

Protective clothing — Ensembles and garments for protection against cold

ICS 13.340.10

National foreword

This British Standard is the UK implementation of EN 342:2004, incorporating corrigendum March 2008. It supersedes DD ENV 342:1998 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PH/3, Protective clothing, to Subcommittee PH/3/1, Clothing for protection against general hazards.

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

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English version

Protective clothing - Ensembles and garments for protection against cold

Vêtements de protection - Ensembles vestimentaires et
articles d'habillement de protection contre le froid

Schutzkleidung - Kleidungssysteme und Kleidungsstücke
zum Schutz gegen Kälte

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Contents

	page
Foreword.....	3
Introduction	4
1 Scope	5
2 Normative references	5
3 Terms and definitions	5
4 Performance assessment and requirements	7
5 Testing methods	8
6 Sizes	9
7 Marking and care labelling.....	9
8 Information supplied by the manufacturer	9
Annex A (normative) Standard reference clothing for use with protective clothing against cold.....	11
Annex B (informative) Levels of performance	13
Annex C (normative) Calibration and measurements for resultant effective thermal insulation.....	15
Annex D (informative) Garment design features	17
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 89/686/EEC Personal Protective Equipment	18
Bibliography	19

Foreword

This document (EN 342:2004) 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of an identical text or by endorsement, at the latest by January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

This document supersedes ENV 342:1998.

This document 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 Personal Protective Equipment.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

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, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard is published to achieve a common basis in Europe for requirements and test methods for protective clothing ensembles and garments 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 ensemble or garment 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 by using a full-sized thermal manikin with the ensemble or garment and accompanying reference clothing in order to account for the effect of layers, fit, drape, coverage and shape. In this respect this standard differs from many other standards specifying only material properties. The insulation is tested with new ensembles and garments. It should be recognized that ensembles and garments in frequent use may lose significant insulation capacity due to laundering 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 ENV ISO 11079.

By this method the resultant effective thermal insulation value I_{cler} can be determined and used to define temperature ranges (see Tables B.1 and B.2). Therefore the protective value of a clothing ensemble is evaluated by comparing its measured insulation value and the calculated required insulation value (I_{REQ}). This comparison is the basis of Tables B.1 and B.2.

This guidance information for the selection of the appropriate cold protective garment(s) is one of the benefits, if the resultant effective thermal insulation value I_{cler} of the garment(s) has been measured on a thermal manikin.

Sweating should 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. When the environment is below freezing, very little, if any, water vapour escapes through the material because of condensation and, eventually, it can freeze 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.

For protection of a specific part of the body, EN 14058 applies.

1 Scope

This European Standard specifies requirements and test methods for performance of clothing ensembles (i.e. two piece suits or coveralls) and of single garments 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

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.

EN 340, *Protective clothing — General requirements*.

EN 20811, *Textiles — Determination of resistance to water penetration — Hydrostatic pressure test*.

EN 31092, *Textiles — Determination of physiological properties — 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 9237:1995)*.

EN ISO 15831, *Clothing — Physiological effects — Measurement of thermal insulation by means of a thermal manikin (ISO 15831:2004)*.

EN ISO 4674-1, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods (ISO 4674-1:2003)*.

3 Terms and definitions

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

3.1

cold environment

environment characterized by the combination of humidity and wind at air temperature below – 5 °C

NOTE See ENV ISO 11079.

3.2

garment

individual component of a clothing ensemble, the wearing of which provides protection to the part of the body that it covers

3.3

ensemble

clothing consisting of a two-piece suit or one-piece suit (coverall) or a number of garments covering the body, except head, hands and feet

3.4

outer shell material

outermost material of which the protective clothing is made

3.5

liner

insert with a watertight property

3.6

thermal lining

non-watertight layer providing thermal insulation

3.7

thermal liner

layer with a watertight property providing additional thermal insulation

3.8

lining

innermost material without watertight property

3.9

thermal resistance (insulation) R_{ct}

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

3.10

water vapour resistance R_{et}

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

3.11

effective thermal insulation I_{cle}

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

The effective thermal insulation value, I_{cle} , is determined in relation to the naked body surface area.

