International Standard

ISO 24231

First edition
2024-04

Protective clothing — Protection against rain — Test method for ready-made garments against high-energy droplets from above

Habillement de protection — Protection contre la pluie — Méthode d'essai pour les vêtements prêts-à-porter contre les fortes précipitations

Reference number
ISO 24231:2024(en)

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Published in Switzerland

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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).

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Protective clothing — Protection against rain — Test method for ready-made garments against high-energy droplets from above

1 Scope

This document specifies a test method for determining the liquid tightness of clothing for protection against rain, using a static manikin exposed to large amount of high energy droplets from above. It is applicable to the testing of jackets, trousers, coats and one- or two-piece suits.

This document is not applicable to the testing of garments for resistance to other weather conditions, e.g. snow, hail-, or strong winds.

NOTE For general background of the rain simulation, see Annex A.

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 11610, *Protective clothing — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11610 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 https://www.electropedia.org/

4 Principle

A manikin with the shape and size of an adult person wearing long underwear made of absorbent fabric is dressed in the protective garment to be tested and exposed to large amount of high energy droplets from above for a specific period. After the exposure the underwear and the inner side of the protective garment are visually inspected for wet areas. In addition, sensors on the manikin may be used in order to detect the timing of water ingress at individual sites.

5 Apparatus

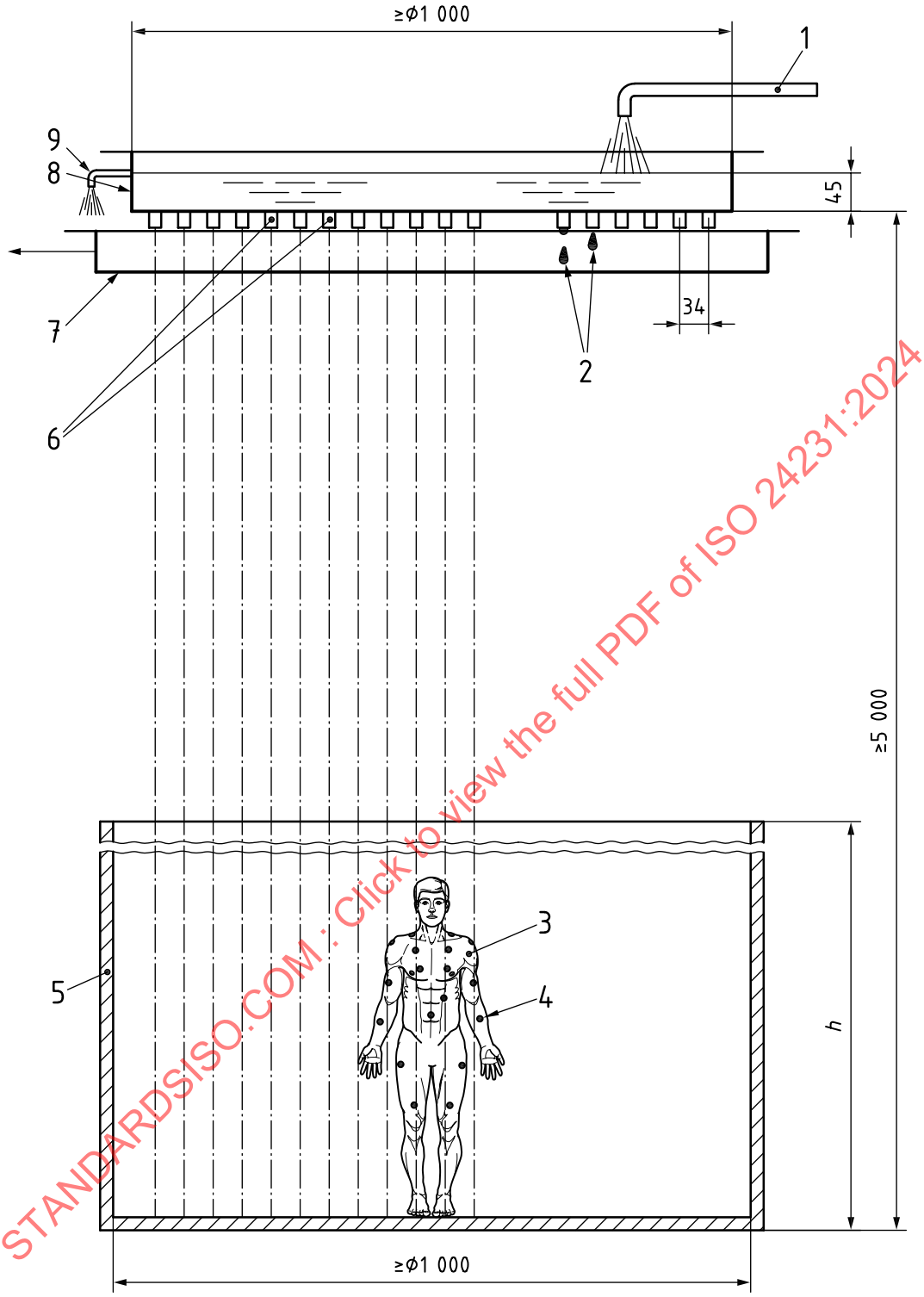
5.1 Tower device, (as shown in Figure 1) comprising a circular tub at least 1 000 mm in diameter supported at least 5 000 mm above the floor and supplied with water from an inflow pipe. The base of the tub shall be fitted with approximately 682 nozzles with a hole diameter of 0,6 mm placed at 34 mm centres to deliver water droplets over a circular area with a diameter of 932 mm at a density of approximately 1 000 droplets/m^2. The tub shall have an overflow pipe placed to maintain a water depth of (45 ± 5) mm in the tub. The tower device shall be shielded to eliminate the effect of wind on the water droplets.

