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**PPE ensembles for firefighters  
undertaking specific rescue  
activities —**

**Part 3:  
Clothing**

*Équipements de protection personnelle pour pompiers entreprenant  
des activités de sauvetage particulières —*

*Partie 3: Vêtements*

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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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

ISO 18639-3 was prepared by Technical Committee ISO/TC 94, *Personal Safety — Protective Clothing and equipment*, Subcommittee SC 14, *Firefighters Personal Equipment*.

A list of all the parts in the ISO 18639 series can be found on the ISO website.

## Introduction

ISO 18639 is a standard for personal protective equipment (PPE) for firefighters when engaged in specific rescue activities. It is not possible to provide a standard for PPE to cover all of the diverse range of rescue scenarios that firefighters are likely to encounter so it is important that risk assessments be undertaken to determine if the PPE covered by ISO 18639 is suitable for its intended use and the expected exposure to hazards. For complete protection against exposures, the risk assessment should include protection of the whole body including the torso, arms and legs, head, face, hands and feet.

For certain rescue activities, safety ropes and harnesses can be required. For certain rescue situations, special PPE for use in and on water may be required. In some cases, appropriate respiratory protection may also be identified as being necessary.

The performance requirements in this document take account of accidental exposure to heat and flame, but do not cover PPE for firefighting. While this standard takes account of accidental exposure to some common chemicals, it is not intended that PPE to this standard should be considered as providing chemical protection as a primary function. It does not cover PPE to protect against biological, electrical or radiation hazards. The risk assessment should determine whether PPE complying to this standard or to the requirements of any other relevant standard is more suitable.

Firefighters should be trained in the use, care and maintenance of the PPE covered by this document, including an understanding of its limitations.

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# PPE ensembles for firefighters undertaking specific rescue activities —

## Part 3: Clothing

### 1 Scope

This document specifies test methods and minimum performance requirements for protective clothing for firefighters while engaged in rescue activities.

Clothing related to specific rescue activities are documented in individual subclauses, see [6.2.1](#) or [6.2.2](#).

NOTE For further guidance see ISO 18639-1.

Subclauses of this document cover general clothing design, the minimum performance level of the materials used and the methods of test for determining this performance level.

This document does not cover special clothing for use in other high risk situations such as firefighting.

It does not cover protection for the head, hands and feet or protection against other hazards, e.g. chemical, biological, radiation and electrical hazards, except for limited, accidental exposure to some chemicals and contaminated blood or other body fluids.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1421, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 3175-1, *Textiles – Professional care, dry cleaning and wet cleaning of fabrics and garments – Part 1: Assessment of performance after cleaning and finishing*

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

ISO 4920, *Textile fabrics — Determination of resistance to surface wetting (spray test)*

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

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

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

ISO/TS 11999-2, *PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures — Part 2: Compatibility*

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

ISO 12947-2, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown*

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 14116, *Protective clothing — Protection against flame — Limited flame spread materials, material assemblies and clothing*

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

ISO 16604, *Clothing for protection against contact with blood and body fluids — Determination of resistance of protective clothing materials to penetration by blood-borne pathogens — Test method using Phi-X 174 bacteriophage*

ISO 18639-1, *PPE for firefighters undertaking specific rescue activities*

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

ISO 20471, *High visibility clothing — Test methods and requirements*

EN 1149-5, *Protective clothing — Electrostatic properties. Material performance and design requirements*

### **3 Terms and definitions**

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

#### **3.1 anti-wicking barrier**

material used to prevent the transfer of liquid from outside the garment to inside the garment, usually in addition to or replacing part of the moisture barrier at the edge(s)

#### **3.2 clothing assembly**

levels of performance specified in this document achieved by the use of a garment or a clothing assembly, which may contain multilayer materials, material combinations in single layers, or a series of separate garments

### **3.3 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.

### **3.4 closure system**

method of fastening openings in the garment including combinations of more than one method of achieving a secure closure

Note 1 to entry: This term does not cover seams.