The value is given in $m^2 \cdot K/W$

3.12

resultant effective thermal insulation I_{cler}

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

The resultant effective thermal insulation value, I_{cler} , is determined in relation to the naked body surface area.

The value is given in $m^2 \cdot K/W$

3.13 insulation required $IREQ$

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

NOTE See ENV ISO 11079.

3.14

resistance to water penetration *WP*

hydrostatic pressure supported by a material as a measure of the opposition to the passage of water through the material

4 Performance assessment and requirements

4.1 General

The ergonomic requirements of EN 340 shall be applied.

4.2 Thermal insulation, I_{cle} and I_{cler}

Requirements for thermal insulation of the human body in a specific cold environment are assessed on the basis of ENV ISO 11079.

To be within the scope of this standard, the resultant effective thermal insulation I_{cler} shall have a minimum value of $0,310 \text{ m}^2 \cdot \text{K/W}$, when measured in accordance with 5.1. Optionally, the effective thermal insulation I_{cle} value can be measured according to 5.1.

Thermal insulation of a clothing ensemble or garment is classified on the basis of measured insulation values. Performance of a clothing ensemble or garment in terms of preserving heat balance at normal body temperature depends on internal body heat production. Therefore the protective value of a clothing ensemble or garment is evaluated by comparing its measured insulation value and the calculated required insulation value (*IREQ*). This comparison is the basis of Tables B.1 and B.2.

4.3 Air permeability, *AP*

When tested in accordance with 5.2, the air permeability *AP* shall be in accordance with Table 1.

Table 1 — Classification of air permeability *AP*

<i>AP</i> mm/s	Class
$100 < AP$	1
$5 < AP \leq 100$	2
$AP \leq 5$	3

Air permeability shall be measured in accordance with 5.2.

4.4 Resistance to water penetration, *WP* (optional)

When tested in accordance with 5.3, resistance to water penetration of the outer shell material together with any incorporated watertight layer and its seams shall be in accordance with Table 2, if required.

Table 2 — Classification of resistance to water penetration *WP*

<i>WP</i> Pa	Class
$8\,000 \leq WP \leq 13\,000$	1
$WP > 13\,000$	2

4.5 Water vapour resistance, R_{et}

If water penetration resistance is required as in 4.4 then water vapour resistance R_{et} shall be measured in accordance with 5.4. In this case, the water vapour resistance R_{et} of the combination of all layers of the garment together (without underwear) shall be less than $55 \text{ m}^2 \cdot \text{Pa/W}$.

4.6 Tear resistance of outer shell material

When tested in accordance with 5.5, the tearing force of the outer shell material (with the exception of vests and excluding elasticated and knitted materials) shall be at minimum 25 N in both orthogonal directions of the material.

5 Testing methods

5.1 Thermal insulation, I_{cle} and I_{cler}

The effective thermal insulation shall be measured with a stationary manikin calibrated according to Annex C with the test procedure as given in EN ISO 15831. The resultant effective thermal insulation is measured with a moving manikin calibrated according to Annex C with the test procedure as given in EN ISO 15831.

For complete ensembles, but not for single garments, the resultant effective thermal insulation I_{cler} is obtained either with a moving manikin or by correcting the value obtained with the stationary manikin. The correction formula is given in Annex C.

The effective as well as resultant effective thermal insulation of the protective clothing ensemble are measured in combination with underwear B (see Table A.1) and optionally with underwear C as specified by the manufacturer. Single garments are tested with reference clothing R as specified in Table A.2.

In the test with underwear B or a single garment the manikin shall not be dressed with any hood not attached to the garment, gloves or boots other than the reference items.

