INTERNATIONAL STANDARD

ISO 11612

Second edition
2008-11-01

Protective clothing — Clothing to protect against heat and flame

Vêtements de protection — Vêtements de protection contre la chaleur et les flammes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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

ISO 11612 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

This second edition cancels and replaces the first edition (ISO 11612:1998). It has been prepared in order to:

a) introduce the principle of three performance levels for heat transmission performance properties, with the exception of a fourth level for extreme exposure to radiant heat;

b) include new terms and definitions;

c) include a chapter on clothing design;

d) include modifications to pre-treatment, pre-treatment by cleaning and ageing;

e) include a heat resistance test as a minimum requirement;

f) include a second possible procedure for limited flame spread (code letter A);

g) include flame spread requirements for seams;

h) modify requirements for dimensional change due to cleaning;

i) specify additional requirements for tensile, tear, burst and seam strength;

j) include the optional requirements of resistance to water penetration and of water vapour resistance (code letter W);

k) include guidance for ergonomic assessment of clothing;

l) include requirements for maximum fat content of leather;

m) specify requirements for innocuousness;

n) change from five to three performance levels for exposure to convective heath (code letter B);

o) readjust the four performance levels for exposure to radiant heat (code letter C) as a consequence of the revision of ISO 6942:1993 to ISO 6942:2002;

p) include requirement for protection against contact heat (code letter F);

q) include guidance for optional assessment of protection against the thermal effects of an electric arc;

r) include optional whole garment testing for prediction of burn injury;

s) modify marking requirements;

t) replace the clause “Instructions for use” by a new clause “Information supplied by the manufacturer”;

u) include an informative annex on guidelines for clothing design;

v) include an informative annex on prediction of burn injury using an instrumented manikin;

w) include an informative annex on checking of basic ergonomic features of protective clothing;

x) include an informative annex on risk assessment;

y) include an informative annex on protection against the thermal effects of an electric arc event;

z) include an informative annex for uncertainty of measurement.

Introduction

The purpose of this International Standard is to provide minimum performance requirements for clothing to protect against heat and flame, which could be worn for a wide range of end uses. All the other standards listed in the Foreword deal also with clothing to protect against heat and fire, but rather for quite specific products or end uses.

Within many of the hazards listed in this International Standard there are three performance levels:

— Level 1 to indicate exposure to perceived low risk;

— Level 2 to indicate exposure to perceived medium risk;

— Level 3 to indicate exposure to perceived high risk.

For protection against extreme exposures to radiant heat, there is a fourth performance level to take into account high performance materials such as aluminized and similar materials. The level of personal protection to be provided is based on the outcome of the risk assessment and some comments on risk assessment are given in Annex E.

In this International Standard, an informative annex on ergonomic features (Annex D) is included in the form of guidelines. Suitable tests for these requirements have not yet been validated internationally.

For complete protection against exposure to heat and/or flame, it is probable that it will be necessary to protect the head, face, hands and/or feet with suitable PPE and in some cases, appropriate respiratory protection might also be considered necessary.

Attention is drawn to CEN Technical Report CEN/TR 14560:2004 [1], which sets out guidelines for selection, use, care and maintenance of protective clothing against heat and flame.

Nothing in this International Standard is intended to restrict any jurisdiction, purchaser or manufacturer from exceeding these minimum requirements. It is one of several standards for clothing that have been developed to protect persons against heat and/or flames. Other standards include:

— ISO 11611, *Protective clothing for use in welding and allied processes*;

— ISO 11613, *Protective clothing for firefighters — Laboratory test methods and performance requirements*;

— ISO 14460, *Protective clothing for automobile racing drivers — Protection against heat and flame — Performance requirements and test methods*;

— ISO 15384, *Protective clothing for firefighters — Laboratory test methods and performance requirements for wildland firefighting clothing*;

— ISO 15538, *Protective clothing for firefighters — Laboratory test methods and performance requirements for protective clothing with a reflective outer surface*;

— EN 469, *Protective clothing for firefighters — Performance requirements for protective clothing for firefighting*;

— EN 1486, *Protective clothing for fire-fighters — Test methods and requirements for reflective clothing for specialised fire fighting*;

— EN 13911, *Protective clothing for firefighters — Requirements and test methods for fire hoods for firefighters*;

— EN 15614, *Protective clothing for firefighters — Laboratory test methods and performance requirements for wildland clothing*.

Protective clothing — Clothing to protect against heat and flame

1 Scope

This International Standard specifies performance requirements for garments made from flexible materials, which are designed to protect the wearer's body, except the hands, from heat and/or flame. For protection of the wearer's head and feet, the only items of protective clothing falling within the scope of this International Standard are gaiters, hoods and overboots. However, concerning hoods, requirements for visors and respiratory equipment are not given.

The performance requirements set out in this International Standard are applicable to garments which could be worn for a wide range of end uses, where there is a need for clothing with limited flame spread properties and where the user can be exposed to radiant or convective or contact heat or to molten metal splashes.

This International Standard is not applicable to protective clothing that is specified by other International Standards, such as for firefighting in structures and for use in welding and allied processes.

