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STANDARD

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11612

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**Protective clothing — Clothing to  
protect against heat and flame —  
Minimum performance requirements**

*Vêtements de protection — Vêtements de protection contre la chaleur  
et les flammes — Exigences de performance minimales*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, and by Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets* in collaboration.

This third edition cancels and replaces the second edition (ISO 11612:2008), of which it constitutes a minor revision with the following changes:

- modify clause in design requirements regarding garment overlaps;
- modify clause in design requirements regarding the areas of the body covered by protective suits;
- modify clause on sampling requirements;
- modify clause for ageing due to washing (maximum number of cleaning procedures as indicated by the manufacturer);
- modify pre-treatment clause to include requirements for single-use garments;
- include new requirement for measuring property value for rating and classification;
- modify requirement for optional heat resistance testing at 260 °C;
- remove reference to melting from flame spread requirements;
- modify afterflame requirement for flame spread;
- modify afterglow requirement for flame spread;
- modify requirement that hardware is tested only after pre-treatment;
- include statement for flame spread testing in regard to interlining materials;
- modify test procedure for the flame testing of labels, badges, and retro-reflective materials;
- modify requirements for tear strength;

- specify test area for burst strength testing;
- modify innocuousness clause to include reference to ISO 13688;
- specify limit for Chromium(VI) Content;
- include new table for summary of tests;
- modify clause for information to be supplied by the manufacturer;
- include new Annex for measuring property value for rating and classification;
- update observation clause in [Annex C](#), prediction of burn injury using an instrumented manikin;
- include new definition for uncertainty of measurement, [Annex E](#).

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## 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 this Introduction deal also with clothing to protect against heat and flame, 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 low risk;
- Level 2 to indicate exposure to medium risk;
- Level 3 to indicate exposure to 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 D](#).

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 Personal Protective Equipment (PPE) and in some cases, appropriate respiratory protection might also be considered necessary.

Attention is drawn to ISO/TR 2801:2007 [[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 specialized 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*.

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# Protective clothing — Clothing to protect against heat and flame — Minimum performance requirements

## 1 Scope

This International Standard specifies performance requirements for protective clothing 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 protective clothing 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 (see Introduction).

## 2 Normative references

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

ISO 3376:2011, *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: Single edge tear*

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, *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 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 12127-1, *Clothing for protection against heat and flame — Determination of contact heat transmission through protective clothing or constituent materials — Part 1: Test method using contact heat produced by heating cylinder*

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 13938-2, *Textiles — Bursting properties of fabrics — Part 2: Pneumatic 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 17493, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*

### 3 Terms and definitions

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

#### 3.1

##### **ageing**

changing of the product performance over time during use or storage

Note 1 to entry: Ageing is caused by a combination of several factors, such as:

- cleaning, maintenance, or disinfecting processes;
- exposure to visible and/or ultraviolet 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 1 to entry: 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 garments arranged in the order as worn

Note 1 to entry: They may contain multilayer materials, material combinations, or a series of separate garments in single layers.

#### 3.4

##### **component**

any material, part, or sub-assembly used in the construction of an item of PPE

**3.5****component assembly**

combination of all materials and hardware 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 which can also cover the upper surface of shoes

**3.8****hardware**

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

EXAMPLE Metal or plastic buttons or zippers and touch and close fasteners or hook and loop fasteners.

**3.9****hole**

any opening, break, or discontinuity of any size in the original structure of the test specimen's fabric caused by application of the test flame

**3.10****hood**

item of PPE made from flexible material, which covers the head and neck and may also cover the shoulders

**3.11****innermost lining**

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

Note 1 to entry: 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**

substances, excluding hardware, of which an item of clothing is made

**3.14****material assembly**

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

**3.15****material combination**

material produced from a series of separate layers, fixed together during the garment manufacturing stage

**3.16****multilayer material**

material consisting of different layers intimately combined prior to the garment manufacturing stage

EXAMPLE The combining process includes weaving, quilting, coating and gluing.

**3.17**

**outer material**

outermost material of which the item of clothing is made

**3.18**

**overboots**

single or multiple layers of material covering the footwear to provide protection to the feet and ankles of the wearer against heat and/or flame

Note 1 to entry: Certain types of overboot used for this purpose can also cover parts of the legs and/or ankles.

