



**International  
Standard**

**ISO 17491-4**

**Protective clothing — Test methods  
for clothing providing protection  
against chemicals —**

**Part 4:  
Determination of resistance to  
penetration by a spray of liquid  
(spray test)**

*Habillement de protection — Méthodes d'essai pour les vêtements  
fournissant une protection contre les produits chimiques —*

*Partie 4: Détermination de la résistance à la pénétration par  
pulvérisation de liquide (essai au brouillard)*

**Second edition  
2024-05**

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Published in Switzerland

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## Foreword

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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 document 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)).

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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).

This second edition cancels and replaces the first edition (ISO 17491-4:2008), which has been technically revised. It also incorporates the Amendment ISO 17491-4:2008/Amd.1:2016.

The main changes are as follows:

- specifications for test liquid have been revised/added;
- [Clause 6](#) has been revised to provide more specificity. Specification have been changed and/or revised for absorbent overall, calibrated stain, turntable, spray booth, spray boom, hydraulic nozzles in [Clause 6](#) and other applicable clauses;
- details for the selection of the right overall size have been added in [6.10](#) as well as in [Annex B](#);
- [8.3](#) has been revised and heading changed to “Distribution of the spray liquid and alignment of spray nozzles.”;
- figure and additional information have been added in [9.1](#) to provide more specificity;
- inclusion of [Annex A](#) on absorbent fabric for the detector suit and non-absorbent fabric for the calibration pattern;
- inclusion of [Annex B](#) on test subject size measurement and right overall size fitting;
- inclusion of [Annex C](#) on right donning and doffing, as well as stain area measurement;
- inclusion of [Annex D](#) with the ILT results.

A list of all parts in the ISO 17491 series can be found on the ISO website.

## ISO 17491-4:2024(en)

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](http://www.iso.org/members.html).

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## Introduction

This document describes a test method for determining the spray penetration resistance of chemical protective clothing Type 4 (with spray-tight connections between different parts of the clothing and, if applicable, between the clothing and other items of personal protective equipment) and Type 6 (limited performance protective clothing).

Such clothing comprises one or more items covering the full surface of the body and is intended to be worn under conditions where there is a risk of exposure to a spray of a liquid chemical. Other requirements with regard to this type of clothing and its constituent materials can be found in the respective product standards<sup>[1]</sup>.

Interlaboratory testing has shown that this test method is a repeatable pass/fail method.

A document on the selection, use and maintenance of chemical protective clothing is available<sup>[2]</sup>.

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# Protective clothing — Test methods for clothing providing protection against chemicals —

## Part 4: Determination of resistance to penetration by a spray of liquid (spray test)

**CAUTION** — Some of the procedures specified in this document involve the use of processes which could lead to hazardous situations and hence appropriate precautions should be taken.

### 1 Scope

This document specifies the test method for determining the resistance of chemical protective clothing to penetration by sprays of liquid chemicals at two different levels of intensity:

- a) Method A: low-level spray test. This is applicable to clothing that covers the full body surface and is intended to be worn when there is a potential risk of exposure to small quantities of spray or accidental low-volume splashes of a liquid chemical.
- b) Method B: high-level spray test. This is applicable to clothing with spray-tight connections between different parts of the clothing and, if applicable, between the clothing and other items of personal protective equipment, which covers the full body surface and which is intended to be worn when there is a risk of exposure to sprayed liquid chemical.

This document does not apply to chemical permeation resistance of the materials from which the chemical protective clothing is made.

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### 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 and the following 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

##### **absorbent overall**

overall made from an absorbent material, worn under the test suit and intended for collecting liquid penetration during spray and jet testing of chemical protective clothing

### 3.2 calibrated stain

visible stain, with a defined minimum area, generated by dropping a specified quantity of test liquid on to an absorbent overall (3.1)

Note 1 to entry: The calibrated stain is used to measure liquid penetration during spray and jet testing of chemical protective clothing.

## 4 Principle of test method

An aqueous spray, containing a visible dye tracer, is directed under controlled conditions at the chemical protective clothing worn by a human test subject. Inspection of the inside surface of the clothing and the outside surface of the absorbent overall worn under the test garment allows any points of inward leakage to be identified.

An interlab was performed and the results and conclusion can be found in [Annex D](#).

## 5 Test liquid

To prepare the test chemical add methyl blue dye and dye stabilizer prior to adding the surfactant to water. The temperature of the test liquid shall be between 20 °C and 30 °C.

