
**Protective clothing — Protection against
liquid chemicals — Test method for
resistance of materials to penetration by
liquids**

*Vêtements de protection — Protection contre les produits chimiques
liquides — Méthode d'essai pour la résistance des matériaux à la
pénétration par des liquides*

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Foreword

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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 6530 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 third edition cancels and replaces the second edition (ISO 6530:1990), which has been technically revised.

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Introduction

This International Standard specifies a test method for measuring indices of penetration, absorption and repellency for protective clothing materials against low-volume, low-pressure splashes of liquid chemicals, usually chemicals of low volatility. ISO 13994 may be used for determining the penetration resistance of protective clothing materials against chemicals in larger volume and higher pressure splashes.

Clothing made of these materials should not be used as the sole means of protection where resistance to permeation by chemicals at the molecular level (see ISO 6529) is essential and where a complete barrier to liquid (or gaseous) chemicals is required (e.g. risk of exposure to massive and forceful discharges of concentrated liquid chemicals).

Data obtained by this test method may be used as a guide for screening protective clothing materials. Clothing, which has been developed from materials selected by this method of test should be used, therefore, only in well-defined circumstances when an evaluation of the finished item has indicated an acceptable level of performance (in laboratory and field-testing of a garment, consideration of exposure levels to specified chemicals, etc.).

In interpreting the results of the test method, the influences of the physical properties of the test chemical (e.g. volatility) should also be taken into consideration.

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Protective clothing — Protection against liquid chemicals — Test method for resistance of materials to penetration by liquids

1 Scope

This International Standard specifies a test method for the measurement of indices of penetration, absorption and repellency for protective clothing materials against liquid chemicals, mainly chemicals of low volatility.

Two levels of the potential performance of materials are assessed by this method of testing to meet with possible requirements for protection against

- a) deposition on the surface of a material, at minimal pressure, of spray droplets up to coalescence or occasional small drips;
- b) contamination by a single low-volume splash or low-pressure jet, allowing sufficient time to divest the clothing or take other action as necessary to eliminate any hazard to the wearer from chemical retained by the protective garment, or, in circumstances where pressure is applied to liquid contaminants on the surface of the clothing material, as a result of natural movements of the wearer (flexing of contaminated areas of clothing at arms, knees, shoulders) and contact with contaminated surfaces (e.g. walking through sprayed foliage).

2 Definitions

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

2.1

penetration

process by which a chemical moves through pores, apertures or essential openings in a material or finished item of clothing

NOTE The apertures can be the result of mechanical damage.

2.2

permeation

process by which a chemical moves through a protective clothing material on a molecular level

NOTE Permeation involves the following:

- a) sorption of the molecules of the chemical onto the contact surface (outer surface) of the material;
- b) diffusion of the sorbed molecules into the material;
- c) desorption of the molecules from the opposite (inner) surface of the material.

2.3

repellency

ability of a material to shed liquid that is applied to its surface

3 Principle

A measured volume of a test liquid is applied in the form of a fine stream or jet to the surface of a clothing material resting in an inclined gutter.

Determination of the respective proportions of the applied liquid which penetrate a test specimen and which are repelled by its surface indicates the potential of the material for use in the described field of application.

4 Method

4.1 Apparatus

The apparatus, as assembled (see Figure 1), shall comprise the following:

- rigid transparent gutter, of semi-cylindrical shape, with an internal diameter (125 ± 5) mm, length (300 ± 2) mm and inclination 45° ;
- rigid cover (not shown in Figure 1), semi-cylindrical in shape, length 270 mm, external diameter (105 ± 5) mm and an evenly distributed mass of (140 ± 7) g;
- hypodermic needle, bore $(0,8 \pm 0,02)$ mm; length is not critical but the pointed tip shall be removed and the end ground flat;
- syringe or other leak-free attachment to the needle, capable of delivering $(10 \pm 0,5)$ cm³ of test liquid;
- motorized syringe-drive unit or a hydraulic pump or other pressurized system, to deliver the correct volume of test liquid [$(10 \pm 0,5)$ cm³] in an unbroken stream or jet via the needle within (10 ± 1) s; manual delivery or gravity shall not be used;

WARNING — Appropriate precautions applicable to the use of equipment under pressure and the forceful discharge of liquid chemicals should be taken.

- mounting device, for maintaining the hypodermic needle and attachments in their required positions (see Figure 1);
- small beaker;
- balance, accurate to 0,01 g;
- transparent film, resistant to the test liquid;
- absorbent paper¹⁾, 0,15 mm to 0,2 mm thick;
- stopwatch, accurate to 0,1 s;
- temperature controlled room or cabinet, to enable tests to be carried out at temperatures other than ambient.

NOTE 1 The transparent film is to protect the gutter and obviate the need to rinse it between tests.

NOTE 2 The filter paper will show any passage of the test liquid through the test specimen. The semi-cylindrical cover is used to maintain intimate contact between the contaminated area of the test specimen and the filter paper after release of the test liquid.

1) Filter paper Whatman no. 1 is found to be suitable for this purpose. This information is given for the convenience of users of this ISO 6530 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4.2 Test liquid

4.2.1 Selection

Use that liquid (or those liquids) against which protection is required.

If necessary, and in particular for safety reasons, substitutes may be used, provided that it can be demonstrated that their results are similar to those of the chemicals against which protection is required.

Water adjusted to a surface tension of $(30 \times 10^{-3} \pm 3 \times 10^{-3}) \text{ Nm}^{-1}$ is a convenient and safe test liquid for general screening purposes.