### **3.5 component assembly**

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

### **3.6 conditioning**

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

### **3.7 drain mesh material**

permeable material designed to allow drainage of water between the moisture barrier and innermost lining

### **3.8 garment**

single item of clothing which may consist of single or multiple layers

### **3.9 hardware**

non-fabric items used in protective clothing including those made of metal or plastic, e.g. touch and close fasteners, buttons, zippers, embroideries, braces

### **3.10 high visibility trim**

material exhibiting separate performance or combined performance of retroreflective and fluorescent properties

Note 1 to entry: Retroreflective materials enhance night time visibility and fluorescent materials improve daytime visibility.

### **3.11 interface area**

area where two separate and adjacent items of PPE interface function together to provide continuity of protection and performance

### **3.12 innermost lining**

lining on the innermost face of a component assembly which is intended to be nearest 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.

### **3.13 interlining**

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

**3.14**

**material**

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

**3.15**

**material assembly**

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

**3.16**

**material combination**

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

**3.17**

**moisture barrier**

fabric or membrane used in a component assembly to achieve the properties of hydrostatic resistance with water vapour permeability

Note 1 to entry: Moisture barriers may not prevent the passage of some chemical (except incidentally), biological, or radiological agents. Appropriate PPE should be provided to protect the wearer in such instances.

**3.18**

**multilayer material**

material consisting of different layers intimately combined prior to the garment manufacturing stage, e.g. by weaving, quilting, coating or gluing

**3.19**

**outer garment**

outermost garment of the clothing that will be exposed to the hazard(s)

**3.20**

**outer material**

outermost material (i.e., outer shell) of which the clothing assembly is made, with the exception of trim, hardware, reinforcing materials and wristlet material

**3.21**

**overlapping seam**

any seam where all or parts of one or more layers of material cover any other layer or layers

**3.22**

**pre-treatment**

standard way of preparing the samples before testing

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

**3.23**

**rank markings**

symbol or colour coding system denoting the rank or position within the hierarchy of an organisation or group

EXAMPLE Embroideries, badges, patches, transfers.

**3.24**

**seam**

permanent fastening between two or more pieces of material

**3.25**

**structural seam**

seam which holds the outer garment together and which if broken would expose the under garments and reduce protection

**3.26****torso**

trunk of the human body, i.e. without arms, legs and head

**4 Design requirements****4.1 General**

The PPE shall provide protection to the wearer against general hazards encountered in rescue activities as well as protection against hazards specific to the individual specific rescue activities covered within sub sections of this document.

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

General requirements which are not covered in this document shall be in accordance with ISO 13688.

NOTE Consideration is given to the design and material make up of this rescue PPE, to maximize thermal metabolic stability of the rescuer. This is especially critical for International Search & Rescue Advisory Group (INSARAG) member nations whose rescuers can be deployed out of or into sub-zero conditions or extremely hot and high humidity areas and be involved in prolonged rescue incidents.

**4.2 Size designation**

Size designations shall be in accordance with ISO 13688.

**4.3 Type of clothing**

The levels of performance specified in this document may be achieved by the use of a garment or a clothing assembly, which may contain multilayer materials, material combinations in single layers, or a series of separate garments.

**4.4 Outer two piece suit**

Where protection to the requirements of this document is provided by an outer two piece suit, it shall be determined that an overlap between the jacket and trousers shall always be maintained as specified in ISO/TS 11999-2.

**4.5 External Pockets**

All external pockets and protective flaps shall be made from the same or equivalent material performance as the outer material of the garment. The pockets, except radio pockets shall have a closure system that shall completely cover and overlap the pocket opening.

All pockets shall be able of fastening the pocket closed. The flap shall be at least 20 mm wider than the opening (approximately 10 mm on each side) to prevent the flap from being tucked into the pocket.

Conformity shall be checked by visual inspection and physical measurement.

**4.6 Padding**

Where the outer garment contains padding, this shall be either permanently fixed to the garment or retained securely inside the garment, either in internally or externally accessible pockets. If externally accessible pockets, the opening shall be at the bottom and completely secured e.g. by touch and close fastener. Padding may be provided to protect the knee, elbow and shoulder areas. Where padding is provided it shall not detract from the performance requirements of the garment.