NOTE The diameter of the water droplets corresponds to those described in ISO 9865, (~5 mm). The amount of water is (450 ± 50) l/(m^2h) (see Figure 1).

To prevent water from the atmosphere condensing inside the garment the water temperature should be the same as the air temperature in the room in which the test is conducted within ±5 °C.

To prevent a blockage of the nozzles, water with low calcium content should be used.

Dimensions in millimetres



Key

1 water filling pipe
2 droplets
3 manikin
4 sensors
5 protection wall
6 nozzles
7 movable tub
8 water tub
9 overflow pipe

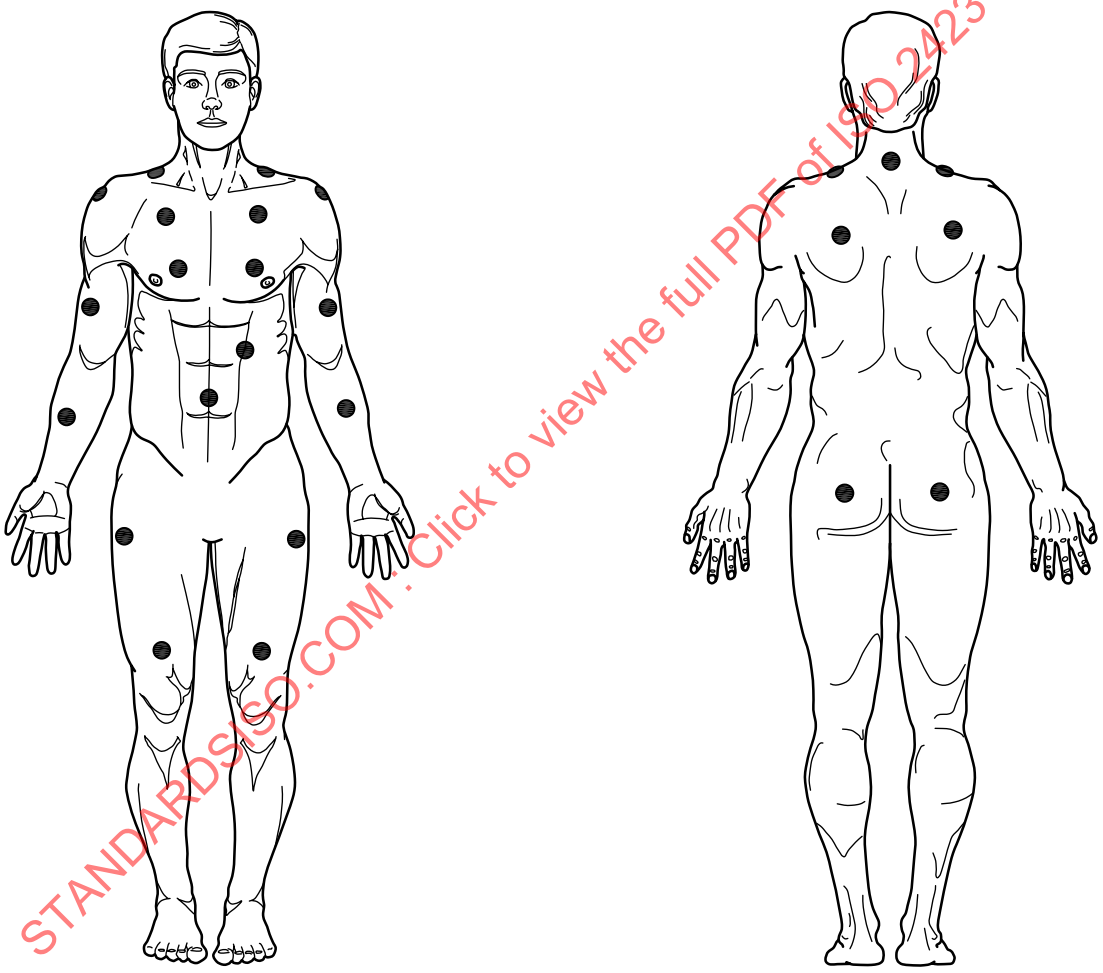
Figure 1 — Example of a tower device

5.2 Thermometers, one in the room in which the test is to be carried out to measure the air temperature and one immersed in the tub to measure the temperature of the water.

5.3 Manikin, with the shape of an adult person, (1 820 ± 40) mm tall and with a chest girth of (1 000 ± 60) mm, comprising a head, torso, abdomen, buttocks, arms, hands, straight legs and feet. The arms shall be moveable to make putting on the garment easier.

5.4 Underwear to fit manikin, comprising an undershirt with long sleeves and underpants with long legs. For testing of jackets with a hood, the undershirt shall have a hood. The underwear shall be made of water absorbent fabric (e.g. washed cotton). When the underwear is tested in accordance with Annex B, the mean time for the drops to be wicked into the fabric shall be not greater than 2 s.

5.5 Optional humidity sensor, connected to a recording system. The humidity sensors shall be placed either on the manikin at convex places or on the underwear. Figure 2 shows a possible position of the sensors. The most critical locations are: shoulder, chest, wrist, back, abdomen (zipper) and shoulder blade.



a) Front view **b) Rear view**

Figure 2 — Position of humidity sensors on the manikin

6 Dressing and positioning the manikin

If only a single piece is to be tested, the manikin has to be fully dressed:

a) jacket testing in combination with any appropriate water tight trousers;

b) trousers testing in combination with any appropriate water tight jacket.

