INTERNATIONAL STANDARD

ISO 17491-3

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

Part 3: Determination of resistance to penetration by a jet of liquid (jet test)

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

Partie 3: Détermination de la résistance à la pénétration par un jet de liquide (essai au jet)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 17491-3 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in collaboration with Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 17491-3, together with ISO 17491-4, cancels and replaces ISO 17491:2002, Clauses 6 and 7 of which have been technically revised.

ISO 17491 consists of the following parts, under the general title *Protective clothing — Test methods for clothing providing protection against chemicals*:

— *Part 3: Determination of resistance to penetration by a jet of liquid (jet test)*

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

The following parts are under development:

— *Part 1: Determination of resistance to outward leakage of gases (internal pressure test)*

— *Part 2: Determination of resistance to inward leakage of aerosols and gases (inward leakage test)*

Introduction

This part of ISO 17491 describes a test method for determining the liquid penetration resistance of chemical protective clothing Type 3 (with liquid-tight connections between different parts of the clothing and, if applicable, between the clothing and other items of personal protective equipment).

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 forceful projection of a liquid chemical.

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

Other requirements with regard to this type of clothing and its constituent materials can be found in the corresponding product standard (see Bibliography [2]).

A document on the selection, use and maintenance of chemical protective clothing is available (see Bibliography [3]).

CAUTION — Some of the procedures specified in this part of ISO 17491 involve the use of processes which could lead to hazardous situations and hence appropriate precautions should be taken.

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

Part 3:
Determination of resistance to penetration by a jet of liquid (jet test)

1 Scope

This part of ISO 17491 specifies a test method for determining the resistance of protective clothing against penetration by a jet of liquid.

This part of ISO 17491 is applicable to clothing with liquid-tight connections between different parts of the clothing and, if applicable, between the clothing and other items of personal protective equipment worn with it.

This part of ISO 17491 does not address chemical permeation resistance of the clothing materials, which is specified in other 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/TR 11610, *Protective clothing — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 11610 and the following apply.

3.1
connection
assemblage or join

3.2
calibrated stain
fluorescent or visible stain, with a defined minimum area, generated by dropping a specified quantity of test liquid on to an absorbent overall

NOTE The calibrated stain is used to measure liquid penetration during spray and jet testing of chemical protective clothing.

3.3
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

4 Principle of the test method

A water jet, containing a fluorescent or visible dye tracer, is directed at 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 protective clothing, allows any points of inward leakage to be identified.

5 Liquid for application in the form of a jet

A test liquid containing the following substances shall be used:

— water at (20 ± 2) °C;

— a water-soluble fluorescent or visible dye, e.g. methyl blue (CAS number [28983-56-4]);

— a surfactant, e.g. Genapol LRO liquid (sodium lauryl ether sulphate, CAS number [009004-82-4]);

— a stabilizer for the dye (if needed), e.g. citric acid (CAS number [77-92-9], analytical grade).

Prepare the test liquid by dissolving the dye in water. Add the surfactant and the dye stabilizer (if needed) in the appropriate proportions to obtain a solution with a surface tension of $(30 \pm 5) \times 10^{-3}$ N/m.

NOTE A typical concentrated solution can be made by dissolving 4 g methyl blue, 25 ml Genapol LRO liquid and 125 g citric acid in 1 l of tap water. The mixture is stirred for 15 min to 20 min with a magnetic stirrer and eventually 200 ml of it is diluted in 10 l of water.

To measure the surface tension within the stated tolerance, any suitable method may be used, e.g. a Wright torsion balance using a standard 12 mm diameter platinum ring. Agents other than surfactants may be mixed with water if the same surface tension can be obtained.

It shall be ensured that the surface tension is 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 test.

Avoid dyes that adhere too strongly to the fibres of the absorbent material resulting in a wet spot larger than the coloured spot.

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 absorbent overall shall be a one-piece garment with a hood. It shall be made from a water-absorbent material that is sufficiently homogeneous to produce absorption spots which vary less than 10 % in surface from the mean value for a given volume of liquid, when sampled at any place on the garment.[1)]

NOTE In order to protect the test subject from the test liquid, water-repellent undergarments should be worn under the absorbent overall.

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1) Sontara PES/Woodpulp 45/55 and Poligard Adsorbent garments are suitable for this purpose. This information is given for the convenience of users of this part of ISO 17491 and does not constitute an endorsement by ISO of the products named. Equivalent products may be used if they can be shown to lead to the same results.

6.2 Calibration stain

A calibration stain shall be produced on every absorbent overall used under the test suit. This can be done before the jet test is performed or immediately afterwards.

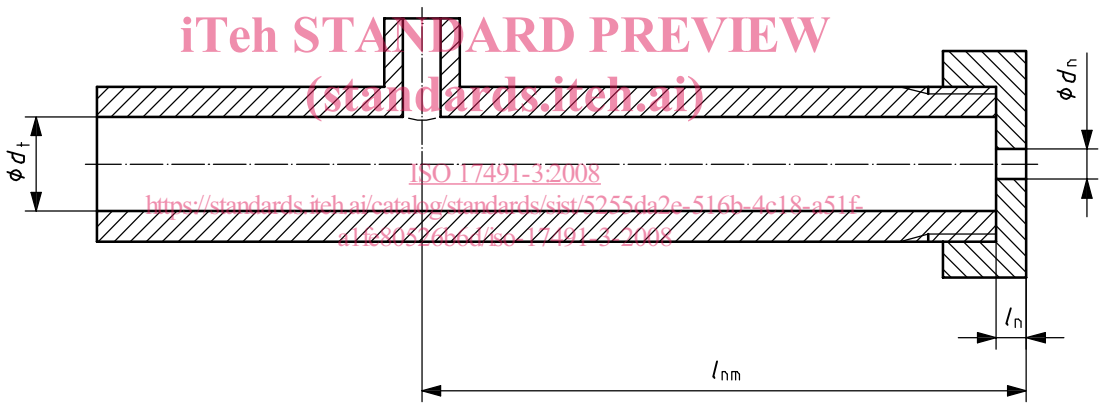
Select an area of the absorbent overall that is not likely to be contaminated. Put under it a piece of undergarment and ensure that both layers are in contact. Put the assembly under a dispenser. The lower tip of the dispenser shall be at a vertical distance of (5 ± 0,5) cm from the assembly. Dispense a volume of (25 ± 5) µl of the test liquid to produce a clearly visible stain on the surface of the overall. 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^2.

