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ISO 14116

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Protective clothing — Protection against flame — Limited flame spread materials, material assemblies and clothing

Vêtements de protection — Protection contre les flammes — Matériaux, assemblages de matériaux et vêtements à propagation de flamme limitée

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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).

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).

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 second edition cancels and replaces the first edition (ISO 14116:2008), which has been technically revised to include the following changes:

— include test procedures for burst strength testing of woven materials;

— include new definition for determination of hole formation;

— modify clause in design requirements regarding garment overlaps;

— modify clause on sampling requirements;

— modify pre-treatment clause to include requirements for single use garments;

— modify clause for ageing due to washing (maximum number of cleaning procedures as indicated by the manufacturer);

— include new requirement for measuring property value for rating and classification;

— modify test procedure for the flame testing of labels, badges, and retro-reflective materials;

— include requirement and procedure for testing of hardware;

— include requirement and test procedure for burst strength testing of knitted materials;

— include requirement and test procedure for tensile strength testing of non-woven materials;

— include requirement and test procedure for tear strength testing of non-woven materials;

— modify requirement for tear strength of woven and non-woven materials;

— modify flame spread definition;

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— modify requirement for flaming debris;

— modify afterflame requirement for flame spread of Index 3 materials;

— modify afterglow requirement for flame spread of Index 1, Index 2, and Index 3 materials.;

— include statement for flame spread testing in regard to interlining materials for Index 2 and Index 3 materials;

— include normative Annex for uncertainty of measurement;

— include normative Annex for measuring property value for rating and classification.

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Introduction

The purpose of this International Standard is to provide minimum performance requirements for clothing in order to reduce the possibility of the clothing and/or its materials burning when in occasional and brief contact with small flames and thereby, itself constituting a hazard.

For complete protection against exposure to flame, 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 ISO/TR 2801:2007,[5] which sets out guidelines for selection, use, care, and maintenance of protective clothing against flame.

Nothing in this International Standard is intended to restrict any jurisdiction, purchaser, or manufacturer from exceeding these minimum requirements.

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Protective clothing — Protection against flame — Limited flame spread materials, material assemblies and clothing

1 Scope

This International Standard specifies the performance requirements for the limited flame spread properties of all materials, all material assemblies, and protective clothing in order to reduce the possibility of the clothing burning when in occasional and brief contact with small flames and thereby constituting a hazard. Additional requirements for clothing are also specified, including design requirements, mechanical requirements, marking, and information supplied by the manufacturer.

When protection against heat hazards is necessary, in addition to protection against flame, this International Standard is not appropriate. International Standards such as ISO 11612 are to be used instead.

A classification system is given for materials, material assemblies and garments which are tested according to ISO 15025, Procedure A.

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 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 13688, *Protective clothing — General requirements*

ISO 9073-4, *Textiles — Test methods for nonwovens — Part 4: Determination of tear resistance*

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

3 Terms and definitions

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

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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 the following:

— cleaning, maintenance, or disinfecting process;

— 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.

[SOURCE: ISO 11611:2007, 3.1]

3.2
cleaning
process by which an item of PPE is made serviceable and/or hygienically wearable again 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 other finishing.

3.3
cleaning index
letter indicating that the material or material assembly was subjected to a cleansing procedure specified in 5.2 before being tested for limited flame spread

3.4
clothing assembly
series of garments arranged in the order as worn

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

3.5
component assembly
combination of all materials and hardware presented exactly as the finished garment construction

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

3.7
garment
single item of clothing which can consist of single or multiple layers

3.8
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

[SOURCE: ISO 15025:2000, 2.8, modified]

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3.9
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.

3.10
interlining
layer between the outermost layer and the innermost lining in a multilayer garment

3.11
limited flame spread index
number indicating that the material or material assembly has achieved a specific level of performance

Note 1 to entry: See Clause 7.

3.12
material
substances, excluding hardware, of which an item of clothing is made

3.13
material assembly
combination of all materials of a multi-layer garment presented exactly as the finished garment construction

3.14
material combination
material produced from a series of separate layers, fixed together during the garment manufacturing stage

3.15
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.

3.16
outer material
outermost material of which the item of clothing is made

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

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

[SOURCE: ISO 11611:2007, 3.8]

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

3.19
structural seam
seam that is necessary for the integrity of the garment

4 General and design requirements

4.1 Single layer garments containing limited flame spread index 1 materials, shall be worn over index 2 or index 3 garments and shall not come into contact with the skin (e.g. in the neck and wrist area). If an

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assembly contains index 1 materials, those shall not come into contact with the skin (e.g. in the neck and wrist area).