2 Normative references

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

ISO 3071, *Textiles — Determination of pH of aqueous extract*

ISO 3376:2002, *Leather — Physical and mechanical tests — Determination of tensile strength and percentage extension*

ISO 3377-1, *Leather — Physical and mechanical tests — Determination of tear load — Part 1: Double edge tear*

ISO 4045, *Leather — Chemical tests — Determination of Ph*

ISO 4048, *Leather — Chemical tests — Determination of matter soluble in dichloromethane and free fatty acid content*

ISO 5077, *Textiles — Determination of dimensional change in washing and drying*

ISO 6942:2002, *Protective clothing — Protection against heat and fire — Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat*

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

ISO 9151, *Protective clothing against heat and flame — Determination of heat transmission on exposure to flame*

ISO 9185, *Protective clothing — Assessment of resistance of materials to molten metal splash*

ISO/TR 11610, *Protective clothing — Vocabulary*

ISO 12127:1996, *Clothing for protection against heat and flame — Determination of contact heat transmission through protective clothing or constituent materials*

ISO 13506, *Protective clothing against heat and flame — Test method for complete garments — Prediction of burn injury using an instrumented manikin*

ISO 13688, *Protective clothing — General requirements*

ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2, *Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method*

ISO 13937-2, *Textiles — Tear properties of fabrics — Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method)*

ISO 13938-1, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*

ISO 15025, *Protective clothing — Protection against heat and flame — Method of test for limited flame spread*

ISO 17075, *Leather — Chemical tests — Determination of chromium(VI) content*

ISO 17493, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*

EN 343:2003, *Protective clothing — Protection against rain*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/TR 11610 and the following apply.

3.1
ageing
changing of the product performance over time during use or storage

NOTE Ageing is caused by a combination of several factors, such as:

— cleaning, maintenance or disinfecting processes;
— exposure to visible and/or ultra-violet radiation;
— exposure to high or low temperatures or to changing temperatures;
— exposure to chemicals including humidity;
— exposure to biological agents such as bacteria, fungi, insects or other pests;
— exposure to mechanical action such as abrasion, flexing, pressure and strain;
— exposure to contaminants such as dirt, oil, splashes of molten metal, etc.;
— exposure to wear and tear.

3.2
cleaning
process by which a PPE is made again serviceable and/or hygienically wearable by removing any dirt or contamination

NOTE A cleaning cycle is typically a washing plus drying or a dry cleaning treatment followed, if required, by ironing or finishing.

3.3
clothing assembly
series of outer and under garments to be worn together

3.4
component
any material, part or subassembly used in the construction of an item of PPE

3.5
component assembly
combination of all materials of a multi-layer garment presented exactly as the finished garment construction

3.6
conditioning
keeping samples under standard conditions of temperature and relative humidity for a minimum period of time

3.7
gaiter
removable covering intended to protect the part of the leg below the knee and may cover the shoes

3.8
garment
single item of clothing, which may consist of single or multiple layers

NOTE In this International Standard, where a garment or garments are referred to, this is intended also to include hoods, gaiters and overboots as appropriate.

3.9
hardware
non-fabric items forming part of or optional extras in a garment

EXAMPLE Metal or plastic buttons or fasteners etc.

3.10
hood
Item of PPE made from flexible material, which covers the head and neck

3.11
innermost lining
innermost face of a component assembly closest to the wearer's skin

NOTE Where the innermost lining forms part of a material combination, the material combination is regarded as the innermost lining.

3.12
interlining
layer between the outermost layer and the innermost lining in a multilayer garment

3.13
material
flexible substance/substances of which the item of clothing is made

3.14
outer material
outermost material of which the item of clothing is made

3.15
overboots
single or multiple layers of material covering the footwear to provide protection against heat and/or flame

NOTE Certain types of overboot used for this purpose can also cover parts of the legs and/or ankles.

3.16
patch pocket
pocket located on the exterior of a protective garment, which is stitched as a patch over the outer layer of the protective garment

3.17
pre-treatment
standard way of preparing the samples before testing

NOTE This might include a number of cleaning cycles, submitting the sample to heat, mechanical action or any other relevant exposure and is finished by conditioning.

3.18
seam
any method of permanent fastening between two or more pieces of material

3.18.1
main seams
seams that are necessary for the integrity of the garment

3.18.2
overlapping seam
seam where all or part of one or more layers of material covers the other layer or layers causing a ridge

4 Clothing design

4.1 General

General requirements which are not specifically covered in this International Standard shall be in accordance with ISO 13688.

Where more than one garment is needed to meet the requirements of this International Standard, each garment shall be labelled to ensure that the correct combination is used.

4.2 Sizes

4.2.1 General

Garment sizes shall be in accordance with the requirements of ISO 13688.

4.2.2 Suits

Heat and flame protective suits shall completely cover the upper and lower torso, neck, arms and legs. Suits shall consist of:

— a single garment, e.g. an overall or boiler suit or

— a two-piece garment, consisting of a jacket and a pair of trousers. Jackets shall be of sufficient length to overlap by a minimum of 20 cm with the top of the trousers. This minimum overlap shall be maintained in all positions and in movements expected during use.

Conformity shall be checked by visual inspection, including an assessment of fit and practical testing, such as physical measurement of the overlap in all positions and movements normally encountered during use, when a suit of appropriate size is donned by a wearer.

4.2.3 Additional protective clothing

Heat and flame protective garments other than suits in accordance with 4.2.2 may be designed to provide protection for specific parts of the body, e.g. neck curtain, hoods, sleeves, apron and gaiters. They are typically designed to be worn in addition to a suit in accordance with 4.2.2.

Performance testing of partial protective garments shall be carried out on complete clothing assemblies. Additional protective clothing such as hoods, sleeves, apron and gaiters shall cover the intended areas if worn with a suit of appropriate size and shall also meet the requirements of this International Standard.