The calibrated stain shall be used as a reference for the pass/fail evaluation of the tested suit. Pass/fail criteria shall be defined in the corresponding product standard (see Bibliography [2]).

6.3 Jet nozzle

A nozzle, as shown in Figure 1, shall be used to generate the jet of test liquid. A pressure gauge capable of providing an accurate reading at a liquid pressure of (150 ± 15) kPa shall be attached to the nozzle.

In order to avoid fluctuations in the distance between nozzle and target, the nozzle shall be fixed on a spray boom for example.



Key

d_n diameter of the opening of the nozzle, (4 ± 0,1) mm

l_n length of the opening of the nozzle, (4 ± 0,1) mm

d_1 inner diameter of the tube, (12,5 ± 1) mm

l_{nm} distance between the opening of the nozzle and the manometer, (80 ± 1) mm

Figure 1 — Shape of nozzle

6.4 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 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.

6.5 Test liquid container

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

6.6 Stopwatch

A stopwatch accurate to 1 s shall be used.

6.7 Test subject

Some of the procedures specified in this part of ISO 17491 involve the use of processes which could lead to a hazardous situation for a human test subject. Attention is drawn to the hazards for the test subject's eyes, ears, nose, mouth, abdomen and genitals deriving from the application of a pressurized jet of liquid.

NOTE 1 This part of ISO 17491 does not claim to indicate all hazards which might occur during its application. For the protection of the test subject, national laws and requirements apply.

Tests shall only be carried out by test subjects whose body dimensions are within the range indicated on the size label of the suit to be tested.

NOTE 2 Garment sizes should be provided to suit the body dimensions of known test subjects, taking into account that the test subject is wearing undergarments and an absorbent overall under the test garment. The test subjects should be selected as close as possible to the upper limit of the size range. If garments are too big, leakages may not be detected because there is no contact between the test garment and the absorbent overall.

7 Preparation for the jet test

The test subject, wearing one layer of water-repellent undergarments, shall be dressed with the absorbent overall, and subsequently with the test garment, in accordance with the manufacturer's instructions, as well as other items of protection.

If the manufacturer's instructions do not require the suit to be taped to any part of the body of the wearer (such as wrists and ankles) or to any additional item worn by the test subject (e.g. gloves or boots), then it shall not be taped.

8 Test procedure

8.1 Selection of test spots

Test spots shall be selected from the expected most critical areas.

These shall include at least:

a) connections that are integral to the chemical protective clothing; three spots shall be tested on all different types of joins, seams and assemblages and particular attention shall be paid to seam crossings; on zips and covered zips three spots shall be checked;

b) connections between different parts of the suit, e.g. overlapping parts of jacket and trousers, or between the suit and other protective items, e.g. a loose hood, gloves and boots; at least one spot on each type of connection line shall be tested.

Each test spot shall be cross-marked prior to the test and identified for use on the test report (see Clause 9).

8.2 Jet test

The jet nozzle shall be positioned at (1,0 ± 0,10) m from the test spot, in a horizontal line and at an angle which is most likely to cause penetration. If, for example, a zip covered by a flap is tested, the jet shall be directed at the open side of the flap.

The pressure of the liquid indicated by the pressure gauge shall be (150 ± 15) kPa.

The liquid jet shall be directed at each test spot for (5 ± 0,5) s, starting at the lowest test spot.

After exposure the test subject shall stay in the test room for 2 min to allow the clothing to drain.

Remove respirator and gloves first before opening the test garment. Remove the chemical protective clothing carefully in order to avoid contamination of the absorbent overall and examine the internal surface of the test garment for signs of penetration, paying special attention to openings, seams, closures and zippers. Mark them.

Similarly, examine visually the external surface of the absorbent overall. Once the absorbent clothing is removed, mark the location and extent of any sign of penetration on the absorbent overall. Measure the area of every spot, with a planimeter for example, and report the total area of the spots.

The absorbent overall or a photograph of it shall be retained as a quality record.

9 Test report

The test report shall include the following information:

a) a statement that the test was carried out in accordance with this part of ISO 17491;

b) the name of the manufacturer/supplier and any identifying mark;

c) the size of the suits tested and the body dimensions (total length, chest girth) of the test subjects wearing the garments (see Bibliography [1]);

d) a description of the absorbent overall;

e) a description of any additional protective equipment or any accessories used during the test and whether and in what manner it was taped to the suit;

f) the test room temperature;

g) the composition and surface tension of the liquid used in the tests;

h) for each chemical protective clothing test, the location of each test spot and direction of the jet, indicated on diagrams of a human figure (front and back separately) or by reference to photographs;

i) the areas of contamination of the internal surfaces of the test clothing and the absorbent overall indicated on a diagram of a human figure, by shading the approximate area, (front and back separately) or by reference to photographs;

j) the total number of penetration spots and the total area measured;

k) the test liquid supply pressure;

l) a description of any pre-treatment and/or pre-conditioning of the suits tested, if applicable;

m) any further qualifying remarks, observations and comments considered appropriate by the person who has carried out the tests.