The manikin shall be dressed with the underwear (5.4) and the protective garment of a size adequate to the manikin. Any zippers, fastening elements and pockets shall be closed. The draw-cord at the hem of the jacket, if fitted, shall be pulled tight. If the jacket has a hood this shall be put on the manikin's head in the normal wearing position, with any draw-cord pulled tight. If the jacket does not have a hood, the head of the manikin shall be covered with a plastic bag in order to prevent water wicking through the collar inside the jacket. The plastic bag shall not cover the seams in the neckline. If during testing it is found that there is water ingress around the face or through the hood, additional tests shall be carried out with the head and hood covered by plastic bag. If the lower ends of the trouser legs are adjustable, they shall be adjusted to the tightest position. The hem area of sleeves and body of the undershirt and the legs of the underpants shall be adjusted to finish about 45 mm above the ends of the jacket and trouser legs, respectively, to prevent water wicking into the underwear at the wrists or ankles.

The manikin shall be adjusted so that it is leaning backwards at an angle of (5 ± 2)° to the vertical.

NOTE This is because the critical area of a jacket with regard to water ingress is normally the zipper fastener.

One arm shall be angled backwards and the other arm shall be angled forwards, each at an angle of (25 ± 5)° to the true vertical.

7 Test procedure

The test sample is positioned on the manikin, the water filling pipe is opened, and the water tub is filled until the overflow pipe is active. The nozzles are opened, and the test begins. Test duration is one hour unless otherwise specified. After the test the sample is allowed to drain for two minutes. Remove the test sample with care to avoid water contacting the underwear. Examine the inner surface of the test sample. Measure the surface of all wetted areas on the underwear and determine the wicking length according to the relevant product standard. A minimum of two separate specimens per type of protective garment shall be tested. If one specimen fails, then a third specimen shall be tested. If only one test sample is available, the same test sample shall be tested twice. The test sample shall be suspended unfolded and shall be dried and conditioned as indicated in B.6.2 before the next test starts.