It shall be verified by visual inspection when the garment is worn by an appropriate user.

4.2 Protective clothing may consist of several separate garments or it may be a single garment with one or more layers.

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

4.4 Hardware penetrating the outer material of a 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 An outer two piece suit, when correctly sized for the wearer, shall provide an overlap between the jacket and trousers which remains when one standing wearer firstly fully extends both arms above the head and then bends over until the fingertips touch the ground. In addition, the wrists and lower arms shall also remain covered in an upright position; this shall also apply to one piece suits.

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5 Sampling, pre-treatment, and ageing

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 in Clause 6. Samples for testing shall be taken from the original garment or shall be representative of the component assembly.

5.2 Pre-treatment of material

Before each test specified in Clause 6, the test materials and test specimens shall be pre-treated by cleaning. If the manufacturer's instructions indicate that cleaning is not allowed, then testing shall be carried out on new material. In addition, 6.1 requires that the limited flame spread tests shall be carried out both before the pre-treatment and after the pre-treatment.

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.

NOTE Manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330,[3] ISO 15797,[4] ISO 3175-2,[6] or equivalent as standardized processes for cleaning.

5.3 Ageing

In case the garment should be submitted to some treatment to maintain its limited flame spread property as specified in Clause 7, 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 Clause 7 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.

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5.4 Conditioning

Specimens 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) %. Testing shall be carried out within 5 min of removal from this atmosphere.

6 Performance requirements

6.1 Limited flame spread performance

6.1.1 Limited flame spread index quoted shall be the lowest value determined either before or after pre-treatment specified in 5.2.

6.1.2 All materials used in a single layer garment claiming compliance with this International Standard shall achieve a limited flame spread index of 1, 2, or 3 (see Clause 7) when tested in accordance with ISO 15025 Procedure A (surface ignition), before and after the pre-treatment in accordance with Clause 5. The flame shall be applied to the outer face.

6.1.3 All material assemblies claiming compliance with this International Standard shall achieve a limited flame spread index of 1, 2, or 3 (see Clause 7) when tested in accordance with ISO 15025 Procedure A, before and after the pre-treatment.

a) The material assembly shall achieve a limited flame spread index of 1, 2, or 3 when tested in accordance with ISO 15025 with the flame applied to the outer face and index 2 or index 3 with the flame applied to the inner face of the assembly (in this case, additional sets of specimen are needed).

b) Or, each layer of a material assembly shall comply with index 1, index 2 or index 3 when tested with the flame applied to the outer face, except the innermost layer which shall comply with index 2 or index 3.

c) When the assembly is a clothing assembly, the materials of each garment of the assembly shall comply with 6.1.2 or 6.1.3, as applicable.

6.1.4 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 test specimen so that the burner flame impinges directly upon the seam. Specimens containing a seam shall meet, respectively, limited flame spread index 1, index 2 or index 3 requirements and for limited flame spread 2 or 3, the specimen shall not separate at the seam. Seams shall be tested only after pre-treatment according to 5.2.

6.1.5 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 of the surface of the item, not the edge. The combination with the outermost layer of the garment shall have the same limited flame spread index as the material to which they are applied. This requirement is not applicable for labels, embroideries, or other added decorations with a surface area of less than 10 cm^2.

6.1.6 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 Clause 5.2. Samples shall be taken in combination with the garment layer(s) to make it possible to have

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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 the place 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 same limited flame spread index as the material to which they are attached. At least five minutes 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, the hardware shall meet the same limited flame spread index as the material to which they are attached, except that the hole formation and the spread of flame to the outer vertical edge or lower edge of the hardware does not apply.

6.2 Physical requirements

All tests in Clause 6 and Clause 7 shall be evaluated in accordance with Annex A. Wherever in Clause 6 and Clause 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.

6.2.1 Tensile Strength

6.2.1.1 When tested in accordance with ISO 13934-1, woven outer materials shall have a minimum tensile strength of 150 N for machine and cross direction.

6.2.1.2 When tested in accordance with ISO 13934-1, non-woven outer materials shall have a minimum tensile strength of 30 N.