Conformity shall be checked by visual inspection including an assessment of fit and physical measuring when the appropriate size of a complete clothing assembly is donned by a wearer.

4.3 Pockets

Where garments are constructed with pockets, the pockets shall be made of material(s) conforming to 6.3.

4.4 Hardware

Hardware penetrating the outer material of a heat and flame protective garment or garment assembly shall not be exposed to the innermost surface of the garment or the garment assembly.

Conformity shall be checked by visual inspection.

4.5 Additional design requirements for molten splash protective garments

Garments that are designed to protect against the risk of exposure to molten metal splash by meeting the performance requirements designated by code letters D and E, shall have the following additional design features.

a) The sleeves of jackets and coveralls and the lower leg regions of trousers, coveralls and bib + brace shall not have turn-ups.

b) External pockets on jackets, trousers, coveralls and bib + brace, other than side pockets below the waist which do not extend more than 10° forward of the side seam, shall be covered by flaps at least 20 mm wider than the opening of the pocket in order to prevent the flap from being tucked into the pocket.

c) Patch pockets shall be made from materials meeting the same protection indices (chosen from A to F) and the same levels for these indices as the rest of the garment.

d) Overlapping seams on the outside of the garment shall be downward facing and secured in this position.

e) Closures shall be designed with a protective cover flap on the outside of the garment. The maximum distance between buttonholes shall be 150 mm. If zippers are used, the slide fastener shall be designed to lock when completely closed. Cuffs may be provided with closures to reduce their width. The closure and any fold which it creates shall be on the underside of the cuff. Neck openings shall be provided with closures. Trousers may have side slits which shall have a means of closure and the slit and closure shall be covered.

Conformity to a), b), d) and e) shall be checked by visual inspection; conformity to c) by visual inspection and physical measurement.

NOTE Further guidance on design of clothing to protect against these risks is given in Annex B.

5 Sampling and pre-treatment

5.1 Sampling

The number of samples and the size of the specimens of garment materials, or garments presented to the different test methods, shall be in accordance with the respective test standards specified in the requirements. Samples shall be representative of the component assembly, exactly as used in the finished garment. Samples for testing shall be taken from the original garment or they may also be cut from the material or materials as used in the component assembly.

5.2 Pre-treatment

5.2.1 Pre-treatment by cleaning

Before each test specified in Clauses 6 and 7, except 6.8, 6.9.2 and 6.9.3, the test materials and test specimens shall be pre-treated by cleaning, if the manufacturer's instructions indicate that cleaning is allowed. In addition, 6.3 requires that the limited flame spread tests shall be carried out both before the pre-treatment and after the pre-treatment, if cleaning is allowed.

The cleaning shall be in line with the manufacturer's instructions, on the basis of standardized processes. If the number of cleaning cycles is not specified, five cleaning cycles shall be performed. This shall be reflected in the information supplied by the manufacturer.

NOTE 1 Manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330, ISO 15797 or equivalent as standardized processes for cleaning.

Tests specified in 6.8 and 6.9 shall be carried out in the new state (as received).

NOTE 2 Leather and metallized materials are usually not pre-treated by cleaning prior to other tests, as the manufacturer's instructions usually indicate that cleaning is not allowed.

5.2.2 Mechanical pre-treatment

Metallized materials shall be pre-treated in accordance with Annex A before being submitted to radiant heat testing (see 7.3).

5.2.3 Ageing

Performance tests described in 6.3 have also to be executed after the maximum number of cleaning procedures indicated by the manufacturer.

5.3 Conditioning

Specimens other than leather shall be conditioned for at least 24 h in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %. Leather specimens shall be conditioned for at least 48 h in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %. Testing shall be carried out within 5 min of removal from this atmosphere.

6 General requirements

6.1 General

Protective garments that comply with this International Standard shall meet the requirements of this clause, with the exception of the requirements of 6.2.2 and 6.6, which are optional, and shall meet one or more of the requirements of Clause 7. Such garments shall be marked in accordance with Clause 8.

6.2 Heat resistance

6.2.1 Heat resistance at a temperature of (180 ± 5) °C

When tested in accordance with ISO 17493 at a temperature of (180 ± 5) °C, all fabrics and hardware used in the garment and/or clothing assembly shall not ignite or melt and shall not shrink by more than 5 %.

6.2.2 Optional requirement — Heat resistance at a temperature of (260 ± 5) °C

If it is intended that the material of a single layer garment or of the innermost lining of a multilayer garment shall be worn next to the skin, the material shall be tested according to ISO 17493 at a temperature of (260 ± 5) °C. The material shall not ignite or melt and shall not shrink by more than 10 %, in addition to meeting the requirement of 6.2.1.

NOTE Heat shrinkage has the potential to reduce the thermal protection level of the garment as it reduces the insulating air pocket between the garment and the body. Therefore heat shrinkage in heat and flame protective garments has to be avoided, especially in cases where a heat or flame hazard exists that could hit a large percentage area of the garment.

6.3 Limited flame spread (code letter A1 and/or A2)

6.3.1 General

Testing of materials and seams shall take place in accordance with ISO 15025:2000, either Procedure A (code letter A1) or Procedure B (code letter A2) or both in accordance with the existent risk during the foreseen use. This test shall be carried out both before and after the pre-treatment specified in Clause 5.

Testing according to Procedure A shall also be carried out on hardware and on materials, which are applied to the outermost surface of a heat and flame protective garment.