**3.19**

**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

**3.20**

**pre-treatment**

standard way of preparing the samples before testing

Note 1 to entry: This might include a number of cleaning cycles, submitting the sample to heat, mechanical action, or any other relevant exposure and is completed by conditioning.

**3.21**

**protective garment**

individual item of protective clothing, which provides protection against specified hazards to the part of the body that it covers

EXAMPLE      Protective coat, apron, trousers, gaiters, hoods, boiler suit or coverall.

**3.22**

**protective clothing**

clothing which covers or replaces personal clothing and which is designed to provide protection for the wearer's upper and lower torso, neck, arms, and legs

**3.23**

**seam**

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

**3.23.1**

**overlapping seam**

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

**3.23.2**

**side seam**

seam that runs laterally along the garment when it is placed flat on a surface, with the front uppermost

**3.23.3**

**structural seam**

seam that is necessary for the integrity of the garment

## 4 General and design requirements

### 4.1 General

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

## 4.2 Size designation and fit

### 4.2.1 General

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

### 4.2.2 Protective clothing

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

- a single garment, e.g. a coverall or boiler suit;
- a two-piece garment, consisting of a jacket and a pair of trousers;
- trouser bottoms shall overlap the top of the footwear and this overlap should be maintained while walking and crawling;
- quick-release fastenings shall be provided to enable rapid removal of the garments in the event of an emergency.

Where protection to the requirements of this International Standard is provided by an outer two-piece suit, it shall be determined that, when correctly sized for the wearer, an overlap between the jacket and trousers remains when one standing wearer firstly fully extends both arms above the head and then bends over until the fingertips touch the ground.

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

In addition, the wrists, lower arms, and ankles shall also remain covered in an upright position; this shall also apply to one-piece suits.

### 4.2.3 Additional protective garments

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 shall be worn in addition to a suit in accordance with 4.2.2 and the additional item alone shall also meet the requirements of this International Standard.

Performance testing of additional protective garments shall be carried out on the assembly, comprising the suit plus the additional protective garment. Additional protective garments such as hoods, sleeves, apron, and gaiters shall cover the intended areas when worn with a suit of appropriate size and the additional item alone shall also meet the requirements of this International Standard.

## 4.3 Pockets and closures

Where garments are constructed with pockets, the pockets shall be made of material(s) conforming to 6.2 and 6.3.

All openings in garments shall be designed in such a way to prevent entry of heat, flame, or hot material. Front openings should be capable of being closed over the entire length by appropriate overlapping.

## 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 and brace shall not have turn-ups.
- b) External pockets on jackets, trousers, coveralls, and bib and 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 (at least 10 mm on each side) 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/press studs 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. Cuffs shall not have turn-ups. 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.
- f) 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 shall incorporate a means whereby entrapment of molten metal can be prevented, for example by incorporating diagonal stitches or some other feature.

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

NOTE Further guidance on design of clothing to protect against these risks is given in [Annex C](#).

## 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 [Clauses 6](#) and [7](#). Samples for testing shall be taken from the original garment or shall be representative of the component assembly.

### 5.2 Pre-treatment

#### 5.2.1 Pre-treatment by cleaning

Before each test specified in [Clauses 6](#) and [7](#), except [6.6](#), the test materials and test specimens shall be pre-treated by cleaning. If the manufacturer's instructions indicate that cleaning is not allowed, i.e. single-use garments, then testing shall be carried out on new material. 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, the tests shall be carried out after five cleaning cycles (a cleaning cycle is one wash and one dry cycle). This shall be reflected in the information supplied by the

manufacturer. If the garment can be washed and dry-cleaned, it shall only be washed. If only dry-cleaning is allowed, the garment shall be dry-cleaned in accordance with the manufacturer's instructions.

Leather materials shall be tested in the new state, except if the manufacturer indicates that cleaning is allowed. In that case, cleaning shall be carried out according to the manufacturer's instructions.

The test specified in [6.6](#) shall be carried out in the new state (as received).

NOTE Manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330,<sup>[2]</sup> ISO 15797,<sup>[3]</sup> ISO 3175-2,<sup>[5]</sup> or equivalent as standardized processes for cleaning.