Conformity shall be checked by visual inspection.

#### 4.7 Closures

The distance between non-continuous closures (e.g. buttons and stud fasteners) shall be no greater than 150 mm. If zippers are used, the slide fastener shall be designed to lock when completely closed.

Sleeve openings may be provided with adjustments, cuffs may be provided with closures to reduce their circumference. The closure and any fold, which it creates, shall be on the underside of the cuff.

Neck openings shall be provided with closures.

Trousers or one-piece suits shall not have turned-up cuffs. They may have side slits, which shall have a means of closure and the slit and closure, shall be covered.

Conformity shall be checked by visual inspection and physical measurement.

#### 4.8 Hardware

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, and it shall not come into contact with the body.

Conformity shall be checked by visual inspection.

#### 4.9 Collar

The collar of the garments shall be designed to remain in the vertical position when closed around the neck but also be capable of being easily opened as required by the wearer.

Conformity shall be checked by visual inspection.

#### 4.10 Integrated personal protective equipment

Where interface areas are provided to incorporate other type of PPE (e.g. against falls from a height) those shall not decrease the protection level achieved by the clothing assembly.

Conformity shall be checked by visual inspection and compatibility check.

#### 4.11 Visibility and Conspicuity

Rescue outer garment shall have high visibility materials, which give all round visibility for operations in both day and night and reduced visual conditions (i.e. rain, fog, snow, dust or smoke). Having at least one band of high visibility material encircling arms, legs and torso of the garments shall ensure all around visibility. The minimum requirements for high visibility materials shall be as specified in [6.6](#).

NOTE ISO 20471 allows discontinuous arrangements for encirclement to a maximum of 100 mm.

### 5 Sampling and pre-treatment

#### 5.1 Sampling

Prior to sampling for each test specified in [Clause 6](#) and [7](#), the test specimen shall be pre-treated by cleaning and conditioned according to [5.2.1](#). For test specified in [6.3](#), [6.4](#) and [6.5](#), the test shall be carried out before and after pre-treatment according to [5.2.1](#), and conditioned according to [5.2.2](#).

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 they may also be cut from the material or materials as used in the component assembly. When using the clothing for samples, the samples shall be taken from evenly distributed areas through all the clothing so that all parts are tested.

## 5.2 Pre-treatment

### 5.2.1 Cleaning

Test samples shall be subjected to five cleaning cycles in accordance with the procedures of ISO 6330. Washing shall be carried out by procedure 4N (at  $40 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$ ) and drying by procedure F (tumble drying) unless otherwise specified in the care labelling.

Materials that are labelled as “dry-clean only” shall be dry-cleaned five times in accordance with ISO 3175-1.

### 5.2.2 Conditioning

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

## 6 Performance requirements

### 6.1 General classification

Clothing shall be classified as RTC or USAR by meeting the performance requirements as shown in [Table 1](#).

### 6.2 Summary requirements and classification

#### 6.2.1 Road Traffic Crash (RTC)

RTC clothing shall meet mechanical strength requirements as set out in [6.4](#), [6.5](#) and [6.6](#).

Additionally, RTC clothing shall meet the thermal requirements specified in [6.3](#).

#### 6.2.2 Urban Search and Rescue (USAR)

USAR clothing shall meet the requirements set out in [6.4](#), [6.5](#), and [6.3.1](#).

**Table 1 — Summary of requirements**

Requirements	RTC	USAR
Flame resistance <a href="#">6.3.1</a>	ISO 15025 Procedure A Index 3 of ISO 14116 except for innerlining Index 1	ISO 15025 Procedure A Index 3 of ISO 14116 except for innerlining Index 1
Radiant heat <a href="#">6.3.2</a>	ISO 6942 at $20 \text{ kW/m}^2$ RHT124 $\geq 7 \text{ s}$ .	—
Contact heat <a href="#">6.3.3</a>	ISO 12127-1 at $100^{\circ}\text{C}$ , $\geq 15 \text{ s}$	—