6.3.2 Testing in accordance with ISO 15025:2000, Procedure A (code letter A1)

6.3.2.1 When tested in accordance with ISO 15025:2000, Procedure A, specimens from single layer garments, including seams, shall meet the following requirements:

a) no specimen shall suffer flaming to the top or either side edge;

b) no specimen shall suffer hole formation;

c) no specimen shall melt or suffer flaming or molten debris;

d) the mean value of afterflame time shall be ⩽ 2 s;

e) the mean value of afterglow time shall be ⩽ 2 s.

A glowing inside the charred area is defined in ISO 15025 as afterglow without combustion and for the purpose of this clause is not regarded as afterglow.

For seams, three specimens containing a structural seam shall be tested in accordance with ISO 15025:2000, Procedure A. Specimens shall be oriented with the seam running up the centreline of the test specimen so that the burner flame impinges directly upon it. The seams shall remain intact.

6.3.2.2 If the garment is multilayer, specimens of the component assembly including seams shall be tested both by applying the flame to the surface of the outer material of the garment and to the innermost lining of the garment and shall meet the requirements of 6.3.2.1, including that no specimen shall suffer hole formation except for an interlining that is used for specific protection other than heat protection, for example liquid penetration.

6.3.2.3 Hardware [e.g. touch and close (hook and pile) fasteners, etc.], whether it is exposed or covered when all closure systems in the garment are in the closed position, shall be tested separately by applying the test flame to the outer surface of the component assembly containing hardware exactly as designed in the garment. The hardware shall remain functional after the test.

6.3.2.4 Labels, badges, retro-reflective materials, etc., which are applied to the outermost surface of the garment, shall be tested in combination with the outer layer to make it possible to take samples with the dimensions as indicated in ISO 15025. They shall be tested by applying the flame to the outer surface of the items. They shall have the same flammability behaviour as the outer layer of the garment.

6.3.3 Testing in accordance with ISO 15025:2000, Procedure B (code letter A2)

6.3.3.1 When tested in accordance with ISO 15025:2000, Procedure B, hemmed specimens from single layer garments shall meet the following requirements:

a) no specimen shall suffer flaming at the top or either side edge;

b) no specimen shall melt or suffer flaming or molten debris;

c) the mean value of after flame time shall be $\leqslant$ 2 s;

d) the mean value of afterglow time shall be $\leqslant$ 2 s.

Glowing inside the charred area is defined in ISO 15025 as afterglow without combustion and for the purpose of this clause is not regarded as afterglow.

For seams, three hemmed specimens containing a structural seam shall be tested in accordance with ISO 15025:2000, Procedure B. Specimens shall be oriented with the seam running up the centreline of the test specimen so that the burner flame impinges directly upon it. The seams shall remain intact.

6.3.3.2 The hemmed fabric specimen shall be prepared in the same manner as used in the construction of the clothing.

6.3.3.3 If the garment is multilayer, hemmed specimens of the component assembly including seams shall be tested by applying the flame to the edge of the multilayer assembly and shall meet the requirements of 6.3.3.1.

6.4 Dimensional change due to cleaning

6.4.1 General

The requirements of 6.4 do not apply to garments intended for single use only, to garments that cannot be washed or dry-cleaned, or to leather.

6.4.2 After pre-treatment as specified in 5.2.1

6.4.2.1 The change in dimensions of woven, non-woven and sheet materials shall be measured in accordance with ISO 5077 and shall not exceed 3 % in either length or width direction.

6.4.2.2 The change of dimensions of knitted materials shall be measured in accordance with ISO 5077 and shall not exceed 5 % shrinkage. Shrinkage shall be measured after the specimen has been uncreased and flattened on a plane surface.

6.5 Physical requirements

6.5.1 Tensile strength

6.5.1.1 When tested in accordance with ISO 13934-1, the tensile strength of the outer material, except leather and knitted materials, shall be minimum of 300 N in both the machine and cross directions.

6.5.1.2 When tested in accordance with ISO 3376, the tensile strength of leather outer material shall be a minimum of 60 N in two directions at right angles when the standard test specimen defined in Table 1 of ISO 3376:2002 is used.

6.5.2 Tear strength

6.5.2.1 When tested in accordance with ISO 13937-2, the tear strength of the outer material, except leather and knitted materials, shall be a minimum of 15 N in both the machine and cross directions.

6.5.2.2 When tested in accordance with ISO 3377-1, the tear strength of leather outer material shall be a minimum of 20 N in two directions at right angles in the plane of the material.

6.5.3 Burst strength for knitted materials

When tested in accordance with ISO 13938-1, the burst strength of knitted outer material shall be a minimum 200 kPa.

6.5.4 Seam strength

When tested in accordance with ISO 13935-2, the seam strength of the outer material or outer garment material of the clothing assembly shall give a breaking load of at least 225 N for woven textiles and 110 N for leather.

6.6 Optional requirement — Resistance to water penetration (code letter W)

If, according to the use foreseen for the product, the manufacturer determines a requirement for resistance to water penetration, the garment shall be tested and classified to both resistance to water penetration and water vapour resistance, and shall comply with the following requirements:

a) resistance to water penetration provided by the garment shall be tested and classified in accordance with EN 343;

b) water-vapour resistance provided by the garment shall be tested and classified in accordance with EN 343.

Garments that have been tested to this subclause shall be marked as specified in 8.4.

6.7 Ergonomic requirements

Ergonomic assessment of clothing covered by this International Standard should be carried out by practical performance testing. Suitable tests for these requirements have not yet been validated internationally but guidance is included in Annex D.