## 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](#)).

## 5.3 Ageing

In the case that the garment should be submitted to some treatment to maintain its limited flame spread property as specified in [6.3](#), the manufacturer shall indicate the maximum number of cleaning cycles that can be carried out before applying the treatment indicated to maintain the garment protective performance. Limited flame spread test according to [6.3](#) shall be carried out after the last cleaning cycles before any treatment as indicated by the manufacturer; in both cases the garment shall comply with the requirement.

## 5.4 Conditioning

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

# 6 General performance requirements

## 6.1 General

Protective garments that comply with this International Standard shall meet the requirements of [Clause 6](#), with the exception of the requirements of [6.2.2](#), which is optional, and shall meet at least one of the heat transmission requirements for letter codes B, C, D, or F of [Clause 7](#) based on their intended use. Such garments shall be marked in accordance with [Clause 8](#).

Wherever in [Clauses 6](#) and [7](#), the requirements for a property value are expressed in terms of a minimum or maximum value, and wherever a minimum or maximum value is to determine a Level or Class for that property, the resultant property value shall be determined according to [Annex B](#). All tests results in [Clauses 6](#) and [7](#) shall be evaluated in accordance with [Annex E](#).

## 6.2 Heat resistance

### 6.2.1 Heat resistance at a temperature of $(180 \pm 5)^\circ\text{C}$

All materials and hardware, including retro-reflective materials used in the garment and/or clothing assembly shall be tested according to ISO 17493 at a temperature of  $(180 \pm 5)^\circ\text{C}$  for an exposure time of 5 min. Materials can be either tested separately or as assembled in the garment and/or component assembly. Test samples shall not ignite or melt, and fabrics and leather also not shrink by more than 5 %. To verify shrinkage on multilayer samples, it might be necessary to close by sewing around the edges of the test samples. At least 5 min after completion of the test, it shall be verified that the closure system can be opened at least once.

## 6.2.2 Optional requirement — Heat resistance at a temperature of $(260 \pm 5)^\circ\text{C}$

The material of a single layer garment or of the innermost lining of a multilayer garment, which is intended to be worn next to the skin, can be optionally tested according to ISO 17493 at a temperature of  $(260 \pm 5)^\circ\text{C}$  for an exposure time of 5 min. The material shall not ignite or melt and shall not shrink by more than 10 % in addition to meeting the requirements 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 limited, 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

### 6.3.1 General

Testing of materials and seams shall take place in accordance with ISO 15025, to Procedure A (code letter A1), and optionally Procedure B (code letter A2). This test shall be carried out both before and after the pre-treatment specified in [5.2.1](#).

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

**6.3.2.1** When tested in accordance with ISO 15025, Procedure A, specimens from single layer garments shall meet the following requirements (see [Table 1](#)):

**Table 1 — Limited flame spread performance requirements, ISO 15025, Procedure A (code letter A1)**

Properties	Requirement
Flame spread	No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
Hole formation	No specimen shall give hole formation of 5 mm or greater in any direction, except for an interlining that is used for specific protection other than heat and flame protection.
Afterglow	Afterglow time shall be $\leq 2$ 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.
Afterflame	Afterflame time shall be $\leq 2$ s.

For seams, three specimens containing a structural seam shall be tested in accordance with ISO 15025, Procedure A. Specimens shall be oriented with the seam running up the centreline of the outer surface of the test specimen so that the burner flame impinges directly upon the seam. Seams shall not separate. Except for leather, seams shall be tested only after pre-treatment according to [5.2](#).

**6.3.2.2** If the garment is multilayer, specimens of the material assembly including seams except the innermost seams, shall be tested both by applying the flame to the surfaces of both 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 give 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, whether it is exposed or covered when all closure systems in the garment are in the closed position, shall be tested separately, using ISO 15025, Procedure A, after the pre-treatment specified in [5.2](#). Samples shall be taken in combination with the garment layer(s) to make it possible to

have samples with the dimensions as indicated in ISO 15025, Procedure A. Three specimens containing the hardware shall be tested.

