditions measured with a moving manikin

depending on the end use of the garment different thermal insulation values apply. For the purpose of this prestandard the resultant basic thermal insulation $I_{cl,r}$ is used

the resultant basic thermal insulation value is determined in relation to the naked body surface area

the value is given in

$$\frac{m^2 \cdot K}{W}$$

or in clo with the following conversion factor:

$$1 \text{ clo} = \frac{0{,}155 \text{ } m^2 \cdot K}{W} \quad (2)$$

3.9.2
resultant total thermal insulation, $I_{t,r}$

total thermal insulation from skin to ambient atmosphere including clothing and boundary air layer under defined conditions measured with a moving manikin

3.9.3
resultant thermal insulation of boundary air layer, $I_{a,r}$

resistance against heat exchange by radiation and convection from the bare skin or the outer clothing surface to the ambient atmosphere measured with a moving manikin

3.9.4
IREQ (= insulation required)

required resultant thermal insulation calculated on the basis of the thermal parameters of the environment (e.g. air temperature, mean radiant temperature, air velocity, relative humidity) and the body metabolism (see ISO/TR 11079)

4 Performance assessment and requirements

4.1 Thermal insulation, $I_{cl,r}$

Requirements for thermal insulation of the human body in a specific cold environment are assessed on the basis of ISO/TR 11079 Technical Report IREQ.

To provide adequate protection against cold within the scope of this prestandard, the resultant basic thermal insulation $I_{cl,r}$ shall have a minimum value of 0,15 $m^2 \cdot K/W$, when measured in accordance with **5.1**.

Thermal insulation of a clothing ensemble (protective suit and underwear) is classified on the basis of measured resultant basic insulation values. Performance of a clothing ensemble in terms of preserving heat balance at normal body temperature depends on internal body heat production. Therefore the protective value of a clothing ensemble is evaluated by comparing its measured insulation value and the calculated required insulation value (IREQ). This comparison is the basis of Table C.1.

4.2 Air permeability, R_A

Classification shall be in accordance with Table 1.

Table 1 — Classification of air permeability

$R_A \left[\frac{I}{m^2 \cdot s}\right]$	**Class**
$150 < R_A$	1
$20 < R_A \leq 150$	2
$R_A \leq 20$	3

Air permeability shall be measured in accordance with **5.2**.

4.3 Water vapour permeability

4.3.1 ***Water vapour resistance,*** R_{et} ***of the outer shell material***

When tested in accordance with **5.3**, the outer shell material or the combination of outer material with the liner (see Figure D.1, Figure D.2 and Figure D.3 in Annex D) shall be classified in accordance with Table 2, unless **4.3.2** applies.

Table 2 — Classification of water vapour resistance

$R_{et} \left[\frac{m^2 \cdot Pa}{W}\right]$	**Class**
$20 < R_{et}$	1[a]
$13 < R_{et} \leq 20$	2
$R_{et} \leq 13$	3

[a] Clothing falling within class 1 can in certain circumstances only be worn for a limited period (see Annex C).

4.3.2 ***Water vapour permeability index (*** i_{mt}***) of thermal liner***

When the composite includes a thermal liner (e.g. nonwoven/membrane-laminate, see Figure D.4 in Annex D) **4.3.1** is not applicable and replaced by the following requirement:

When the water vapour permeability index i_{mt} and the thermal resistance of the thermal liner are measured in accordance with **5.4** and **5.5** respectivley, the thermal liner shall be classified as specified in Table 3 in relation to the minimum value $i_{mt\ min}$, defined as:

$$i_{mt\ \min} = \frac{S \cdot R_{ct}}{133{,}3 \cdot R_{ct} + 20} \qquad (3)$$

where S equals 60 Pa/K.

Table 3 — Classification of water vapour permeability index

i_{mt}	**Class**
$i_{mt} \geq i_{mt,\ min}$	2
$i_{mt} < i_{mt,\ min}$	1

4.4 Tear resistance of outer shell material

The tearing force of the outer shell material shall be at minimum 25 N in both directions of the material.

Testing of the tear resistance, see **5.6**.

5 Testing methods

5.1 Resultant basic thermal insulation, $I_{cl,r}$

The resultant basic thermal insulation is measured with a thermal manikin with a test procedure as given in Annex A.