6.8 Fat content of leather

When tested in accordance with ISO 4048 the fat content of leather shall not exceed 15 %.

6.9 Innocuousness

6.9.1 Possible harmful effect

No component of the clothing must be known to produce any harmful effect on the wearer. This shall be verified by checking technical safety sheets of the individual materials and components.

6.9.2 pH value

When tested in accordance with ISO 3071 (for textiles) or with ISO 4045 (for leather), the pH-value shall be $> 3,5$ and $< 9,5$.

6.9.3 Chromium(VI) content

When tested in accordance with the procedure described in ISO 17075, the content of Cr(VI) of leather shall be less than the detection limit.

7 Heat transmission performance requirements

7.1 General

For all end-uses, the minimum performance requirement shall be at least one of the heat transmission performance code letters, i.e. code letter B, code letter C, code letter D, code letter E or code letter F, in addition to the obligatory minimum performance requirements of Clause 6. The application of the performance requirements of this clause will be relevant according to the intended use claimed by the manufacturer for the clothing.

7.2 Convective heat (code letter B)

When tested in accordance with ISO 9151, single or multilayer garments and/or clothing assemblies that are claimed to offer protection against convective heat shall meet at least performance level B1 in Table 1. The number of specimens indicated in ISO 9151 shall be tested and the performance classified according to the lowest single result rounded to 0,1 s.

Table 1 — Performance levels: convective heat test

Performance levels	Range of HTI [a] 24 values s	
	min.	max.
B1	4,0	< 10,0
B2	10,0	< 20,0
B3	20,0	

[a] Heat transfer index, as defined in ISO 9151.

7.3 Radiant heat (code letter C)

When tested in accordance with ISO 6942, Method B, at a heat flux density of 20 kW/m^2, single or multilayer garments and/or clothing assemblies that are claimed to offer protection against radiant heat shall meet at least performance level C1 in Table 2. Tests on metallized materials shall be carried out after pre-treatment as specified in Annex A. The number of samples indicated in the standard shall be tested and the performance classified according to the lowest single result rounded to 0,1 s.

Table 2 — Performance levels: radiant heat test

Performance levels	Heat transfer factor RHTI [a] 24 s	
	min.	max.
C1	7,0	< 20,0
C2	20,0	< 50,0
C3	50,0	< 95,0
C4	95,0	

[a] Radiant heat transfer index, as defined in ISO 6942.

7.4 Molten aluminium splash (code letter D)

When tested in accordance with ISO 9185 using molten aluminium, single or multilayer garments and/or clothing assemblies that are claimed to offer protection against molten aluminium splash shall meet at least performance level D1 in Table 3.

NOTE 1 Labels, badges, hardware, touch and close (hook and pile) fasteners, retro-reflective materials, etc. present on garments may affect the performance of garments and/or clothing assemblies.

NOTE 2 Acceptable performance against molten aluminium will normally ensure that a material will be acceptable against molten aluminium bronze and molten minerals.

Table 3 — Performance levels: molten aluminium splash

Performance levels	Molten aluminium splash g	
	min.	max.
D1	100	< 200
D2	200	< 350
D3	350	

7.5 Molten iron splash (code letter E)

When tested in accordance with ISO 9185 using molten iron, single or multilayer garments and/or clothing assemblies that are claimed to offer protection against molten iron splash shall meet at least performance level E1 in Table 4.

NOTE 1 Labels, badges, hardware, touch and close (hook and pile) fasteners, retro-reflective materials, etc. present on garments may affect the performance of garments and/or clothing assemblies.

NOTE 2 Acceptable performance against molten iron will normally ensure that a material will be acceptable against molten copper, molten phosphor bronze and molten brass.

Table 4 — Performance levels: molten iron splash

Performance levels	Molten iron splash g	
	min.	max.
E1	60	< 120
E2	120	< 200
E3	200	

7.6 Contact heat (code letter F)

When tested in accordance with ISO 12127 at a temperature of 250 °C, single or multilayer garments and/or clothing assemblies that are claimed to offer protection against contact heat, shall meet at least performance level F1 in Table 5. The number of samples indicated in the standard shall be tested and the performance classified according to the lowest single result rounded to 0,1 s.

Table 5 — Performance levels: contact heat

Performance levels	Threshold time s	
	min.	max.
F1	5,0	< 10,0
F2	10,0	< 15,0
F3	15,0	

7.7 Optional requirement — Protection against the thermal effects of an electric arc event

Comments are included in Annex F as guidance to users whose risk assessment determines a requirement for protection against the thermal effects of an electric arc event.

7.8 Optional test — Whole garment testing for prediction of injury by burns

The complete component assembly or multi-layer clothing assembly that is intended to be used to provide protection according to the requirements of this International Standard can be optionally tested according to the test in ISO 13506 for prediction of burns. If this optional test is performed, it shall be undertaken on an instrumented manikin and never on human subjects.

Also, additional integrated devices to be used with the protective clothing should be included in the testing.

The test method described in ISO 13506 is able to provide the information as recommended in Annex C.

NOTE Experience has shown that test conditions of at least 4 s at 84 kW/m^2 give the most complete information about the protective performance of single and multilayer clothing assemblies. For multilayer garments or for clothing assemblies, test conditions of up to 8 s might be necessary. However, more research work is needed before firm recommendations for test conditions and firm statements about the correlation between test conditions and real fire scenarios can be made. For reasons that are inherent to the test method, tests are not carried out at less than 3 s due to a problem of repeatability of a test at less than 3 s.

