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Protective clothing — Protection against rain

Habillement de protection — Protection contre la pluie

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Foreword

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This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 13, *Protective clothing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In this document the measured properties of materials and seams of protective garments and their subsequent classification are intended to ensure an adequate protection level. Water proofness and water vapour resistance are the essential properties tested and marked on the label.

Water proofness is the most important property and it is measured on material of the outer garment layer. Tests are made on pretreated fabric samples and on parts with seams. A test method for an optional readymade garment test after cleaning is described (rain tower test).

Some waterproof materials are impermeable to water vapour transmission. However other materials on the market combine water proofness with water vapour permeability. This property expressed by low water vapour resistance enhances sweat evaporation and significantly contribute to body cooling. This is valuable, because it contributes to better comfort and less physiological strain and prolongs the wearing time in certain climatic conditions (see Annex A).

Protective clothing — Protection against rain

1 Scope

This document specifies requirements and test methods for the performance of materials and readymade garments for protection against the effects of precipitation (e.g. rain, snowflakes), fog and ground humidity. Garments for protection against other effects than precipitation (e.g. water splashes, waves) are excluded from this document.

The protective effects and requirements of footwear, gloves and separate headwear are excluded from the scope of this document.

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 811:2018, *Textiles — Determination of resistance to water penetration — Hydrostatic pressure test*

ISO 1421:2016, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 1817:2024, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 4674-1:2016, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 7854:1995, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing*

ISO 11092:2014, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*

ISO 12947-1:1998, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 1: Martindale abrasion testing apparatus*

ISO 12947-2:2016, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown*

ISO 13688:2013, *Protective clothing — General requirements*

ISO 13688:2013/Amd.1:2021, *Protective clothing — General requirements — Amendment 1*

ISO 13934-1:2013, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2:2014, *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 13938-1:2019, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*

ISO 13938-2:2019, *Textiles — Bursting properties of fabrics — Part 2: Pneumatic method for determination of bursting strength and bursting distension*

ISO 23388:2018, *Protective gloves against mechanical risks*

ISO 24231:2024, *Protective clothing — Protection against rain — Test method for ready-made garments against high energy droplets from above*

EN 530:2010, *Abrasion resistance of protective clothing material — Test methods*

3 Terms and definitions

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

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

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

— IEC Electropedia: available at https://www.electropedia.org/

3.1
water vapour resistance
R_{et}
water-vapour pressure difference between the two faces of a material divided by the resultant evaporative heat flux per unit area in the direction of the gradient

Note 1 to entry: It is a quantity specific to textile materials or composites, which determines the "latent" evaporative heat flux across a given area in response to a steady applied water-vapour pressure gradient. The evaporative heat flux can consist of both diffusive and convective components.

Note 2 to entry: The water-vapour resistance is expressed in square metres pascal per watt.

[SOURCE: ISO 11092:2014, 2.2]

3.2
water penetration resistance
W_p
property of a material to support the hydrostatic pressure based on the opposition to the passage of water through the material

[SOURCE: ISO 11610:2023, 4.6.9]

3.3
outer shell material
outermost shell material of which the garment is made

Note 1 to entry: Based on the definition of outer material, ISO 11610:2023, 4.3.27.

3.4
waterproof liner
liner with a waterproof property

3.5
waterproof thermal liner
thermal liner with a waterpoof property

3.6
lining
innermost lining
innermost layer of fabric or other material inserted in a garment which is intended to be nearest to the wearer's body

Note 1 to entry: Where the lining forms part of a quilted assembly, the quilted assembly shall be regarded as the innermost lining

Note 2 to entry: In this document, lining is without waterproof property.

[SOURCE: ISO 11610:2023, 4.3.7, modified — added Note 2 to entry]

4 Performance assessment and requirements

4.1 General requirements and innocuousness

4.1.1 General requirements

All the individual results of the specimens of a test shall meet the performance requirement. If a material exhibits differing behaviour for a property in the length and cross directions of the material, the resultant property value shall be the value obtained in the lesser performing direction. In the event that only one specimen fails, another set of specimens shall be tested and all the individual results of this second set of specimens shall meet the requirements. Otherwise, the sample is considered to have failed the requirement.

When tested in accordance with 5.2.1, the requirements according to ISO 13688:2013, 4.3.1, 4.3.2, 4.4.1 and the following requirements shall be met:

— all pockets shall be constructed to avoid water penetration inside the garment;

— closures, such as slide fasteners, fasteners, buttons etc. shall not open inadvertently.

If the protective clothing claims to have other protective properties, it shall also meet applicable requirements in relevant product standards.

For material testing the application of the single tests to each component is shown in Table 1.