The resultant basic thermal insulation of clothing ensembles (protective suit and standard underwear) is measured. The resultant basic thermal insulation of the protective clothing is measured in combination with any of the underwears A or B as specified in Annex B.

5.2 Air permeability, R_A

Air permeability is measured in accordance with EN ISO 9237.

In case that the composite material cannot be tested in one piece because of technical reasons, it is necessary to separate the individual components and measure the component with the lowest value.

Measurements shall be carried out at a pressure differential of 100 Pa and a test area of 20 cm^2.

5.3 Water vapour resistance, R_{et}

a) Testing of three specimens in accordance with EN 31092;

b) Another reproducible method other than method a), e.g. a nationally recognized non-desiccant type cup method may be applied, to test the water vapour permeability for other use than classification or testing to meet specified values as laid down in related standards.

The results obtained using methods a) and/or b) can be correlated for individual materials. Note that this correlation will be different between the individual materials.

5.4 Water vapour permeability index, i_{mt}

Test method in accordance with EN 31092.

This index is calculated from water vapour resistance and thermal resistance in accordance with formula (1) in **3.8.3**.

5.5 Thermal resistance, R_{ct}

Test method in accordance with EN 31092 or ISO 5085-1 in the single plate version. It shall be reported which test method was used.

5.6 Tear resistance

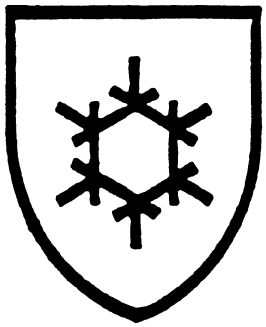
Testing in accordance with method A1 as given in ISO 4674. Testing with conditioned specimens, speed of the drawing clamp (100 ± 10) mm/min.

6 Marking and care labelling

Marking and care labelling shall be in accordance with EN 340:

— care labelling shall be carried out in accordance with EN 23758;

— levels of performance pictograms for protective clothing against cold weather with values and classes shall be as follows:



ENV 342	
X (A or B)	Measured resultant basic thermal insulation (with underwear type A or B) value $I_{cl,r}$ in $m^2 \cdot K/W$
X	Air permeability class
X	Water vapour resistance class or the class for i_{mt} (optional)

7 Sizes

These sizes shall be in accordance with EN 340.

8 Manufacturer's information

Manufacturer's information shall be in accordance with EN 340 providing the following information:

— Product designation;

— How to put on and take off, if relevant;

— Provide basic information on possible uses and where detailed information is available, state the source;

— Explanation how to use the information given in the marking;

— The class for water vapour resistance R_{et} or the class for i_{mt} shall be given (see **4.3**);

— Necessary warnings of misuse (see Annex C, e.g. limited wear time);

— A note that the thermal insulation may decrease after any cleansing procedure.

Annex A (normative)
Thermal manikin for measuring the resultant basic thermal insulation

A.1 Scope

This Annex describes the requirements of the thermal manikin and the test procedure to be used in testing the resultant basic thermal insulation of clothing.

A.2 Basic requirements of the manikin

A manikin shall be used that is formed in the shape and size of an adult person and heated to a constant, average skin temperature, with a skin temperature distribution similar to that of a human being.

The manikin shall be able to make walking movements at a rate of (45 ± 2) steps/min.

It shall consist of a head, chest/back, abdomen/buttocks, arms, hands (preferably with fingers extended to allow gloves to be worn), legs, and feet. Total surface area shall be (1,8 ± 0,3) m^2, and height shall be (175 ± 10) cm. The manikin's dimensions should correspond to those required for standard sizes of garments.

A.3 Description

The manikin shall be constructed so as to maintain a constant temperature distribution over the nude body surface, with no local hot or cold spots. The mean skin temperature of the manikin shall be between 32 and 35 °C. It is recommended that the average temperature of the hands and feet be lower.

Power to the manikin shall be measured so as to give an accurate average over the period of a test. Overall accuracy of the power monitoring equipment shall be within ± 2 % of the reading for the average power for the test period.

The mean skin temperature shall be measured with point sensors or distributed temperature sensors.

At least one sensor shall be placed on each of the thermally controlled sections of the manikin. Point sensors may be thermocouples, resistance temperature devices (RTD's), thermistors, or equivalent sensors. They shall be no more than 3 mm thick and shall be well bonded, both mechanically and thermally, to the manikin's surface. Lead wires shall be bonded to the surface or pass through the interior of the manikin, or both.