When the hardware is covered, the flame shall be applied to the outer surface of the component assembly containing hardware exactly as designed in the garment so that the burner flame impinges directly upon where the hardware is located. When the hardware is directly exposed, the flame shall be applied directly upon the hardware.

When the hardware is covered when all closure systems in the garment are in the closed position, the assembly shall meet the requirements of [6.3.2.1](#). At 5 min after completion of the test, it shall be verified that the closure system can be opened at least once.

When the hardware is directly exposed, it shall comply with: No specimen shall melt or give flaming or molten debris; the afterglow time shall be  $\leq 2$  s, and the afterflame time shall be  $\leq 2$  s. At least 5 min after completion of the test, it shall be verified that the closure system can be opened at least once.

**6.3.2.4** Labels, badges, retro-reflective materials, transfers, etc., which are applied to the outermost surface of the garment, shall be tested only after pre-treatment according to [5.2](#) in combination with the outer layer to make it possible to take samples with the dimensions as indicated in ISO 15025, Procedure A. Three specimens containing the item shall be tested. The items shall be oriented with the longer dimensions running up the centreline of the test specimen so that the burner flame impinges directly upon the middle surface of the item, not the edge. The combination with the outermost layer of the garment shall meet the requirements of [6.3.2.1](#). This requirement is not applicable for labels, embroideries, or other added decorations with a surface area of less than 10 cm<sup>2</sup>.

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

**6.3.3.1** When tested in accordance with ISO 15025, Procedure B, hemmed specimens from single-layer garments shall meet the following requirements (see [Table 2](#)):

**Table 2 — Limited flame spread performance requirements, ISO 15025, Procedure B (code letter A2)**

Properties	Requirement
Flame spread	No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
Afterglow	Afterglow time shall be $\leq 2$ 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.
Afterflame	Afterflame time shall be $\leq 2$ s.

For seams, three hemmed specimens containing a structural seam shall be tested in accordance with ISO 15025, 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 the seam. Seams shall not separate. Except for leather, seams shall be tested only after pre-treatment according to [5.2](#).

**6.3.3.2** The hemmed fabric specimen shall be taken from the original garment or 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 material 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 of textile materials

Dimensional change shall be measured before and after the samples have undergone five cleaning cycles according to 5.2.1.

The change in dimensions of woven, non-woven sheet materials and aluminized fabrics shall not exceed  $\pm 3\%$  in either length or width direction when measured in accordance with ISO 5077.

The change of dimensions of knitted materials shall not exceed  $\pm 5\%$  when measured in accordance with ISO 5077.

Dimensional change shall be measured after the specimen has been uncreased and flattened on a plane surface.

Dimensional change does not apply to single-use garments.

## 6.5 Physical requirements

### 6.5.1 Tensile strength

6.5.1.1 When tested in accordance with ISO 13934-1, woven outer materials shall have a minimum tensile strength of 300 N in both the machine and cross directions.

6.5.1.2 When tested in accordance with ISO 3376, leather outer materials shall have a minimum tensile strength of 60 N in two directions at right angles when the standard test specimen defined in Table 1 of ISO 3376:2011 is used.

### 6.5.2 Tear strength

6.5.2.1 When tested in accordance with ISO 13937-2, woven outer materials shall have a minimum tear strength of 10 N in both the machine and cross directions.

6.5.2.2 When tested in accordance with ISO 3377-1, leather outer materials shall have a minimum tear strength of 10 N in two directions at right angles in the plane of the material.

### 6.5.3 Burst strength for knitted materials and seams

When tested in accordance with ISO 13938-1 or ISO 13938-2, knitted outer materials and structural seams in knitted materials shall have a minimum burst strength of 100 kPa, when using 50 cm<sup>2</sup> test area, or of 200 kPa, when using a 7,3 cm<sup>2</sup> test area.

### 6.5.4 Seam strength

When tested in accordance with ISO 13935-2, structural seams of woven outer materials, leather materials, and aluminized materials of the clothing assembly shall have a minimum seam strength of 225 N.

## 6.6 Fat content of leather

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

## 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-layer 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 3](#). If the garment is multi-layered, the test shall be carried out on the complete material assembly with the innermost layer facing the calorimeter and the outermost layer facing the energy source.

