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Protective clothing for firefighters — Laboratory test methods and performance requirements for wildland firefighting clothing

Vêtements de protection pour sapeurs-pompiers — Méthodes d'essai en laboratoire et exigences de performance pour vêtements portés pendant la lutte contre les feux d'espaces naturels

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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 15384 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

Introduction

The purpose of this International Standard is to provide minimum performance requirements for protective clothing designed for use for extended periods during wildland fire fighting and associated activities.

Wildland fire fighting involves work primarily in summer temperatures, for many hours in which the firefighter may develop high levels of metabolic heat. Consequently, the protective clothing should be light, flexible and commensurate with the risks to which the firefighter may be exposed in order to be effective without introducing heat stress to the wearer.

Accordingly, a risk assessment should be undertaken to determine if the clothing covered by this International Standard is suitable for its intended use and the expected exposure. This International Standard does not cover clothing for use in risk situations where clothing complying with ISO 11613 or ISO 15538 is more suitable, nor does this International Standard cover clothing to protect against chemical, biological, electrical or radiation hazards.

The risk assessment should include what additional personal protective equipment is necessary for head, hand and feet. In some situations, respiratory protection may also be required.

Firefighters should be trained in the use, care and maintenance of the protective clothing covered by this International Standard, including an understanding of its limitation.

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

A list of International Standards related to ISO 15384 is given in the Bibliography.

Protective clothing for firefighters — Laboratory test methods and performance requirements for wildland firefighting clothing

1 Scope

This International Standard specifies methods of test and minimum performance requirements for protective clothing to be worn in wildland firefighting and associated activities. This clothing is not intended to provide protection during fire entrapment. This International Standard applies to the general design of the garment, the minimum level of performance for the materials employed and the methods of test to determine these levels.

This International Standard is not applicable to clothing for use in risk situations where clothing complying with ISO 11613 or ISO 15538 is more suitable, nor does this International Standard cover clothing to protect against chemical, biological, electrical or radiation hazards.

This International Standard is not applicable to protection of the head (it may cover the neck), eyes, hand, feet and respiratory system. These aspects may be dealt with in other International Standards.

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 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 3146, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods*

ISO 3175-1, *Textiles — Dry cleaning and finishing — Part 1: Method for assessing the cleanability of textiles and garments*

ISO 3758, *Textiles — Care labelling code using symbols*

ISO 4674-1:—[1)], *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

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

ISO 6330:2000, *Textiles — Domestic washing and drying procedures for textile testing*

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

1) To be published. (Revision of ISO 4674:1977)

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

ISO 13934-2, *Textiles — Tensile properties of fabrics — Part 2: Determination of maximum force using the grab method*

ISO 15025:2000, *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*

EN 471:1994, *High-visibility warning clothing*

CIE 54.2-2001, *Retroreflection: definition and measurement*

3 Terms and definitions

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

3.1
cleaning cycle
wash and a drying cycle or dry-cleaning cycle

3.2
closure system
method of fastening the openings in the garment including combinations of more than one method of achieving a secure closure, for example a slide fastener covered by an overlap fastened down with a touch and close fastener

NOTE This term does not cover seams.

3.3
component assembly
combination of all materials of a multi-layer garment presented exactly as the finished garment construction

3.4
coverall
protective coverall
one piece garment that completely covers the wearer’s torso, arms and legs

3.5
firefighter's protective clothing
specific garments providing protection for the firefighther's upper and lower torso, neck, arms and legs, but excluding the head, eyes, hands and feet

3.6
garment
protective garment
single item of clothing which may consist of single or multiple layers

EXAMPLE Coat or shirt, trouser, or coverall

3.7
hardware
non-fabric items used in protective clothing including those made of metal or plastic

EXAMPLE Fasteners, rank marking, buttons, etc.

3.8
innermost lining
lining on the innermost face of a component assembly

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

3.9
interlining
layer between the outermost layer and the innermost lining in a multilayer garment

3.10
main seam
seam which is necessary for the integrity of the garment

3.11
material combination
material produced from a series of separate layers, intimately combined prior to the garment manufacturing stage

EXAMPLE Quilted material.

3.12
outer material
outermost material of which the protective clothing is made

3.13
seam
any method of permanent fastening between two or more pieces of material

3.14
suit
protective suit
an upper and lower garment worn together that completely covers the wearer's torso, arms and legs

3.15
wildland fire fighting
suppression action involving a fire in vegetative fuels such as forest, crops, plantations, grass or farmland

4 Clothing design

4.1 General

Protective clothing for firefighters shall consist of one of the following:

— a coverall;

— a suit provided with an interface area; or

— a number of inner and/or outer garments designed to be worn together.