The results of tests with volatile liquids may not be reproducible unless validated procedures are followed to control losses by evaporation to a constant definable level. The measurements of penetration, absorption and repellency may be facilitated conveniently however by the solution of an analysable substance (e.g. fluorescent or visible dye tracers) in the volatile liquid, provided it does not influence the performance of the test specimen (i.e. its resistance to penetration and repellency).

4.2.2 Temperature of application

Test liquids shall be adjusted to the required test temperature. If not otherwise specified, tests shall be performed at $(20 \pm 2) ^\circ\text{C}$ and $(65 \pm 5) \%$ relative humidity.

4.3 Preparation of test specimens

Test specimens are taken from flat samples of materials used, or under consideration for use, in construction of protective clothing resistant to penetration (see Bibliography). Where required, samples should be conditioned in accordance with the procedures specified in the relevant product standards, e.g. washing and cleaning.

Where the influence of environmental factors, washing, chemical degradation, etc., on resistance to penetration is to be assessed, representative control specimens should be retained.

4.4 Procedure

4.4.1 For each test liquid, cut six test specimens of (360 ± 2) mm by (235 ± 5) mm from the clothing or sample of material and weigh them to the nearest 0,01 g.

In the case of woven fabrics, take three test specimens in the direction of the warp and three in the direction of the weft. For non-woven fabrics, if the direction of manufacture is recognizable, take three test specimens in that direction and three at right angles to it.

If there is no recognizable direction of manufacture, an arbitrary direction should be assigned prior to sampling. This should be noted in the test report.

4.4.2 Fold under 30 mm of the length of the test specimen and hold the fold in position on both sides by an appropriate means. Avoid any creases in the fabric.

4.4.3 Cut out a rectangle of (300 ± 2) mm by (235 ± 5) mm of the filter paper and the transparent film, and weigh them together to the nearest 0,01 g.

4.4.4 Check that the apparatus, test liquid and test specimens have been conditioned to the required test temperature.

4.4.5 Check that the volume of test liquid delivered via the needle is within the designated limit (see 4.1).

4.4.6 Place the weighed transparent film, absorbent paper and test specimen (in that order) in the gutter. The sample should be mounted so that the liquid strikes the “contacted” (outside) face of the fabric. Ensure that the top edges align with the top edge of the gutter and that the folded edge of the test specimen is face-down and protruding 30 mm from the lower edge (Figure 1). Eliminate all creases in each layer and ensure that all surfaces are in close contact. Secure with clips.

4.4.7 Weigh the beaker to the nearest 0,01 g. Place it under the folded edge of the test specimen for collection of test liquid running off the surface.

4.4.8 Mount the hypodermic needle vertically through the centre of an imaginary line, which joins the apices of the two uppermost corners of the gutter, so that the tip of the needle is (100 ± 2) mm from the inclined surface of the gutter (see Figure 1).

4.4.9 Simultaneously, start the stopwatch and discharge the test liquid (10 cm^3) within (10 ± 1) s, via the needle, onto the surface of the test specimen. Without delay, rest the semi-cylindrical cover centrally on top of the test specimen and ensure that the lower edges of the cover and the gutter are in line.

Test operators should realize that testing with volatile chemicals can lead to evaporative losses despite precautions taken in the testing of these chemicals. Evaporative losses may result in lower indices unless a complete mass balance is conducted (i.e. measurement of the mass change in the material specimen itself combined with the mass change of the absorbent paper/underlying film, and the mass of the beaker should be compared against the total mass of liquid dispensed).

4.4.10 After 60 s (from the start of the discharge of the test liquid), tap the gutter to dislodge any drops hanging from the folded edge of the test specimen. Remove the cover and the test specimen carefully to avoid additional run off, either into the beaker or onto the underlying absorbent paper and reweigh the following items to the nearest 0,01 g:

- the absorbent paper and underlying film;
- the beaker;
- the test specimen.

4.5 Expression of results

For each test specimen and each test liquid, calculate the indices of penetration, repellency and absorption in accordance with Equations (1) to (3).

a) For the index of penetration, I_P :

$$I_P = (M_p/M_t) \times 100 \tag{1}$$

where

M_p is the mass, expressed in grams, of test liquid accumulated by the absorbent paper/film combination;

M_t is the mass, expressed in grams, of test liquid discharged onto the test specimen.

b) For the index of repellency, I_R :

$$I_R = (M_r/M_t) \times 100 \tag{2}$$

where

M_r is the mass, expressed in grams, of test liquid collected in the beaker;

M_t is the mass, expressed in grams, of test liquid discharged onto the test specimen.

c) Index of absorption, I_A :

$$I_A = (M_a/M_t) \times 100 \quad (3)$$

where

M_a is the mass, expressed in grams, of test liquid absorbed by the material tested;

M_t is the mass, expressed in grams, of test liquid discharged onto the test specimen.

Express the indices I_P , I_R and I_A to one decimal place.

Where reliable correction factors for evaporative losses can be applied, the mass lost under the experimental conditions should be added to M_a , M_p or M_r before calculation of the respective indices I_P , I_R and I_A .

5 Test report

The test report shall include the following information:

- a) testing was carried out in accordance with this International Standard (e.g. ISO 6530:2004);
- b) manufacturer's identity for the material tested and, where appropriate, the particular part of a named item from which the test specimens were taken;
- c) mass per unit area, expressed in grams per square metre, of the material tested;
- d) description of any pre-treatments and/or preconditioning of the material tested;
- e) test liquid(s) used, including composition, trade names, etc.;
- f) boiling point of the liquid, or of the most volatile component of a mixture, and any allowance made for evaporative losses (if none, record "none");
- g) temperature, expressed in degrees Celsius, and range used in the tests;
- h) all individual test results (indices of penetration, absorption and repellency for a given liquid and flow rate of application) and any other influencing factors;
- i) any comments considered appropriate by the person who has carried out the tests.