6.2.2 Tear strength

6.2.2.1 When tested in accordance with ISO 13937-2, woven outer materials shall have a minimum tear strength of 7,5 N.

6.2.2.2 When tested in accordance with ISO 9073-4, non-woven outer materials shall have a minimum tear strength of 10 N.

6.2.3 Burst strength

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

6.2.4 Seam strength

6.2.4.1 When tested in accordance with ISO 13935-2, structural seams of woven outer materials shall have a minimum seam strength of 75 N.

6.2.4.2 When tested in accordance with ISO 13935-2, structural seams of non-woven outer materials shall have a minimum seam strength of 30 N.

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6.3 Dimensional change of textile materials

Dimensional change shall be measured before and after the samples have undergone five cleaning cycles according to 5.2.

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

The change of dimensions of knitted materials shall not exceed ±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.

7 Classification

7.1 Requirements for limited flame spread index 1

Requirements for limited flame spread index 1 are given in Table 1.

Table 1 — Requirements for limited flame spread index 1

Properties	Requirement
Flame spread	No specimen shall permit any part of the lowest boundary of any flame or the boundary of any hole to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
Afterglow	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, shall not be regarded as afterglow.

7.2 Requirements for limited flame spread index 2

Requirements for limited flame spread index 2 are given in Table 2.

Table 2 — Requirements for limited flame spread index 2

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 ≤2 s. A glowing inside the charred area is defined in ISO 15025 as afterglow without combustion and, for the purpose of this clause, shall not be regarded as afterglow.
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 flame protection.

7.3 Requirements for limited flame spread index 3

Requirements for limited flame spread index 3 are given in Table 3.

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Table 3 — Requirements for limited flame spread index 3

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 flame protection
Afterglow	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, shall not be regarded as afterglow
Afterflame	Afterflame time shall be ≤2 s.

8 Marking

8.1 Final index

The final index to be marked shall be in the following form:

— limited flame spread index.

8.2 Single-layer materials

All single-layer materials claiming compliance with this International Standard shall be supplied with the following information:

a) manufacturer's name, trade mark, or other identifying mark;

b) statement material that complies with ISO 14116 index 1, index 2, or index 3, as appropriate;

c) instructions for the care and cleaning of the material with particular emphasis on any special precautions to be taken.

8.3 Material assemblies

All material assemblies claiming compliance with this International Standard shall be supplied as described in 8.2 but with the statement required under 8.2 b) modified to

— "material assembly complies with ISO 14116 index 1, index 2, or index 3 for outer face and index 1, index 2, or index 3 for inner face", if the requirements of 6.1.3 a) are satisfied or

— "each material in the assembly complies with ISO 14116", with indices given for each layer, if the requirements of 6.1.3 b) are satisfied.

The presence and position of any index 1 material in the assembly shall be indicated.

8.4 Garments

8.4.1 Garments conforming to this International Standard which do not conform to any other standard for heat and flame protection shall not be marked with a graphical symbol or pictogram to depict heat and/or flame protection.

8.4.2 Garments shall additionally contain data as described in 8.2 or 8.3.

8.4.3 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) or equivalent ISO symbol.

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8.4.4 The final index(es) shall be marked as described in 8.2 or 8.3.

8.4.5 For clothing assemblies, each assembly shall be marked that they should always be worn together.

9 Information supplied by the manufacturer

9.1 Garments shall be accompanied by manufacturer's information according to ISO 13688.

The manufacturer shall indicate if protective clothing contains index 1 flame spread materials or if parts of the clothing are manufactured from thermally conductive hardware that are likely to be exposed to flame and warn that those materials and parts shall not be worn next to the skin. It shall also be indicated that single layer garments which contain index 1 materials shall only be worn over index 2 or index 3 garments.

Manufacturers shall give clear information on the design of index 2 or index 3 garments so the contact of index 1 garment with skin is avoided.

Explanation of any symbols used in the marking shall be in the language of the user in the country of destination.

9.2 Instructions shall be given to advise the user on cleaning procedures, the maximum number of cleaning cycles, maintenance, inspection, and repair of the garment where practical.

Manufacturers shall include the information that limited flame spread garments be cleaned regularly in accordance with the manufacturer's recommendations and that after cleaning, the clothing should be inspected.

9.3 In case that applying a finish can maintain 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.

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Annex A
(normative)

Uncertainty of measurement

For each of the required measurements performed in accordance with this International Standard, a corresponding estimate of the uncertainty of measurement shall be evaluated. This estimate of uncertainty shall be applied when it might affect the rating or classification of a property.

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