4.2 Collar

Any collar shall be able to remain in the vertical position when it is set upright. All protective clothing which encircles the neck shall have a closure system at the level of the line of the collar.

4.3 Coverall or suit

The coverall or suit shall not have turn-ups or cuffs.

4.4 Pockets

All pockets with external openings shall be constructed entirely from the outer material and the external opening shall be provided with a closure system or covered with a protective flap.

4.5 Hardware

Hardware penetrating the outer material shall not be exposed on the innermost surface of the component assembly.

4.6 Retroreflective and/or fluorescent materials

Where retroreflective and/or fluorescent materials are attached to the clothing these materials shall meet the requirements in 6.1, 6.3 and 9.2.

NOTE Further guidance in clothing design is referenced in Annex A.

4.7 Sleeves

The end of the sleeves shall be designed to protect the wrist and shall have a closure system, all of which allow the end of the sleeve to interface sufficiently well with gloves that may be used for wildland firefighting.

5 Sampling and pretreatment

5.1 Sampling

Test specimens shall be taken so as to be representative of the material and the garment construction employed.

5.2 Number and size of test specimen

The number and the size of the test specimens for the different tests shall be in accordance with the respective International Standards.

5.3 Pretreatment before thermal tests

Carry out washing in accordance with ISO 6330:2000 Procedure 2A at (60 ± 3) °C and drying by Procedure E (tumble drying) or carry out the dry cleaning in accordance with ISO 3175-1 unless otherwise specified in the care labelling.

For materials with flame retardant treatment, excluding retroreflective and fluorescent materials, carry out the flame spread test (6.1) after 50 cleaning cycles.

For the other materials, carry out the tests after five cleaning cycles before testing to the thermal requirements (6.1, 6.2 and 6.3).

For materials which are labelled as dry-cleanable only, carry out the tests after five dry-cleaning cycles before testing to thermal requirements (6.1, 6.2 and 6.3).

5.4 Preconditioning

Prior to all tests and after having performed the pretreatment specified in 5.3, precondition the specimens in accordance with ISO 139 with the following modification: relative humidity (65 ± 5) %. Test the specimens within 5 min following their removal from the conditioning atmosphere.

5.5 Exposure surface

In all surface tests, test the outer surface.

6 Thermal requirements

6.1 Flame spread

6.1.1 General

Each material in the garment assembly, including retroreflective and fluorescent materials but excluding hardware, shall be tested separately using 6.1.2 and 6.1.3, following the appropriate cleaning specified in 5.3.

6.1.2 Face ignition

Carry out the flame spread test in accordance with ISO 15025:2000, Procedure A face ignition after the pre-treatment specified in 5.3 using the surface application procedure and a flame application time of 10 s. The following requirements shall be satisfied:

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

b) no specimen shall give hole formation;

c) no specimen shall give molten or flaming debris;

d) the mean value of the afterflame time shall be $\leqslant$ 2 s;

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

6.1.3 Edge ignition

Carry out the flame spread test in accordance with ISO 15025:2000, Procedure B edge ignition on a hemmed fabric specimen after the pre-treatment specified in 5.3 using the edge application procedure and a flame application time of 10 s. The following requirements shall be satisfied:

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

b) no specimen shall give hole formation;

c) no specimen shall give molten or flaming debris;

d) the mean value of the afterflame time shall be $\leqslant$ 2 s;

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

Prepare the hemmed fabric specimen in the same manner as it is used in the construction of the clothing. Fix the retroreflective and fluorescent materials with the bottom edge unstiched to the fabric specimen.

6.2 Heat transfer (radiation)

Test the single layer, the component assembly or multilayer clothing assembly, excluding any retroreflective or fluorescent materials. Carry out the tests after five cleaning cycles as specified in 5.3. When tested in accordance with Method B of ISO 6942:2002 with a heat flux density of 20 kW/m^2 the single layer, the component assembly or multilayer clothing assembly shall have the minimum level as following:

$t_{24} \geqslant 11$ s $\qquad T_F \leqslant 70$ % $\qquad t_{24} - t_{12} \geqslant 4$ s

where T_F is the heat transmission factor.

6.3 Heat resistance

Test each material including badges, patches, embroideries, hardware and closure systems, including retroreflective and/or fluorescent materials, separately. Carry out tests after five cleaning cycles as specified in 5.3. When tested in accordance with ISO 17493 at a temperature of (260 $\pm$ 5) °C, no material shall melt, drip, ignite or shrink $>$ 10 %.

Hardware, that is not in contact with the skin and is protected on the outside, shall be tested in accordance with ISO 17493 at a temperature of (180 $\pm$ 5) °C and shall not melt, drip, ignite and shall remain functional.