Hoods are not a mandatory part of rain protection clothing. If a hood is part of the rain protection garment, and the rain protection garment claims the optional requirement given in Table 4, wicking length on hood hems shall be tested and reported.

NOTE Protective clothing against rain typically consist of the outermost shell of a garment ensemble containing additional layers underneath. It has been demonstrated that the garment layers underneath can support the overall breathability and comfort if they provide a moisture management capability.

Table 1 — Application of performance tests on the components

Property	Reference subclause	Outer shell material	Waterproof liner or waterproof thermal liner	Lining
Water penetration resistance [a] (before and/or after pretreatment)	4.2	X	X	—[d]
Water vapour resistance [b]	4.3	X	X	X
Tensile strength	4.4	X (wovens)	—	—
Tear resistance	4.5	X (wovens)	—	—
Bursting strength	4.6	X (knits)	—	—
Dimensional change [c]	4.7	X	X	X
Seam strength	4.8	X	—	—

[a] The outer shell or liner material with any applied waterproof layers shall be tested together.

[b] All layers to be tested together.

[c] Materials to be tested separately.

[d] "—" means: no requirement.

4.1.2 Innocuousness

When tested in accordance with 5.2.2 the requirements of ISO 13688:2013, 4.2 and as impacted by ISO 13688:2013/Amd.1:2021, shall be met with regard to innocuousness.

4.2 Water penetration resistance, W_p

When tested in accordance with 5.4, resistance to water penetration W_p shall be in accordance with Table 2.

For each class all requirements given in Table 2 shall be met.

If specimens from the garment get different classes of classification in the different tests for marking in accordance with Clause 7, the lowest value of water penetration from all specimens shall be used to classify the garment.

Table 2 — Classification of water penetration resistance

Water penetration resistance W_p	Class			
	1	2	3	4
Specimen to be tested — material before pretreatment	$W_p \geq 8\,000$[a] Pa	—[b]	—	—
— material after each pretreatment (see 5.3.2 to 5.3.5)	—	$W_p \geq 8\,000$ Pa	$W_p \geq 13\,000$ Pa	$W_p \geq 20\,000$ Pa
— seams before pretreatment	$W_p \geq 8\,000$ Pa	$W_p \geq 8\,000$ Pa	$W_p \geq 13\,000$ Pa	no test required
— seams after pretreatment by cleaning (see 5.3.2)	—	—	—	$W_p \geq 20\,000$ Pa

[a] 1 000 Pa is approximately 102 [mmH_2O].

[b] "—"means: no test required.

4.3 Water vapour resistance, R_{et}

WARNING — All classes can result in a restricted wearing time, see Annex A.

When tested in accordance with 5.5, water vapour resistance R_{et} of all layers of the garment in combination shall be in accordance with Table 3.

Table 3 — Classification of water vapour resistance

Water vapor resistance R_{et}	Class			
	1	2	3	4
$\frac{m^2 \cdot Pa}{W}$	R_{et} >40	25< R_{et} ≤40	15< R_{et} ≤25	R_{et} ≤15

4.4 Tensile strength of the woven outer shell material

When tested in accordance with 5.6, the outer shell material shall withstand a minimum tensile force of 450 N in both orthogonal directions of the material. For materials with an elongation of more than 50 % this requirement is not applicable.

4.5 Tear resistance of the woven outer shell material

When tested in accordance with 5.7 the outer shell material shall withstand a minimum tearing force of 20 N in both orthogonal directions of the material.

4.6 Bursting strength of the knitted outer shell material

When tested in accordance with 5.8 the knitted outer shell material shall withstand a minimum bursting strength of 100 kPa for the 50 cm^2 test area or 200 kPa for the 7,3 cm^2 test area.

4.7 Dimensional change of the materials

When tested in accordance with 5.9 and as specified in Table 1, the dimensional change in both orthogonal directions shall not exceed ±3 % for woven materials and shall not exceed ±5 % for knitted materials after five washing or dry-cleaning cycles according to 5.3.2.

4.8 Seam strength of the outer shell material

When tested in accordance with 5.10, the seam strength of the outer shell material shall be at least 200 N. For materials with an elongation of more than 50 % this requirement is not applicable.

4.9 Waterproofness of a readymade garment (optional)

When tested in accordance to 5.11, the following requirements for the garments shall be met.

Table 4 — Requirements for waterproofness of readymade garment

Wicking length[a] on sleeves and lower hems	max. 5 cm
Wicking length[a] on trouser hems	max. 10 cm
Wicking length[a] on hood hems	max. 4 cm
Wicking tricot area[a] on manikin	0 cm^2
[a] Measurement of wicking length starts at the last stitching.	

5 Test methods

5.1 Sampling principles

Specimens shall be taken from the garment or, if this is not possible, from the material used in the finished garment. Size and shape shall be as required for each test procedure.