NOTE The product standard may specify a greater number of tests. A repetition test of the same specimen can influence the test results. Normally the second test of the same specimen shows a greater water ingress due to the worse repellency.

8 Test report

The test report shall include the following information

a) a reference to this document, i.e. ISO 24231:2024;

b) identification/description of the test sample;

c) size of the protective garment;

d) test temperature, pre-treatment if relevant;

e) for each sample tested, the location of wet areas on the inner side of the protective garment, and wicking length(s) according to the relevant product standard. The total wet area on the underwear and details of the size and location of wet areas. Wet areas should preferably be indicated by shading on diagrams of a human figure (front and back views) or by photographs of the front and back of the manikin.

f) details of the timing of water ingress obtained from the humidity sensors, if available;

g) date of testing;

h) any deviations from the method given in this standard;

i) any qualifying remarks and observation (e.g. the pocket filled with water, visible changes in water repellency);

j) any areas covered with plastic bags (hood etc.);

k) the number of specimens tested.

Annex A
(informative)

General background to the rain simulation

This document has been prepared to achieve a common basis for rain shower testing for protective clothing against rain, in particular in the interests of manufacturers, test houses and end-users. The rain-proof properties are tested on the complete garment especially to check design features under non-dynamic conditions.

The pre-treatment and the pass-fail criteria have to be specified in the specific type of garment (e.g. maximum wicking length on sleeves and lower hems, etc).

Some meteorological data on amounts of rainfall and size of raindrops are given here to allow a comparison between the artificial rain used in the test and natural rain.

The mean amount of precipitation in many places in Central Europe is 500 mm to 1 000 mm (500 l/m^2 to 1 000 l/m^2) per year. Peak values in the Alps can reach more than 3 000 mm per year. A cloudburst is defined as especially heavy rain during which the water falling is at least 1 $l/m^2\ min^{-1}$. During such a cloudburst in Central Europe, a substantial part of the annual precipitation can fall within less than an hour. However, rainfall of more than 1 $l/m^2\ min^{-1}$, is rare. In tropical regions, values may exceed 600 $l/m^2\ min^{-1}$ in certain cases.

The velocity of rain drops with a diameter of 5 mm is about 9 m/s at a falling height of 10 m.

Although the amount of water for this rain tower test is high, a garment with a good material, design and properly sealed seams can easily remain dry inside after one hour of cloudburst rain. The advantage of a higher rain intensity is that leakages appear quicker and the rain duration time can be reduced.

The results of comparative testing[1] have shown that the same ranking could be established for the water tightness of the jackets under test, when the tests were repeated by the same or by another test house. The wet areas were similar. The repeatability of rain test results with regard to the wet areas is influenced by a number of factors, including the fit and creasing of the test garment on the manikin as well as positioning and size of the manikin and the treatment of the jacket. Additional tests of the same specimen can increase the water ingress due to the wash out of the hydrophobic water repellent treatment.

Annex B
(normative)

Absorbency of bleached textiles

B.1 Purpose and scope

Absorbency is one of several factors that determine the suitability of a fabric for a particular use, as in the case of gauze or towelling. It is important in fabrics that are to be dyed, since the completeness and uniformity of the dyeing are dependent upon the absorbency. Where fabrics are to be given resin or other specialised finishes, absorbency is a factor to be considered. Wettability or absorbency of textile fabrics or yarns can be determined by this test method[1].

NOTE Refer to AATCC test method 79-2007 for more information.

B.2 Principle

A drop of water is allowed to fall from a fixed height onto the taut surface of a test specimen. The time required for the specular reflection of the water drop to disappear is measured and recorded as wetting time.

B.3 Terminology

Absorbency, the propensity of a material to take in and retain a liquid, usually water, in the pores and interstices of the material.

B.4 Safety precautions

These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers should be consulted for specific details such as material safety data sheets and other manufacturer's recommendations.

Wear safety glasses in all laboratory areas.

B.5 Apparatus

B.5.1 Embroidery hoop, with a diameter of 15 cm or more.

B.5.2 Burette, delivering 15 drops to 25 drops of water per millilitre.

B.5.3 Stop watch.

B.5.4 Burette stand.

B.6 Test specimen

B.6.1 A swatch or skein of bleached material can be used for this test, as long as the specimen can be spread tightly over an embroidery hoop.