8 Marking

8.1 Marking requirements shall be as specified in ISO 13688 and in this clause.

8.2 The protective clothing for which compliance with this International Standard is claimed shall be marked with the pictogram as shown in Figure 1, incorporating the number and year of this International Standard and the relevant performance levels recorded following testing to the requirements of Clause 6 and Clause 7 as relevant.

8.3 All garments complying with this International Standard shall be marked with code letter A1 and/or A2 plus at least one other code letter B, C, D, E or F as appropriate followed by a number indicating the level of performance achieved. The code letters identifying additional properties, which are appropriate and have been tested, shall be included on the pictogram.

8.4 Where a garment has been tested to the requirements of 6.6, Code letter W followed by the numbers that are appropriate and have been tested shall be included on the pictogram.

According to EN 343, there are three levels of performance for resistance to water penetration and three levels of performance for water-vapour resistance. For garments tested to code letter W in 6.6, the first number following code letter W should relate to the level of performance achieved for resistance to water penetration and the second number following should relate to the level of performance achieved for water-vapour resistance, e.g. a garment achieving level 2 for resistance to water penetration in EN 343 and level 3 for water-vapour resistance in EN 343 should be marked W23.

8.5 If the requirements of this International Standard are met by the use of a combination of garments, this shall be declared on the labels of all garments involved; each garment shall be labelled to ensure that the correct combination is used.

8.6 For garments intended for a single use only, the garment marking shall indicate “For single use only”.

8.7 The pictogram ISO 7000-2417 shown in Figure 1 shall be used.

ISO 11612

A B C D etc.

Figure 1 — Pictogram: clothing for protection against heat and flames

9 Information supplied by the manufacturer

9.1 Clothing to protect against heat and flame shall be supplied to the customer with information written at least in the official language(s) of the state of destination.

9.2 The information to be supplied by the manufacturer shall be as specified in ISO 13688. The manufacturer shall give as much information as possible on known factors of durability, especially on durability to cleaning. In cases where applying a finish can restore the protective properties, the maximum number of cleaning cycles before re-application of the finish shall clearly be indicated.

9.3 The manufacturer shall include a note in the information giving the items of clothing that need to be worn in order to protect the wearer’s body according to the scope of this International Standard.

9.4 The manufacturer shall include a note in the information to the effect that in the event of an accidental splash of chemical or flammable liquids on clothing covered by this International Standard whilst being worn, the wearer should immediately withdraw and carefully remove the garments, ensuring that the chemical or liquid does not come in contact with any part of the skin. The clothing shall then be cleaned or removed from service.

9.5 If the optional whole garment test in 7.8 has been performed, the manufacturer shall provide a report in the information, which shall contain at least the results according to indent d) of Annex C.

9.6 If the garment is claimed to offer protection against molten aluminium or molten iron splashes or both and has therefore been evaluated according to 7.4 or 7.5 or both, the manufacturer shall indicate that in the event of a molten metal splash the user shall leave the working place immediately and take off the garment. The manufacturer shall also include a warning that in the event of a molten metal splash, the garment, if worn next to the skin, may not eliminate all risks of burn.

Annex A
(normative)

Mechanical pre-treatment for metallized materials

A.1 Principle

The effectiveness of metallized coatings in reflecting radiant heat can be drastically reduced by the effects of wear. This method is designed to simulate the effect of repeated use. Specimens are mechanically pre-treated using a test device that simultaneously twists and compresses the specimen.

A.2 Sampling

Specimens measuring 280 mm × 280 mm shall be taken from the material or garment. Specimens may include a seam if it is not possible to take a specimen of the specified size without one.

NOTE This specimen size is just sufficient to wrap around the circumference of the discs, but overlaps the discs at each end. Only the central portion of the specimen is used for subsequent testing. Thus, two specimens (230 mm × 70 mm) can be taken from each flexed specimen for subsequent testing by ISO 6942.

A.3 Apparatus (see Figure A.1)

The test device consists of two discs, (90 ± 1) mm in diameter and (12 ± 0,5) mm thick. One disc is fixed and the other is mounted on a grooved shaft so that it moves towards the fixed disc in two stages:

a) forward movement of (90 ± 5) mm accompanied by rotation of (450 ± 10)° followed by

b) forward movement with no rotation.

When the initial disc separation is set at (190 ± 1) mm, the disc separation at the completion of the forward motion shall be (35 ± 2) mm.

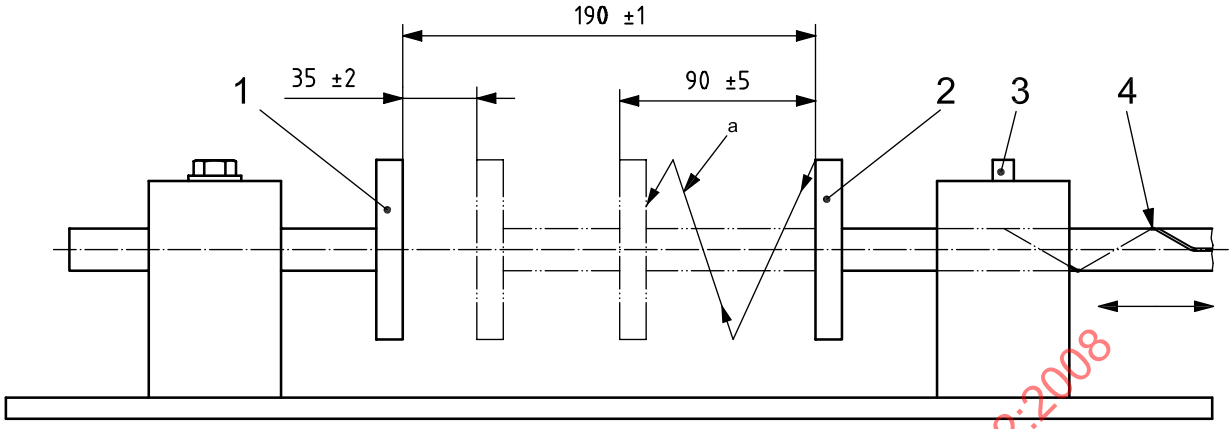
The movement of the revolving disc shall be uniform, except during the change from rotary to forward motion and vice versa. One cycle shall comprise one forward and one reverse movement. The device shall complete (40 ± 4) cycles/min.