5.2 Testing related to general requirements and innocuousness

5.2.1 Testing related to general requirements

Testing related to general requirements shall be carried out in accordance with ISO 13688:2013, Annex C.

5.2.2 Innocuousness

The innocuousness of the protective garment shall be tested according to ISO 13688:2013, 4.2 and as impacted by ISO 13688:2013/Amd.1:2021.

5.3 Pretreatment

5.3.1 General

The specimens with pretreatment requirements in Table 2 shall be pretreated according to 5.3.2 to 5.3.5.

5.3.2 Pretreatment by cleaning

Four specimens of the material and four specimens with seams constructions in the middle of the specimen shall be cleaned (see Table 1 footnote a).

Cleaning shall be performed on specimens from garment materials in line with the manufacturer's instructions for cleaning for the garment on basis of standardized processes.

If the number of cleaning cycles is not specified, the tests shall be carried out – in case of laundering after five laundering cycles (one laundering cycle consisting of one washing and one drying), or – in case of dry cleaning after five cycles of dry cleaning.

If the manufacturer's instructions indicate that both cleaning methods are allowed, the test specimen shall undergo the laundering procedure only.

NOTE Manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330, ISO 15797, ISO 3175-2 and a qualification label according to ISO 30023 or equivalent as standardized processes for cleaning.

5.3.3 Pretreatment by abrasion

Four specimens shall be submitted to pretreatment by abrasion. The pretreatment shall be carried out on the outer face of the outer shell material but with all materials of the garment assembly combined with any applied waterproof layer.

Except for outside coated shell materials, pretreatment shall be carried out in accordance with EN 530:2010, Method 2, with the following specifications:

— abradant in accordance with ISO 23388:2018, Annex A;

— pressure to the specimen: (9,0 ± 0,2) kPa;

— number of cycles: 1 000; remove debris after 500 cycles;

— abradant replacement after each pretreatment.

For outside coated shell material pretreatment shall be carried out in accordance with ISO 12947-1:1998 and ISO 12947-2:2016, with the following specifications and modifications:

— abradant: standard woolen cloth in accordance with ISO 12947-1:1998;

— the abradant is mounted in the upper sample holder; the specimen to be tested is mounted in the lower (larger) sample holder;

— pressure to the specimen: (9,0 ± 0,2) kPa;

— number of cycles: 25 000; remove debris after 10 000 cycles;

— abradant shall be replaced after each pretreatment.

5.3.4 Pretreatment by repeated flexing

Pretreatment shall be carried out on the lines of ISO 7854:1995, method C, and with the following deviations:

— two specimens shall be tested in longitudinal direction;

— two specimens shall be tested in cross direction;

— number of cycles shall be 9 000.

5.3.5 Pretreatment with fuel and oil

Two specimens shall be submitted to pretreatment with fuel and two specimens shall be submitted to pretreatment with oil in accordance with ISO 1817:2024. The specimens consisting of the outer shell material combined with any applied waterproof layer shall be arranged in the modified apparatus of ISO 1817:2024 (see Figure B.1) in such a way that the surface to be tested faces upwards and is in direct contact with the test agent.

The test vessels shall be made of materials that are resistant to the test agent.

They shall be tight enough, when closed, to prevent diffusion to ambient atmosphere.

Test agents:

a) Liquid A: Isooctane (2,2,4-trimethylpentane), percentage by volume 100 %; in accordance with ISO 1817:2024;

b) Liquid F: Test oil: straight-chain paraffins (C12 to C18), 80 % by volume and 1-methylnaphthalene, 20 % by volume in accordance with ISO 1817:2024;

— quantity of test agents: (50 ± 5) ml;

— test temperature: (20 ± 2) °C;

— duration of exposure: 60 min.

After removal of the specimens from the test device, any test agent remaining on them shall be carefully removed with absorbent filter paper.

The test for water penetration resistance shall be carried out directly after the removal of any test agent, and be initiated within 10 min.

5.4 Water penetration resistance, W_p

Four specimens of the material and four specimens with seams constructions in the middle of the specimen shall be tested in accordance with ISO 811:2018, Clause 9, but with an increase of water pressure of (980 ± 50) Pa/min. The lowest single value in Pa on penetration of the first water drop on the specimen shall be noted.

If due to the nature of the tested material the first drop is not visible, use an absorbent filter paper wipe gently test surface to indicate water being absorbed to the filter paper.

5.5 Water vapour resistance, R_{et}

Three specimens shall be tested in accordance with ISO 11092:2014.