**Table 1** (continued)

Requirements	RTC	USAR
Tensile strength <a href="#">6.4.1</a> — outer material — seams	ISO 13934-1 (woven); ISO 1421 (coated) ≥450N ISO 13935-2 ≥360 N	ISO 13934-1 (woven); ISO 1421 (coated) ≥450N ISO 13935-2 ≥360 N
Tear strength <a href="#">6.4.2</a>	ISO 4674-1 (coated) ISO 13937-2 (non-coated) ≥25 N	ISO 4674-1 (coated) ISO 13937-2 (non-coated) ≥25 N
Abrasion resistance (rubs) <a href="#">6.4.3</a>	ISO 12947-1 at 12 kPa ≥20 000	ISO 12947-1 at 12 kPa ≥20 000
Dimensional change <a href="#">6.4.4</a>	ISO 5077 ≤3 %(woven fabric) ≤5 %(non-woven fabric or knitted)	ISO 5077 ≤3 %(woven fabric) ≤5 %(non-woven fabric or knitted)
Surface wetting <a href="#">6.5.1</a>	≤15 % ISO 4920 as amended by <a href="#">Annex A</a>	≤15 % ISO 4920 as amended by <a href="#">Annex A</a>
Electro-static resistance <a href="#">6.5.2</a>	EN 1149-5	EN 1149-5
Water vapour resistance <a href="#">6.5.3</a>	ISO 11092 ≤20 m <sup>2</sup> Pa/W	ISO 11092 ≤20 m <sup>2</sup> Pa/W
Visibility Requirements <a href="#">6.6</a>	ISO 20471	ISO 20471
Viral requirements <a href="#">6.7.1</a>	ISO 16604	ISO 16604

### 6.3 Thermal/arc requirements

#### 6.3.1 Flame resistance

Testing of materials and seams shall take place in accordance with ISO 15025 Procedure A.

This test shall be carried out both before and after the pre-treatment specified in [5.2](#).

##### 6.3.1.1 Testing in accordance with ISO 15025 Procedure A

When tested in accordance with ISO 15025 Procedure A, specimens from single layer outer fabric, innermost lining or composite, including seams on outer fabric, shall meet the requirements of ISO 14116 Index 3 (see [Table 1](#)). Results shall be evaluated when the specimens are on the test frame.

**Table 2 — Limited Flame Spread Performance Requirements (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 inner layer that is used for specific protection other than flame or heat 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.

NOTE [Table 1](#) and 2 taken from ISO 14116

For an interlining that is used for specific protection other than heat protection, ISO 14116 index 1 shall be met, see [Table 3](#).

**Table 3 — Intermediate layer not intended for thermal protection (Index 1)**

Properties	Requirements
Flame spread	No specimen shall permit any part of the lowest boundary of any flame or hole 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. 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

NOTE Such intermediate layers are only used for specific protection other than thermal protection, for example protection against liquid penetration and/or wind.

### 6.3.1.2 Hardware

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 or when the hardware is covered and when all closure systems in the garment are in the closed position, the hardware shall comply with Index 3 of [6.3.1](#). At least five minutes after completion of the test, it shall be verified that the closure system can be opened at least once.

### 6.3.1.3 Labels

Labels, badges, rank markings, high visibility trim, transfers, which are applied to the outermost surface of the garment, shall be tested only after the 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 Index 3 in [6.3.1](#). This requirement is not applicable for labels, embroideries or other added decorations with a surface area of less than 1 000 mm<sup>2</sup>.

### 6.3.2 Radiant heat transfer

The component assembly or clothing assembly when tested in accordance with ISO 6942 at a heat flux of 20 kW/m<sup>2</sup>, the radiant heat transfer index (RHTI for 24°C) shall be  $RHTI_{24} \geq 7$  s.

The number of specimens indicated in the document shall be tested and the performance classified according to the lowest single result, rounded to one decimal place.

During the test, should any of the materials ignite, glow, or give a hole formation, the test shall be considered as having failed.

### 6.3.3 Contact heat

The component assembly or clothing assembly, when tested in accordance with ISO 12127-1 at a temperature of 100 °C, shall have a threshold time,  $t_t$ , of a minimum of  $\geq 15$  s.