The precision of the temperature measurement shall be ± 0,2 °C. If distributed sensors are used (for example, resistance wire), then the sensors must be distributed over the surface so that all areas are equally weighted. If several such sensors are used to measure the temperature of different parts of the body, then their respective temperatures should be area-weighted when calculating the mean skin temperature. Distributed sensors must be small in diameter (that is, less than 1 mm) and firmly bonded to the manikin surface at all points.

The manikin shall be placed in a chamber at least 2 m by 2 m by 2 m in dimension that can provide uniform conditions, both spatially and temporally.

Spatial variations shall not exceed the following: air temperature ± 1,0 °C, relative humidity ± 5 %, and air velocity ± 50 % of the mean value. In addition, the mean radiant temperature shall not be more than 2 K different from the mean air temperature.

Temporal variations shall not exceed the following: air temperature ± 0,5 °C, mean radiant temperature ± 0,5 °C, relative humidity ± 5 %, air velocity ± 20 % of the mean value for data averaged over 5 min.

Any humidity sensing device with an accuracy of ± 5 % relative humidity and a repeatability of ± 3 % is acceptable. Only one location needs to be monitored during a test to ensure that the temporal uniformity requirements are met.

Any temperature sensor with an overall accuracy of ± 0,15 °C is acceptable. The sensor shall have a time constant not exceeding 1 minute. The sensor(s) shall be 0,5 m in front of the manikin. A single sensor may be used, but multiple sensors are prefered. If a single sensor is used it shall be 1,0 m above the floor. If multiple sensors are used, they shall be spaced at equal height intervals and their readings averaged.

An omni-directional anemometer with ± 0,05 m/s accuracy shall be used. Measurements shall be averaged for at least 1 min at each location. If it is demonstrated that velocity does not vary temporally by more than ± 0,05 m/s, then it is not necessary to monitor air velocity during a test.

A.4 Sampling

It is desirable to test two identical garment ensembles so that sample variability will be reflected in the test results. However, if only one is available at least three independent replicate measurements shall be made on one garment ensemble.

A.5 Preparation of test garments

Select the size of garments that fit the manikin properly to achieve the desired fit.

Garments should not normally be laundered or dry cleaned prior to testing because different procedures may affect the results. However, if garments are cleaned, the specific care procedures should be reported.

A.6 Procedure

The outer windspeed in the environmental chamber shall be set at a value between 0,3 and 0,5 m/s. The relative humidity in the enviromental chamber shall be set at a value of 30 % to 70 %. The mean skin temperature of the manikin shall be set at a value between 32 °C and 35 °C. The air temperature in the environmental chamber shall be at least 15 °C below the manikin's mean skin temperature or the total heat loss value from the manikin has to be at least 40 W/m^2.

To measure the resultant total thermal insulation $I_{t,r}$ dress the manikin in the garment ensemble to be tested. Set the walking movements of the manikin to (45 ± 2) steps per minute. Bring the clothed manikin to the selected skin temperature and allow the system to reach steady-state (that is, the mean skin temperature of the manikin and the power input remain constant) within the precision given in clause **A.3**.

After the ensemble reaches equilibrium conditions, record the manikin's skin temperatures and the air temperature at least every minute. The average of these measurements taken over a period of 30 min will be sufficient to determine the insulation value. Heating power shall be measured at least every minute over the test period.

Two independent replications of the clothing test shall be conducted. If the difference in the results between these two tests exceeds 5 % at least one more test has to be carried out. If only one ensemble or set of garments is being tested, they shall be removed and put back on the manikin for another test. In this way, normal variations in dressing and instrumentation will be taken into account.

To measure the resultant thermal insulation of the boundary air layer, $I_{a,r}$ conduct a test with a nude manikin in the same set of test conditions as stated above. The nude manikin shall be tested at the beginning of each series of clothing tests.