5.6 Tensile strength

Testing (e.g. of coated fabrics) shall be in accordance with ISO 1421:2016, Method 1. Two sets of specimens shall be tested, one set in the longitudinal direction and the other in the transverse direction. Each set shall consist of five specimens. If there are difficulties such as separation of edge threads testing shall be carried out in accordance with the method as given in ISO 13934-1:2013.

5.7 Tear resistance

Testing shall be in accordance with ISO 4674-1:2016, Method A. Two sets of specimens shall be tested, one set in the longitudinal direction and the other in the transverse direction. Each set shall consist of five specimens. The testing speed of the moving jaw is (100 ± 10) mm/min.

5.8 Bursting strength

Testing shall be in accordance with ISO 13938-1:2019 or ISO 13938-2:2019. When testing in accordance with ISO 13938-1:2019 or ISO 13938-2:2019, five specimens shall be selected. The result as specified in the test standard shall be noted.

5.9 Dimensional change after cleaning

One specimen shall be tested in accordance with the testing procedures for dimensional change on materials according to ISO 13688:2013, 5.3 and as impacted by ISO 13688:2013/Amd.1:2021.

5.10 Testing of seam strength

Three specimens from straight seams obtained from the protective garment shall be tested in accordance with the principles of ISO 13935-2:2014. The result as specified in the test standard shall be noted.

5.11 Testing the waterproofness of a readymade garment (optional)

The readymade garment shall be tested according to ISO 24231:2024. One specimen shall be pretreated as described in 5.3.2 for the maximum number of cleaning cycles indicated by the manufacturer.

If only single garments like trousers or jackets are tested, or if a jacket has no hood, the manikin shall be covered in the remaining parts by means of waterproof materials.

Wicking effects occur when water is absorbed and transported along the lower hems to the inside of the garment due to capillary effects.

Wicking effects do not necessarily cause wet areas on the tricot in the standard test procedure but will cause wet sensation for the wearer in use.

6 Size designation

The size designation shall be in accordance with ISO 13688:2013, Clause 6 and as impacted by ISO 13688:2013/Amd.1:2021.

7 Marking and care labelling

Marking and care labelling shall be in accordance with ISO 13688:2013, Clause 7 and as impacted by ISO 13688:2013/Amd.1:2021.

The pictogram indicating that protection against rain is offered shall be as in Figure 1 with the appropriate performance levels added:

ISO 24232
Y water penetration resistance class
Y water vapour resistance class
R readymade garment rain tower test, optional

Figure 1 — Pictogram for water penetration resistance, water vapour resistance and optional readymade garment (ISO 7000-2413, Protection against foul weather)

NOTE R will be replaced with X if the garment has not been tested.

8 Information supplied by the manufacturer

The information supplied with the protective garment shall be in accordance with ISO 13688:2013, Clause 8, and shall provide the following additional information:

— product designation;

— how to put on and take off, if relevant;

— usage and storage of hoods, if applicable;

— whether the requirements according to 4.9 for readymade garment have been met, if applicable;

— basic information on possible uses and where detailed information is available, state the source;

— if cleaning cycle was not specified in the care labelling, information should be provided that the requirements according to 4.2 and 4.9 (if applicable) was met after 5 cleaning cycles;

— a warning that the lifetime of the garment is not only affected by cleaning but will also depend on usage, care, storage, etc.;

— if water vapour resistance class is equal to 1 the following warning shall be given as follows:

WARNING — Restricted wearing time according to the following table:

Temperature of working environment	25 °C	20 °C	15 °C	10 °C	5 °C
Wearing time min	60	75	100	240	—

NOTE The R_{et} of class 1 garments can be much higher than 40 m^2·Pa/W which means that especially those garment materials are almost not breathable. Therefore, a warning is considered necessary.

This table is valid for medium physiological strain M = 150 W/m^2, standard man, at 50 % relative humidity and wind speed v_a = 0,5 m/s.

Annex A
(informative)

Recommendations for wearing time

Table A.1 gives recommendation to illustrate the effect of water vapour permeability on the recommended continuous wearing time of a garment in different ambient temperatures.

Table A.1 — Recommended maximum continuous wearing time (min) for a complete suit consisting of jacket and trousers without additional lining for thermal insulation

Temperature of working environment °C	Class			
	1	2	3	4
	R_{et} >40 m^2Pa/W	25< R_{et} ≤40 m^2Pa/W	15< R_{et} ≤25 m^2Pa/W	R_{et} ≤15 m^2Pa/W
25	60	105	180	—[a]
20	75	250	—	—
15	100	—	—	—
10	240	—	—	—
5	—	—	—	—

[a] "—"means: no limit for wearing time.

Table A.1 is valid for medium physiological strain M = 150 W/m^2, standard man, at 50 % relative humidity and wind speed v_a = 0,5 m/s.

With effective ventilation openings and/or break periods the time for wearing can be prolonged.