A.4 Procedure

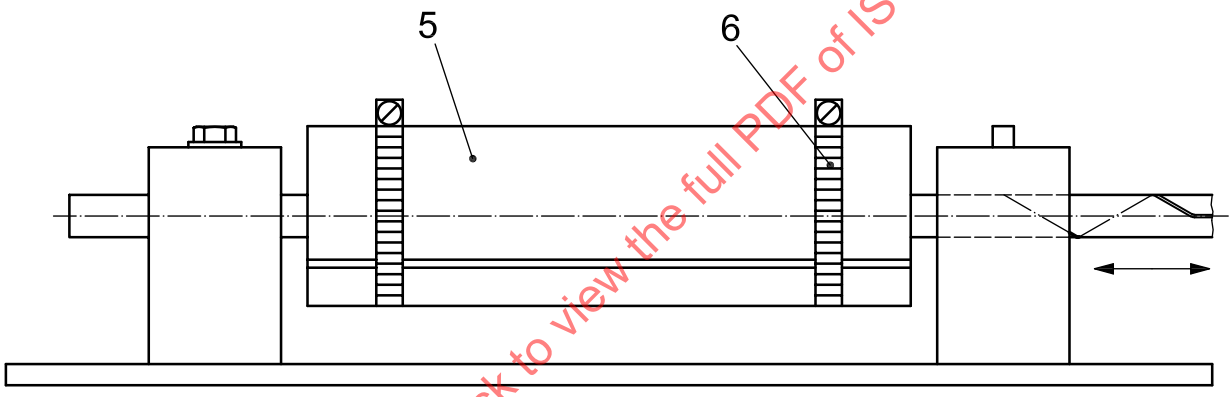
Adjust the distance between the two discs to (190 ± 1) mm. Attach the specimen to the discs without tensioning it, with the coating facing outwards and the specimen protruding over the edges of the two discs.

Subject the specimen to 2 500 cycles. Remove the specimen after every 500 cycles (approximately 12,5 min), rotate it through 90° and reclamp it.

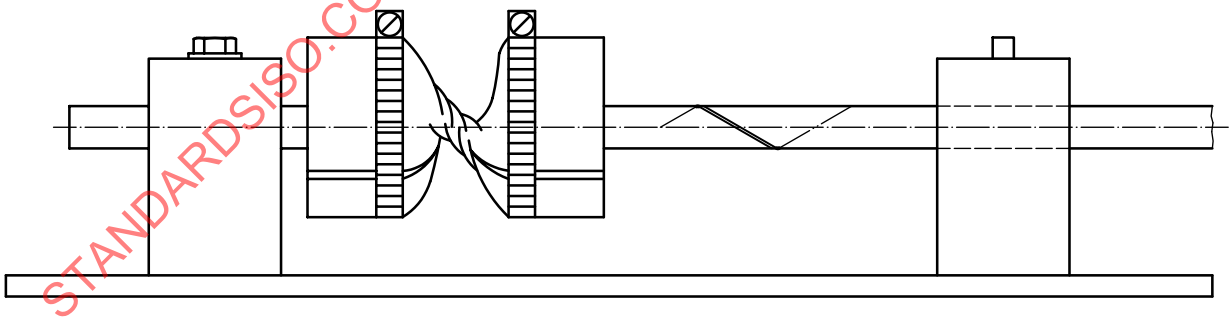
Dimensions in millimetres



a) Disc movement



b) Initial specimen position



c) Specimen fully compressed key

Key

1 fixed disc
2 moving disc
3 peg
4 grooved shaft
5 specimen
6 clamp on to disc

[a] Rotation 450°.

Figure A.1 — Mechanical pre-treatment apparatus

Annex B
(informative)

Guidelines for clothing design

B.1 The requirements for the design of heat and flame protective clothing in accordance with this International Standard are given in Clause 4. This annex contains some additional considerations, some of which are relevant when combining the heat and flame protective clothing according to this International Standard with other protective items such as gloves, footwear, visors, etc.

B.2 The specific requirements of 4.5, for garments designed to protect against the risk of exposure to molten metal, should also be considered for all garments designed to protect against heat and flame.

B.3 If gloves are worn, there should be an overlap between the sleeves and the gloves and this overlap should be retained while the user is working in such a way that trapping points and entry of heat, flame or hot material is avoided.

B.4 Trouser bottoms should overlap the top of the footwear and this overlap should be maintained whilst walking and crawling.

B.5 All openings in garments should be designed in such a way that it is possible to close them in order to prevent entry of heat, flame or hot material. Front openings should be capable of being closed their entire length by appropriate overlapping.