A.7 Calculation of test results

Calculate the resultant total insulation $I_{t,r}$ including the air layer resistance $I_{a,r}$ using the following equation (A.1) on the test results gained with the dressed manikin:

$$I_{t,r} = \sum_i f_i \left[\frac{(T_{s\,i} - T_a) \cdot a_i}{H_{c\,i}} \right] \quad in \quad \frac{m^2\,K}{W} \tag{A.1}$$

$$f_i = \frac{a_i}{A} \tag{A.2}$$

f_i = area factor of section i of the manikin

T_{si} = local surface temperature of section i of the manikin in °C

T_a = air temperature in environmental chamber in °C

a_i = surface area of section i of the manikin in m^2

H_{cl} = local heating power fed to section i of the manikin in W

A = total body surface area of the manikin in m^2

Calculate the resultant thermal insulation of boundary air layer $I_{a,r}$ using equation (1) on the test results gained with the nude manikin.

Calculate the resultant basic thermal insulation $I_{cl,r}$ using equation (3):

$$I_{cl,r} = I_{t,r} - I_{a,r} \quad \text{in} \quad \frac{m^2\ K}{W} \tag{A.3}$$

$I_{a,r}$ is not corrected for clothing surface area. Since this correction is very small for high insulative ensembles (approximately less than 5 % for 0,4 $m^2 \cdot K/W$) the cost and labour required for obtaining a correction factor is presently not justified.

A.8 Report

State the ambient temperature, relative humidity and windspeed in the environmental chamber, set in the manikin tests and state also the resultant thermal insulation of boundary air layer found in the tests. Report the resultant basic thermal insulation (see **5.1**) as the average of the independent replications performed.

A.9 Repeatability and reproducibility

For resultant thermal basic insulation $I_{cl,r}$ the precision of three repeated measurements with a manikin on the same specimen has been found to be 3 %.

In an interlaboratory trial using 4 clothing ensembles tested in 4 laboratories an average variation for resultant basic thermal insulation $I_{cl,r}$ of 8,5 % was found.

Annex B (normative)
Standard underwear for use with protective clothing against cold[1)]

Table B.1 — Underwear A

No	Piece of garment	Thermal resistance $R_{ct}\ \left[\frac{m^2 \cdot K}{W}\right] \pm 10\ \%$
01	Undershirt with long sleeves	0,060
02	Long underpants	0,060
03	Socks	0,053
04	Felt slippers	0,189

Table B.2 — Underwear B

No	Piece of garment	Thermal resistance $R_{ct}\ \left[\frac{m^2 \cdot K}{W}\right] \pm 10\ \%$
01	Undershirt with long sleeves	0,060
02	Long underpants	0,060
03	Socks	0,053
04	Felt slippers	0,189
05	Thermojacket	0,100
06	Thermopants	0,100
07	Knitted gloves	0,082
08	Balaclava	0,060

[1)] For sources of supply contact the secretariat of CEN/TC 162.

Annex C (informative)
Levels of performance

C.1 The protective value of measured resultant thermal insulation of a garment assembly is converted into combinations of ambient air temperature and activity level (metabolic heat production) (see Table C.1).

The three levels correspond to very light, light and moderate loads. For each level is calculated a minimal temperature at which the body can be maintained at thermoneutral conditions indefinitely (8 h), and a lowest temperature at which a one hour exposure can be sustained with an acceptable rate of body cooling. Values are based on the conditions that air temperature is equal to mean radiant temperature, relative humidity equals to 50 % and air velocity is between 0,3 m/s and 0,5 m/s.

NOTE An adequate level of whole body insulation may not be sufficient to prevent the cooling of susceptible parts of the body (e.g. hands, feet, face) and the concomitant risk of cold injury. The protection of hands against cold is dealt with in EN 511.

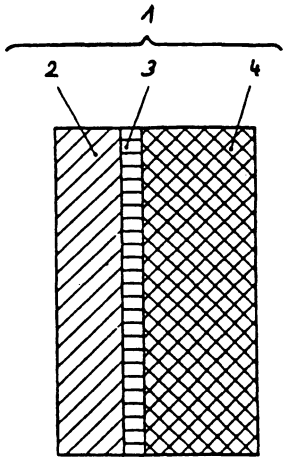
Table C.1 — Resultant basic insulation of clothing $I_{cl,r}$ and ambient temperature conditions for heat balance at different activity levels and duration of exposure