6.4 Heat resistance of the sewing thread

Specimens of the sewing threads shall be tested as received in accordance with the hot plate test in ISO 3146 and shall not melt at a temperature less than 260 °C.

7 Mechanical requirements

7.1 Tensile strength

When tested in accordance with ISO 13934-1, the outer material shall give a breaking load in both machine and cross direction:

$\geqslant$ 450 N

7.2 Tear strength

When tested in accordance with ISO 4674-1, at a rate of traverse 5 mm/s, the outer material shall give a tear strength in both machine and cross direction:

$\geqslant$ 20 N

7.3 Main seam strength

When tested in accordance with ISO 13934-2, the main seams in the outer garment shall give a seam strength:

$\geqslant$ 250 N

8 Ergonomic and comfort requirements

8.1 Thermal resistance

When tested in accordance with ISO 11092, the material or material combination shall give a thermal resistance:

$\leqslant$ 0,055 m^2·K/W

8.2 Water vapour resistance

When tested in accordance with ISO 11092, the material or material combination shall give a water vapour resistance:

$\leqslant$ 10 m^2·Pa/W

9 General requirements

9.1 Dimensional change after washing and/or dry-cleaning

Dimensional changes shall be measured in accordance with ISO 5077.

For garments labelled for washing only, carry out five washes in accordance with ISO 6330:2000 washing Procedure 2A with a drying cycle according to Procedure E.

For garments labelled as dry-cleanable, carry out five dry-cleaning cycles in accordance with ISO 3175-1.

The dimensional change shall not exceed 3 % in either the machine or cross-direction.

9.2 Retroreflective and/or fluorescent performance

When tested in accordance with 7.3 of EN 471:1994, using the CIE 54 measurement protocol, and following preconditioning according to the conditions established in 6.3, the retroreflective and/or fluorescent material shall have a coefficient of retroreflection $\geqslant$ 100 cd/(lx·m^2) with an entrance angle of 5° and observation angle of 12′.

10 Marking

Each garment shall be marked. The marking shall be on the garment itself or on a label permanently fixed on the inside of the garment and shall remain legible following 50 cleaning cycles.

The marking shall provide the following information:

a) name, trade mark or other means of identifying the manufacturer or its authorized representative;

b) designation of size;

c) materials employed;

d) care instructions indicated in accordance with ISO 3758;

e) conformity of the clothing with the requirements of ISO 15384;

f) lot or trace number.

11 Information supplied by the manufacturer

The protective clothing shall be strictly supplied to the client accompanied by instructions written at least in the official languages of the country of destination. All this information shall be clear. It shall comprise:

a) the name and address of the manufacturer or its authorized representative;

b) the designation of the product;

c) a reference to this International Standard, i.e. ISO 15384;

d) the mode of use:

— test to be carried out by the user before use, if necessary;

— the instructions explaining how to put on and take off the garment, if necessary;

— the limits of use (e.g. scale of temperatures);

— the storage and maintenance instructions;

— the instructions for cleaning and/or decontamination;

— the method of drying;

— a warning against problems which might arise, if necessary;

— any illustrations, if these might be useful;

— the type of packaging suitable for transport.

Annex A
(informative)

Guidelines for clothing design

Loose-fitting clothing is as important as the fire resistance of materials in preventing serious burn injury. Clothing that is tight-fitting poses a danger to the wildland firefighter from radiant heat and heat stress, while, at the same time, diminishing the firefighter's ability to perform.

Clothing should be light and flexible in order to be effective without inducing heat stress in the wearer.

As a guide, a suit should be provided with an interface area of at least a 15 cm overlap between them which should be maintained for example whilst stooping, reaching or turning movements.

Closure systems, any label, accessory, touch and close fastener, retroreflective and/or fluorescent material, etc. attached to the protective clothing should not adversely affect the clothing's performance.

Pocket flaps should be able to maintain pocket as being closed. As a guide a pocket flap may be 20 mm larger than the opening in order to avoid the flap being placed inside the pocket.

All closure systems should be designed to prevent the entry of burning debris.

Trousers should have a closure system which allows the ends of the trousers to interface sufficiently well with footwear that may be used for wildland firefigthing.

Firefighters should be trained in the use, care and maintenance of the protective clothing covered by this International Standard, including an understanding of its limitation.

Bibliography

[1] ISO 11613:1999, *Protective clothing for firefighters — Laboratory test methods and performance requirements*

[2] ISO 15538:2001, *Protective clothing for firefighters — Laboratory test methods and performance requirements for protective clothing with a reflective outer surface*

ICS 13.340.10

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