B.6 Quick-release fastenings should be provided to enable rapid removal of the garments in the event of an emergency.

B.7 Pleats in the exterior surface of the garment can act as trapping points for hot/molten materials. If pleats are present in the garment, the bottoms of the pleats should incorporate a means whereby entrapment of molten metal can be prevented, for example by incorporating diagonal stitches or some other feature.

B.8 If the clothing covered by this International Standard is provided with a hood, the hood should be designed in such a way that it remains in position and the integrity of joints or interfaces is maintained when the wearer adopts a full range of body movements and positions. Where the hood is provided with a visor, the hood including the visor should be examined to determine whether the sensory perception (sight and hearing) is reduced to a point that would endanger the user.

Annex C
(informative)

Prediction of burn injury using an instrumented manikin

The given information about the results of the test shall contain at least the following.

a) The name and address of the laboratory in which the test described in 7.8 was carried out.

b) A statement confirming the following:

   1) that the test was carried out for garment evaluation;

   2) that the component or clothing assembly that was tested in accordance with 7.8 was manufactured from the same materials that were used to achieve certification to this International Standard and was designed and manufactured according to the requirements of this International Standard.

c) The following information:

   1) description of any special pre-treatment of any part of the component or clothing assembly prior to the test in 7.8 or alternatively a statement that the garment ensemble did not have any special pre-treatment;

   2) description of any holes or cuts that were necessary to be made in the component or clothing assembly to accommodate cable connections or other necessary parts of the test manikin;

   3) statement of the nominal heat flux density level, the duration of the exposure and the duration of the data acquisition time for the test.

d) The results of the test as follows:

   1) predicted manikin area of second-degree burn injury (percent);

   2) predicted manikin area of third-degree burn injury (percent);

   3) predicted total manikin area of burn injury (sum of the second degree and third degree burn injury as a percentage and associated variation statistics such as standard deviation).

e) Comments on:

   1) intensity and duration of after flame;

   2) amount of smoke generated during and after the test, if measured;

   3) stability of the component or clothing assembly during and after the test with particular reference to the amount of dimensional change, which shall be listed in Table C.1.

Measurements shall be taken according to ISO 13506.

Any other information relating to the test may be included to assist in interpretation of the test results.

Table C.1 — Garment ease and dimensional changes as test results of the optional test in 7.8

Dimensions in centimetres

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Location	**Instrumented manikin measurements**	**Specimen before testing to 7.8** [a]	**Difference: Column 3 minus 2**	**Specimen after testing to 7.8** [a, b]	**Difference: Column 3 minus 5** [b]
Chest circumference					
Waist circumference (jacket)					
Arm length					
Arm width					
Jacket length					
Inside leg length					
Leg circumference					
Waist circumference (trousers)					

NOTE Results of the whole garment testing performed by different laboratories cannot be compared directly because there is too much variation in results between different laboratories for the moment.

[a] Measurements are taken from the innermost and outermost layers.

[b] After testing, it is possible that the materials in the specimen are so badly damaged that accurate measurement is not possible. In this case, it is not necessary to fill in columns 5 and 6 and instead, observations be made with regard to the amount of change in dimensional stability seen as a result of the test.

Annex D
(informative)

Checking of basic ergonomic features of protective clothing

D.1 General

This annex informs how some basic ergonomic features can be checked for many types of protective clothing in a pragmatic way. This annex is not intended to replace specific ergonomic testing required by the user for the individual assessment of protective clothing at a specific workplace. In general, carrying out ergonomic assessments can help to improve protective clothing and detect major deficiencies.

In principle, one or more experienced assessors should examine the protective clothing after reading the information supplied from the manufacturer. The test clothing of a suitable size should be put on together with such normal clothing as is intended to be worn, and some ergonomic features relating to the practical performance of the protective clothing should be checked (e.g. if no movement restrictions are caused). Some of the relevant questions that might be asked are set out below and it is desirable that responses given should be positive.

An assessor can have difficulties deciding whether the product is acceptable or unacceptable. It is recommended that the product should be compared with similar items on the market. If it is significantly worse ergonomically, without redeeming features such as enhanced protection, it can be regarded as unnecessarily uncomfortable. Care will need to be taken if there are no directly comparable products. Care will also be taken when protection against mortal danger is intended and "the state of the art" does not allow comfortable conditions for users, nor perhaps conditions free of harm caused by the protective clothing. Carrying out (subjective) ergonomic assessments will more often result in recommendations for changes to improve protective clothing, than in finding the clothing does not comply with this International Standard.

D.2 Ergonomic assessment questions

D.2.1 Question: *Is the protective clothing free from any sharp or hard edges, rough surfaces or other items on the inner or outer surface of the clothing that are likely to cause harm to the user?*

Protective clothing should be inspected manually and visually to ensure that that no harmful points exist; e.g. no protruding wire ends or other items that could seriously harm a person.

D.2.2 Question: *Is it possible to put on and take off the protective clothing without difficulty?*

The following points should be considered:

— the ease of putting on and removing the clothing with or without assistance as is appropriate for the type of clothing;

— the clothing is not too tight for comfort and deep breathing is not restricted and there is nowhere any blood flow restriction;

— clothing design features at, e.g. armholes and crotch, are appropriately proportioned and positioned.

D.2.3 Question: *Can the closures, adjusters and restraint systems be operated without difficulty?*

The following points should be considered:

— the adequacy of the range of adjustments available;