5.2 Air permeability, AP

Air permeability shall be 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 Resistance to water penetration, WP

Testing of resistance to water penetration of the material and seams shall be in accordance with EN 20811, but with an increase of water pressure of $(980 \pm 50) \text{ Pa/min}$ and the following deviations:

Number of specimens:

- 5 specimens for the testing of the seams;
- 5 specimens for the testing of material.

Size of specimens: at least 130 mm diameter.

5.4 Water vapour resistance, R_{et}

Testing shall be in accordance with EN 31092.

5.5 Tear resistance

Testing shall be in accordance EN ISO 4674-1, method A. Testing speed of the moving jaw (100 ± 10) mm/min.

6 Sizes

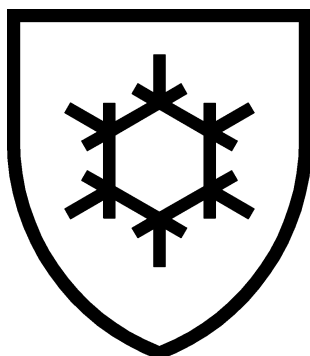
The size designation shall be in accordance with EN 340.

7 Marking and care labelling

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

The pictogram indicating that protection against cold is offered shall be as follows with the appropriate performance levels added:

EN 342



Y(B)/Y(C)/Y(R) I_{cler} in $m^2 \cdot K/W$ of the ensemble (with underwear B and optionally with underwear C of the manufacturer) or of the single garment (with standard reference clothing R);

Y(B)/Y(C)/Y(R) I_{cle} in $m^2 \cdot K/W$ of the ensemble (with underwear B and optionally with underwear C of the manufacturer) or of the single garment (with standard reference clothing R); optional

Y Air permeability class

Y Resistance to water penetration class; optional

NOTE X indicates, that the garment has not been submitted to testing.

8 Information supplied by the manufacturer

The information supplied with the protective clothing shall be in accordance with EN 340 and shall provide the following additional information:

- product designation;
- how to put on and take off, if relevant;
- provide basic information on possible uses, e.g. the temperature values given in Tables B.1 and B.2 as related to the garment's I_{cle} or I_{cler} , and where detailed information is available, state the source;

- explanation how to use the information given in the marking;
- If the insulation in the garment is given related to underwear type C, this underwear shall be clearly specified (e. g. product identification code);
- necessary warnings of misuse (see Annex B, e.g. limited wear time);
- a note that the thermal insulation may decrease after any cleansing procedure.

Annex A (normative)

Standard reference clothing for use with protective clothing against cold

Table A.1 — Underwear B for ensembles ¹⁾

Garment	Item No.	Thermal resistance R_{ct}
		$\frac{m^2 \cdot K}{W}$ $\pm 10 \%$
Undershirt with long sleeves	01	0,060
Long underpants	02	0,060
Socks (up to the knee)	03	0,053
Bootee	04	0,189
Thermojacket	08	0,100
Thermopants	09	0,100
Knitted gloves	10	0,082
Balaclava	11	0,060

Table A.2 — Reference clothing R for use with single garments ¹⁾

Garment	Item No.	Thermal resistance R_{ct}
		$\frac{m^2 \cdot K}{W}$ $\pm 10\%$
Undershirt with long sleeves	01	0,060
Long underpants	02	0,060
Socks (up to the knee)	03	0,053
Bootee	04	0,189
Jacket (one layer)	05	0,013
Trousers (one layer)	06	0,013
Shirt	07	0,013
Knitted gloves	10	0,082
Balaclava	11	0,060
<p>NOTE 1 Examples of test procedures for different single garments:</p> <p>a) Jacket: replace the reference jacket 05 in the reference clothing by the test jacket.</p> <p>b) Trousers: replace the reference trouser 06 in the reference clothing by the test trousers.</p> <p>c) Waist coats: replace the reference jacket 05 in the reference clothing by the waist coats.</p> <p>d) Coat: replace the reference jacket 05 in the reference clothing by the coat.</p> <p>e) Separable thermal lining: tested together with the reference jacket 05.</p> <p>NOTE 2 I_{cler} of the complete standard reference clothing R is 0,185 m²· K/W ± 3 %.</p>		