$I_{cl,r}$		Activity					
		Very light 90 W/m^2		Light 115 W/m^2		Moderate 170 W/m^2	
$\frac{m^2 \cdot K}{W}$	clo	8 h °C	1 h °C	8 h °C	1 h °C	8 h °C	1 h °C
0,31	2,0	10	– 4	1	– 23	– 18	– 31
0,38	2,5	4	– 12	– 6	– 33	– 29	– 44
0,46	3,0	– 1	21	– 13	– 43	– 39	– 57
0,54	3,5	– 7	– 30	– 20	– 53	– 49	– 70
0,62	4,0	– 13	– 39	– 28	– 63	– 60	—
0,70	4,5	– 19	– 48	– 35	—	—	—

These $I_{cl,r}$ values are only valid with adequate hand-, foot- and headwear and an air velocity between 0,3 m/s and 0,5 m/s.

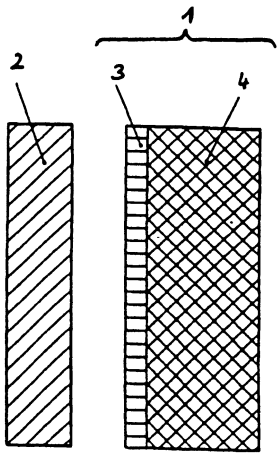
Higher wind speeds will increase the temperatures in Table C.1 because of wind chill effects (see ISO/TR 11079).

Annex D (informative)
Examples of textile laminates or thermal liners



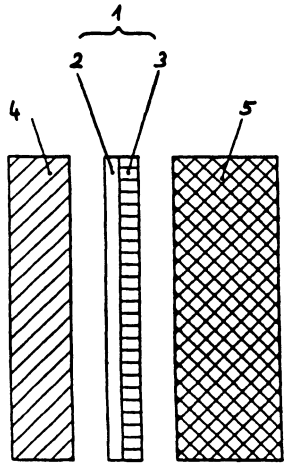
1 Outer shell material
2 Lining
3 Membrane
Foile
Coating
4 Outer material

Figure D.1 — 3-layer laminate as outer shell



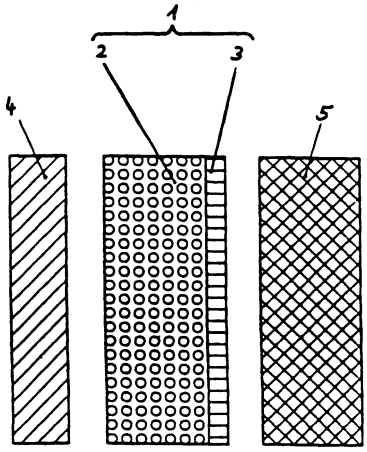
1 Outer shell material
2 Lining (loose)
3 Membrane
Foile
Coating
4 Outer material

Figure D.2 — 2-layer laminate plus lining



1 Liner
2 Knitted
3 Membrane
4 Lining (loose)
5 Outer material (loose)

Figure D.3 — Combination of lining, liner and outer material



1 Thermal liner
2 Nonwoven
3 Membrane
4 Lining (loose)
5 Outer material (loose)

Figure D.4 — Combination of lining, thermal liner and outer material

Annex ZA (informative)
Clauses of this European Prestandard addressing essential requirements or other provisions of EU Directives

This European Prestandard 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/CEE.

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

The following clauses of this prestandard are likely to support requirements of Directive 89/686/CEE:

Table ZA.1

Essential requirements of EU Directive 89/686/CEE, Annex II		Clauses of this prestandard and standards referred to
1.1	Design principles	**4**, **5**, **7** and EN 340 and **8**
1.1.2.2	Classes of protection appropriate to different levels of risk	**4.2/5.2** and **4.3/5.3**, **5.4**,**5.5**
1.2	Innocuousness of PPE	**4**, **5**, **7** and EN 340
1.3	Comfort and efficiency	**4**, **5**, **7** and EN 340
1.4	Information supplied by the manufacturer	**6**, **8**
2.1	PPE incorporating adjustment systems	EN 340
2.2	PPE "enclosing" the parts of the body to be protected	**7** and EN 340
2.12	PPE bearing one or more identification or recognition marks directly or indirectly relating to health and safety	**6**, **8**
3.7	Protection against cold	**3**, **4**, **5**, **7**, **8**, Annex A, Annex B, Annex C, Annex D

Compliance with the clauses of this prestandard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

BSI
389 Chiswick High Road
London
W4 4AL