For methods A and B, the concentration of the methyl blue dye (CAS number 28983-56-4) shall be  $(0,2 \pm 0,02)$  g/l. The dye stabilizer shall be analytical grade citric acid (CAS number 77-92-9) with a concentration of  $(2,45 \pm 0,05)$  g/l.

The surfactant is then added to achieve the required surface tension. Mixtures such as dish washing detergent that include other ingredients are not considered surfactants and shall not be used.

a) For method A: a surface tension of  $(52,0 \pm 7,5) \times 10^{-3}$  N/m;

b) For method B: a surface tension of  $(30,0 \pm 5,0) \times 10^{-3}$  N/m.

NOTE 1 Surfactants: Genapol LRO liquid<sup>1)</sup> [sodium lauryl ether sulfate (CAS number [009004-82-4])] that can be used to achieve the required surface tension at the concentration of 0,03 ml/l for method A and 0,5 ml/l for method B. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the products named. Equivalent products can be used if they can be shown to lead to the same results.

NOTE 2 To measure the surface tension within the stated tolerance, any suitable method can be used, e.g. a wright torsion balance using a standard 12 mm diameter platinum ring.

It shall be ensured that the surface tension and temperature of the test liquid are stable throughout the test, i.e., the surface tension of the liquid leaving the nozzle as well as the tension of the liquid in the tank shall meet the requirements. This shall be verified before and after each day of test and shall meet all the above requirement in this clause according to either Method A or Method B.

The necessary measures shall be taken to protect the test subject and to avoid contamination of the surface water drainage system.

## 6 Apparatus and test subjects

### 6.1 Absorbent overall.

The overall shall be a one-piece garment with a hood made with absorbent white or off-white fabric. It shall not include elastic waistband/gathers at the waist as it affects contact between the test garment and the absorbent overall. The absorbent overall shall be sufficiently homogeneous to produce absorption spots which vary less than 10 % in surface area from the mean value for a given volume of liquid, when sampled

1) Genapol LRO liquid is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.



at any place on the garment. It shall be made from a water-absorbent material. See [Annex A](#) for absorbent overall requirements.

## 6.2 Calibrated stain.

Calibrated stains shall be used as a reference for the pass/fail evaluation of the tested suit. Pass/fail criteria shall be specified in the relevant product standard<sup>[1]</sup>.

A calibration stain shall be produced only after a test where a leakage has been detected on the absorbent overall.

Select an area of the absorbent overall where no leakage has been detected right after the doffing of the garment. Put under it a piece of undergarment and ensure that both layers are in contact. Put the assembly under a dispenser, with the lower tip of the dispenser at a vertical distance of  $(5,0 \pm 0,5)$  cm above the assembly. Dispense a volume of  $(25 \pm 5)$   $\mu$ l of the test liquid to produce a clearly visible stain on the surface of the overall. After 5 min ( $\pm 15$  s), define the outline of the stain before it is measured. Several methods can be used to measure the calibration stain, such as a planimeter. The minimum area of the stain shall be 1 cm<sup>2</sup> after 5 min ( $\pm 15$  s).

## 6.3 Turntable.

A waterproof platform capable of supporting a test subject and rotating at  $(1,0 \pm 0,1)$  full circle per minute.

The diameter of the turntable shall be 60 cm or more.

## 6.4 Test liquid container.

The test liquid shall be prepared and stored in a container.

## 6.5 Hydraulic pump.

A self-priming, recirculating-type pump shall be used. The pump shall be equipped with a pressure gauge and adjustment, a variable output control filter and hoses to convey the test liquid from the test liquid container to the spray boom. A four-way distribution tube shall be connected to the pump outlet, with each of the four outlets connected directly to a nozzle.

The pump shall be capable of supplying a minimum pressure of 400 kPa.

Provisions shall be taken to avoid the test starting before the pressure is completely built up.