1) Such reference can be obtained by:

- for items 01, 02, 03, 08, 09, 10 and 11

by company Tempex, Germany,

Tel: +49 73 21-3 25 61, Fax: +49 73 21-3 25 47 0

- for items 05, 06 and 07

by company Fristads, Sweden,

Tel: +46 33 20 22 00, Fax: +46 33 20 02 70

This information is given for the convenience of users of this standard and does not constitute an endorsement by CEN/TC 162 of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Annex B (informative)

Levels of performance

The protective value of measured effective thermal insulation or resultant effective thermal insulation of a garment assembly is converted into combinations of ambient air temperature and activity level (metabolic heat production) (see Tables B.1 and B.2).

The levels in Table B.1 correspond to a standing wearer and in Table B.2 to a wearer moving and performing light or moderate activity. For each level a minimum temperature is calculated 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 is about 50 % and air velocity is between 0,3 and 0,5 m/s and a walking speed of about 1,0 m/s.

NOTE It is possible that an adequate level of whole body insulation is not 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 B.1 — Effective thermal insulation of clothing I_{cle} and ambient temperature conditions for heat balance at different durations of exposure

Insulation I_{cle} $m^2 \cdot K/W$	Wearer standing activity $75 W/m^2$	
	8 h	1 h
0,310	11	-2
0,390	7	-10
0,470	3	-17
0,540	-3	-25
0,620	-7	-32

Table B.2 — Resultant effective thermal insulation of clothing I_{cler} and ambient temperature conditions for heat balance at different activity levels and durations of exposure

Insulation I_{cler} $\text{m}^2 \cdot \text{K/W}$	Wearer moving activity			
	light 115 W/m^2		medium 170 W/m^2	
	8 h	1 h	8 h	1 h
0,310	-1	-15	-19	-32
0,390	-8	-25	-28	-45
0,470	-15	-35	-38	-58
0,540	-22	-44	-49	-70
0,620	-29	-54	-60	-83

These temperature values are only valid with even distribution of the insulation on the body and 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 Tables B.1 and B.2 because of wind chill effects (see ENV ISO 11079).

Annex C (normative)

Calibration and measurements for resultant effective thermal insulation

The measurement with the thermal manikin and related operating conditions is based on the reference set of 2 cold protective clothing ensembles. The test procedure (with ensemble A moving manikin; with ensemble B stationary or moving manikin) and evaluation method (parallel, serial or mean value of parallel and serial model) applied to the thermal manikin shall give an I_{tr} value for ensemble A of $0,299 \text{ m}^2 \cdot \text{K/W} \pm 3 \%$ and of ensemble B of $0,395 \text{ m}^2 \cdot \text{K/W} \pm 3 \%$.

NOTE 1 The reference set of cold protective clothing ensemble A and B is available e.g. from:

— Hohensteiner Institute, Schloss Hohenstein, 74357 Bönnigheim, Germany;

— VTT Tampere University of Technology, Fibre Materials Science, P.O Box 589, 33101 Tampere, Finland.

NOTE 2 These ensembles A and B are specified in the report of the project: "Thermal insulation measurement of cold protective clothing using thermal manikins (subzero project); Tampere 2003, ISBN 952-15-0989-9".