**Table 3 — Performance levels: Convective heat test**

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

<sup>a</sup> 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<sup>2</sup>, single-layer 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 4](#). Tests on metallized materials shall be carried out after pre-treatment as specified in [Annex A](#). For multi-layered garments, the test shall be carried out on the complete material assembly with the innermost layer facing the calorimeter and the outermost layer facing the energy source.

**Table 4 — Performance levels: radiant heat test**

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

<sup>a</sup> 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 layer 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 5](#).

Material and material assemblies which ignite during the test do not meet this requirement.

NOTE 1 Labels, badges, hardware, touch and close (hook and pile) fasteners, retro-reflective materials, etc. present on garments can 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 5 — Performance levels: Molten aluminium splash**

Performance levels	Molten aluminium splash	
	g	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-layer 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 6](#).

Material and material assemblies which ignite during the test do not meet this test.

NOTE 1 Labels, badges, hardware, touch and close (hook and pile) fasteners, retro-reflective materials, etc. present on garments can 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 6 — Performance levels: molten iron splash**

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

## 7.6 Contact heat (code letter F)

When tested in accordance with ISO 12127-1 at a temperature of 250 °C, single-layer 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 7](#).

**Table 7 — Performance levels: Contact heat**

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

## 8 Summary of flame and heat transmission tests and corresponding letter codes (see [Table 8](#))

**Table 8 — Heat transmission performance**

Heat transmission performance	Letter code	Paragraph	Test method
Limited flame spread	A1 or (A1 and A2)	<a href="#">6.3</a>	ISO 15025
Convective heat	B1 to B3	<a href="#">7.2</a>	ISO 9151
Radiant heat	C1 to C4	<a href="#">7.3</a>	ISO 6492
Molten aluminium splash	D1 to D3	<a href="#">7.4</a>	ISO 9185
Molten iron splash	E1 to E3	<a href="#">7.5</a>	ISO 9185
Contact heat	F1 to F3	<a href="#">7.6</a>	ISO 12127-1

## 9 Optional test — Whole garment test against fire exposure on thermal manikin

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. Report test results in accordance with ISO 13506.

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

**NOTE** Experience has shown that test conditions of at least 4 s at 84 kW/m<sup>2</sup> give the most complete information about the protective performance of single and multilayer clothing assemblies. Depending on the scenario, where a risk of high level of heat is expected (e.g. scenario of a fire flash over), the time of exposure can be increased. For multilayer garments or for clothing assemblies, test conditions of up to 8 s might be necessary. 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.

## 10 Marking

**10.1** Marking requirements shall be as specified in ISO 13688 and in this Clause.

**10.2** The protective clothing for which compliance with this International Standard is claimed shall be marked with the graphical symbol 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 [Clauses 6](#) and [7](#) as relevant.

**10.3** All garments complying with this International Standard shall be marked with code letter A1 or A1 and A2 as appropriate 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 graphical symbol.

**10.4** 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.

**10.5** For garments intended for single use only, the garment marking shall indicate “Do not re-use” (or the equivalent term in the language of the country of destination) and in addition, the graphical symbol ISO 7000-1051.

**10.6** The graphical symbol ISO 7000-2417 shown in [Figure 1](#) shall be used.



A1 or A1 + A2, B(x), C(x), D(x), E(x), F(x)

NOTE (x) = level of performance obtained.

**Figure 1 — Graphical symbol: Clothing for protection against heat and flames (ISO 7000-2417)**

## 11 Information supplied by the manufacturer

**11.1** 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 the case that applying a finish can restore the protective properties, the maximum number of cleaning cycles before re-application of the finish and the procedure for re-application shall be clearly indicated in the information notice.

**11.2** 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 intended use as specified by the manufacturer.

**11.3** 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 while 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.

**11.4** If the optional whole garment test in [Clause 9](#) has been performed, the manufacturer shall provide a report of test results in accordance with ISO 13506.

**11.5** 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. The manufacturer shall specify the intended use of the clothing.