## 6.6 Stopwatch.

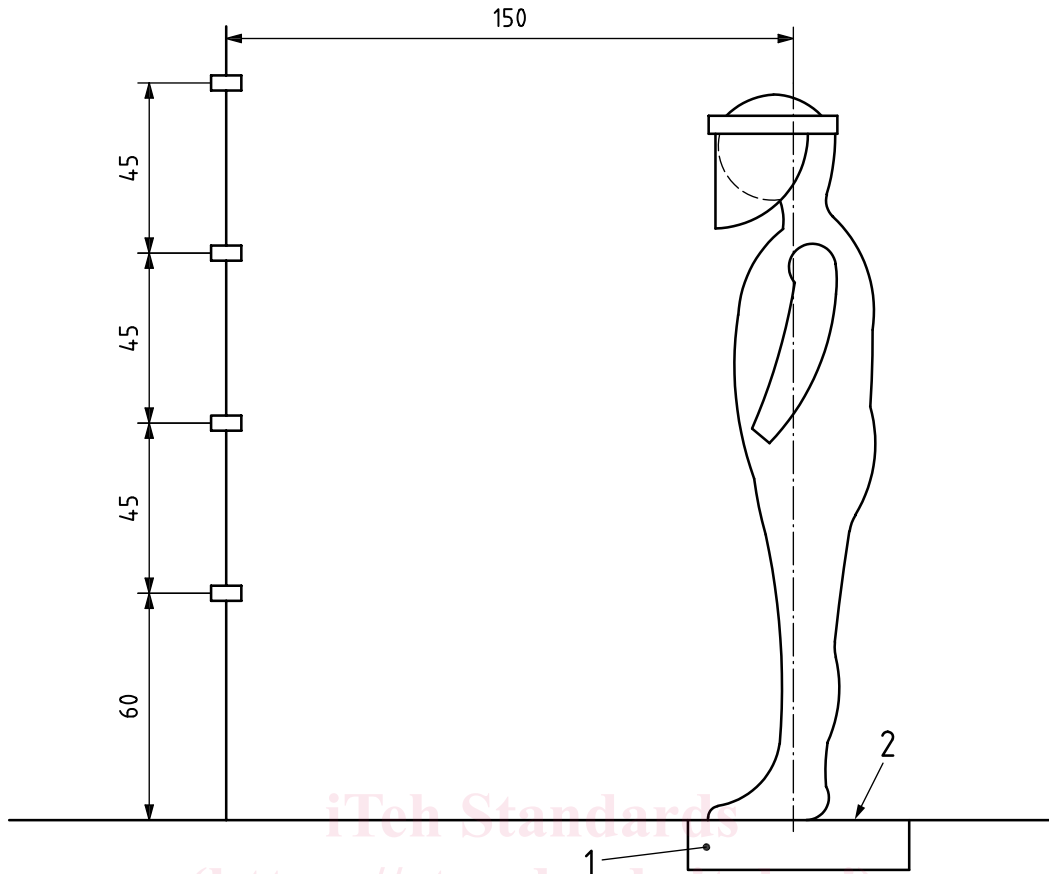
A stopwatch accurate to 1 s shall be used.

## 6.7 Spray booth.

The size of the spray booth shall be at least 2,14 m (H)  $\times$  1,2 m (W)  $\times$  2 m (D), but it shall not exceed 3 m (H)  $\times$  3 m (W)  $\times$  3,5 m (D).

## 6.8 Spray boom.

A vertical rod or frame to which four nozzles can be attached  $(45,0 \pm 0,5)$  cm apart from each other starting from the top of the turntable (see [Figure 1](#)). In [Figure 1](#), the turntable surface is at the same level as the floor. For cabins with turntable above the floor, the lowest nozzle shall be  $(60,0 \pm 0,5)$  cm from the surface of the turntable and not from the cabin floor.

**Key**

- 1 turntable
- 2 top of turn table (cabin floor may be even with or lower than turn table)

**Figure 1 — Apparatus for determining the resistance to spray**

## 6.9 Hydraulic nozzles.

Hydraulic nozzles<sup>2)</sup> shall be of the hollow cone type, each nozzle supplying liquid at a rate of:

- $(0,47 \pm 0,05)$  l/min at a 300 kPa pressure for method A.
- $(1,14 \pm 0,10)$  l/min at a 300 kPa pressure for method B.

Each nozzle shall be equipped with an individual pressure gauge and pressure control valve in order to obtain the same pressure at each nozzle.

Nozzles are subject to deterioration with use. A flowrate verification procedure is recommended to check if they are still fit for use. For easy exchange of nozzles, it is recommended to mount the nozzles on a bayonet-nut since the nozzles typically use plastic screw rings, which can become loose over time.

2) Typical spray nozzles can be obtained from Lurmark (Hypro EU Ltd, Longstanton, Cambridge CB4 5DS, UK), Agrotop (Agrotop GmbH, Obertraubling 93083, Germany), Albuz (Solcera, Evreux 27000, France) and Teejet (Spraying Systems Co, Glendale Heights, IL 60139-3408, USA):

- for the method A: disc DC-03, core CR-23 with a spraying angle of  $(70 \pm 10)^\circ$  300 kPa pressure
- for the method B: disc DC-04, core CR-25 with a spraying angle of  $(70 \pm 10)^\circ$  300 kPa pressure

This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products (same nozzle spraying type, flow and spraying angle at the indicated pressure) can be used if they can be shown to lead to the same results.