If I_{cler} of ensemble B or of complete clothing ensembles which with their resultant effective thermal insulation fall within the scope of this standard is to be determined from I_{cle} measured with a stationary manikin the following correction formulae apply:

for $v = 0,4 \text{ m/s}$ to $2,0 \text{ m/s}$:

$$I_{tr} / I_t = 0,54 \cdot e^{(-0,15v - 0,22w)} + 0,5 \quad (1)$$

for $v = 2,0 \text{ m/s}$ to $18,0 \text{ m/s}$:

$$I_{tr} / I_t = 0,54 \cdot e^{(-0,15v - 0,22w)} \cdot p^{0,075} - 0,06 \cdot \ln(AP) + 0,5 \quad (2)$$

validity interval of equations (1) and (2): $w = 0$ to $1,2 \text{ m/s}$; $AP = 1 \text{ mm/s}$ to $1\,000 \text{ mm/s}$

and

$$I_{cle} = I_t - I_a$$

$$I_{cler} = I_{tr} - I_{ar}$$

where

I_t is the total thermal insulation from skin to ambient atmosphere, including clothing and boundary air layer, measured with a stationary manikin under the conditions defined in EN ISO 15831 in $\text{m}^2 \cdot \text{K/W}$;

I_{tr} is the resultant total thermal insulation from skin to ambient atmosphere, including clothing and boundary air layer, measured with a moving manikin under the conditions defined in EN ISO 15831 in $\text{m}^2 \cdot \text{K/W}$;

I_a is the thermal insulation of the boundary air layer, measured with a stationary manikin in $\text{m}^2 \cdot \text{K/W}$;

I_{ar} is the thermal insulation of the boundary air layer, measured with a moving manikin in $\text{m}^2 \cdot \text{K/W}$;

v is the air velocity in m/s;

w is the walking speed in m/s;

AP is the air permeability in mm/s.

Annex D (informative)

Garment design features

D.1 Waistcoats

Waistcoats in this context are thermally-insulating, sleeveless garments covering at least the upper part of the body down to the waist. They can be lengthened at the back to protect the kidney region against the effects of cold, e.g. when bending.

D.2 Jackets/coats

The jacket or coat should be closeable up to the collar or neckband.

The cuff should be adjustable to give a close fit.

Jackets and coats should be adjustable at the waistline to allow for close fitting.

Jackets should be long enough to cover the tops of the trousers even when the wearer is bending over.

External pockets on jackets and overalls – intended to be used in wet conditions – should be covered by flaps at least 20 mm wider than the pocket opening to avoid the flap being tucked into the pocket.

D.3 Trousers

Trousers can be supported (e.g. by suspenders), self-supported or be of a bib and brace type.

The trouser bottoms can be adjustable to give a close fit.

Annex ZA (informative)

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

This European Standard has been prepared under a mandate given to CEN and CENELEC 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 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 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 — Correspondence between this European Standard and Directive 89/686/EEC

Clauses/sub-clauses of this standard	Essential requirements of EU Directive 89/686/EEC, Annex II	
4.2	3.7.1	PPE constituent materials and other components
4.2	3.7.2	Complete PPE ready for use
4.2	2.2	PPE 'enclosing' the parts of the body to be protected
4.3	3.7.1	PPE constituent materials and other components
4.3	3.7.2	Complete PPE ready for use
4.3	1.1.2.2	Classes of protection appropriate to different levels of risk
4.4	3.7.2	Complete PPE ready for use
4.4	1.1.2.2	Classes of protection appropriate to different levels of risk
4.5	2.2	PPE 'enclosing' the parts of the body to be protected
4.5	3.7.1	PPE constituent materials and other components
4.6	1.3.2	Lightness and design morphology
6	1.4	Information supplied by the manufacturer
7	1.4	Information supplied by the manufacturer
7	2.12	PPE bearing one or more identification or recognition marks directly or indirectly relating to health and safety
8	1.4	Information supplied by the manufacturer
8	3.7.2	Complete PPE ready for use
8	1.2.1.1	Suitable constituent materials

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

Bibliography

- [1] EN 511, *Protective gloves against cold*.
- [2] EN 14058, *Protective clothing - Garments for protection against cool environments*
- [3] EN 23758, *Textiles — Care labelling code using symbols (ISO 3758:1991)*.
- [4] ENV ISO 11079, *Evaluation of cold environments — Determination of required clothing insulation (REQ) (ISO/TR 11079:1993)*.

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