## 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:

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

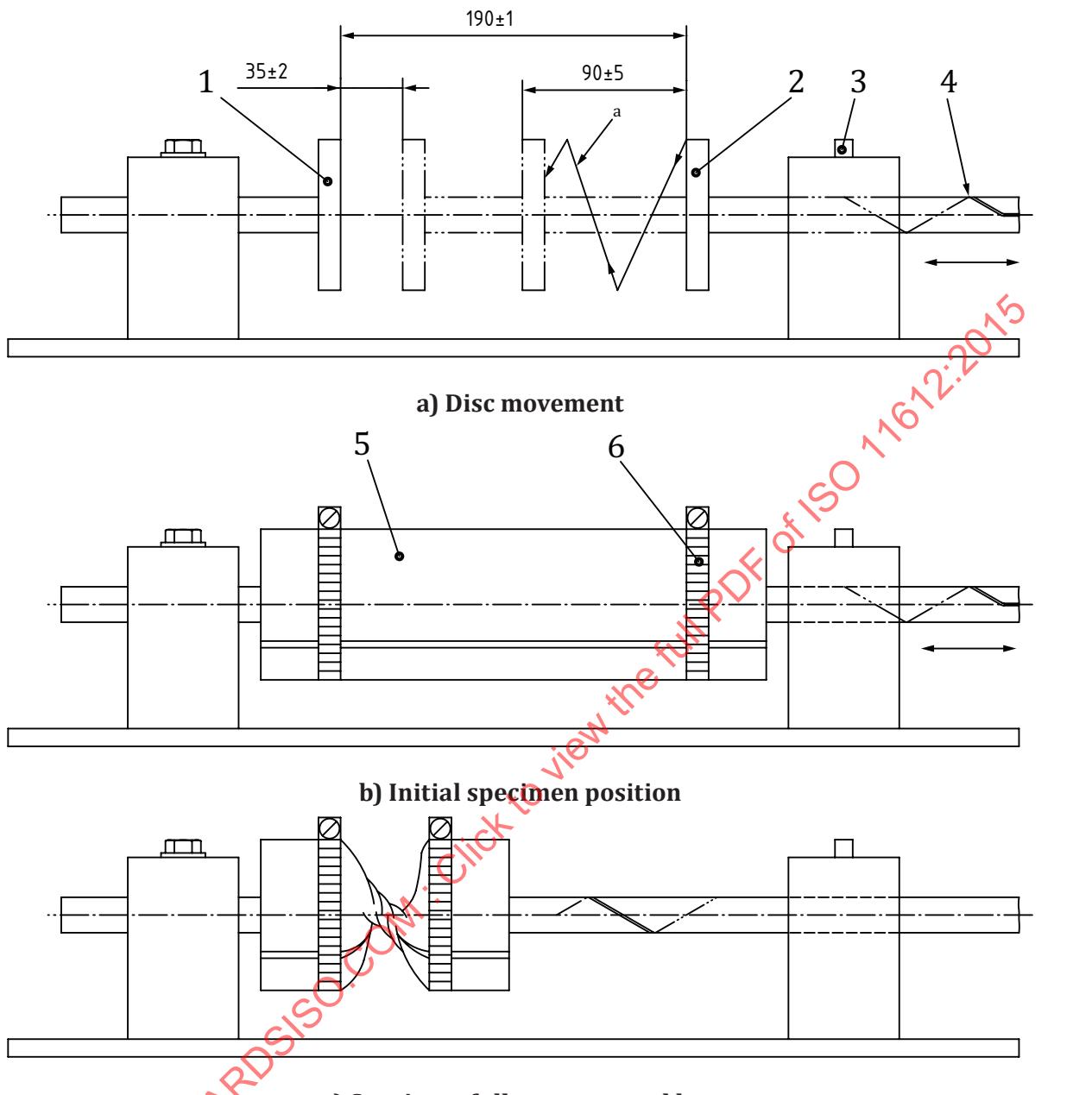
The movement of the revolving disc shall be uniform, except during the change from rotary to forward motion and vice versa. One cycle shall comprise one forward and one reverse movement. The device shall complete (40 ± 4) cycles/min.

#### 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

**Key**

1	fixed disc	4	grooved shaft
2	moving disc	5	specimen
3	peg	6	clamp on to disc
a	Rotation $450^\circ$		

**Figure A.1 — Mechanical pre-treatment apparatus**