The number of samples indicated in this document shall be tested and the performance result shall be the lowest single result, rounded to one decimal place.

## 6.4 Mechanical protection requirements

### 6.4.1 Tensile strength

The outer material when tested in accordance with ISO 13934-1 for woven textiles or ISO 1421 method 1, for coated textiles, shall give a breaking load in both machine and cross direction  $\geq 450$  N.

The main seams of the outer material when tested in accordance with ISO 13935-2 shall give a maximum force to seam rupture  $\geq 360$  N.

### 6.4.2 Tear strength

The outer material shall give a tear strength in both machine and cross direction  $\geq 25$  N. Coated fabrics shall be tested in accordance with ISO 4674-1, method B, non-coated fabrics in accordance with ISO 13937-2.

### 6.4.3 Abrasion resistance

The outer material when tested in accordance with ISO 12947-2 at 12 kPa with crossbred worsted abradant shall achieve a minimum of 20 000 cycles, the end point will be two broken threads.

Checks of the sample material shall be carried out every 500 rubs above 10 000 rubs.

### 6.4.4 Dimensional change

The dimensional change shall be equal to or less than 3 % in both directions when tested in accordance with ISO 5077 after 5 cleaning cycles using the pre-treatment specified in [5.2](#).

Each single layer material or component assembly of a clothing assembly shall be tested separately.

The combination of materials in a component assembly shall be prepared so that the layers of material are sewn together around all four sides of the test sample; only one sample shall be tested.

The change in dimensions of knitted materials or non-woven materials shall not exceed 5 %.

## 6.5 Environmental Protection requirements

### 6.5.1 Surface wetting

Surface wetting, in accordance with ISO 4920, is performed on outer materials before and after five cleaning cycles without reimpregnation or ironing and shall give a spray rate of  $\geq 4$ .

This test is to be carried out, even if the garment has a moisture barrier.

The outer material fabric when tested in accordance with [Annex A](#), both before and after pre-treatment by laundering or dry cleaning as specified in [5.2](#) shall have a percent water absorption (PWA) of  $\leq 15$  %.

### 6.5.2 Electrostatic resistance

The outer fabric shall meet the requirements of EN 1149-5, when tested according to

- EN 1149-1, surface resistance shall meet the requirements  $\leq 2,5 \times 10^9 \Omega$ , on at least one surface, or
- EN 1149-3 Method 2, the decay time,  $t_{50}$  shall be  $< 4$  s or the shielding factor,  $S$  shall be  $> 0,2$ .

NOTE EN 1149-5 and the respective test methods can be substituted by other equivalent standards.

### 6.5.3 Water vapour resistance

The requirements for water vapour resistance shall be achieved by testing either the component assembly or the clothing assembly of single garments. Anti-wicking barriers, retro-reflective, or combined materials are excluded from this requirement. Testing shall be in accordance with ISO 11092 and shall achieve  $\leq 20 \text{m}^2 \text{Pa/W}$ .

## 6.6 Visibility requirements

The visibility requirements shall meet the retroreflective material requirements from ISO 20471.

## 6.7 Biological and chemical requirements

### 6.7.1 Viral requirements

The moisture management component including seams, when tested in accordance with ISO 16604, Method A (or B if a retaining screen is required) following pre-treatment of 25 wash cycles shall demonstrate 0 plaques.

Moisture management component seams shall be tested by preparing a 380 mm square sample of the component assembly with an extra layer of outer material against the innermost layer. The moisture barrier layer within the sample shall include a centre seam that extends across the entire 380 mm width of the sample.

The samples shall be stitched along the peripheral edge.

The samples shall first be subjected to pre-treatment by laundering or dry cleaning as specified in [5.2.1](#) and then be subjected to pre-treatment by oven exposure as specified in ISO 17493 at a temperature of  $140 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$  for 5 min, except that no measurement or observation shall be made.

This sequence of pre-treatments shall be repeated a second time. Testing following the last oven exposure shall take place within 5 min of the oven exposure.

Following the last pre-treatment, specimens shall be taken from the moisture management component seam for viral penetration resistance testing.