
**Protective clothing — Protection
against liquid chemicals —
Measurement of repellency, retention,
and penetration of liquid pesticide
formulations through protective
clothing materials**

*Vêtements de protection — Protection contre les produits chimiques
liquides — Mesurage de la répulsion, de la rétention et de la
pénétration des formulations de pesticides liquides à travers les
matériaux des vêtements de protection*

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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.

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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 13, *Protective clothing*.

This second edition cancels and replaces the first edition (ISO 22608:2004), which has been technically revised. The main changes compared to the previous edition are as follows:

- thickness of the specimen holder;
- test condition;
- extraction procedure options and extraction efficiency requirement;
- inclusion of an [Annex A](#) for repeatability and reliability.

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

The health and safety of workers involved in the mixing, loading and application of liquid pesticides can be affected by dermal exposure to liquid pesticide formulations. Use of protective clothing can assist in minimizing the danger of contact with potentially harmful pesticides

The movement of liquid pesticides through these materials is primarily due to penetration through spaces between fibres and interstices between yarns. As these materials provide protection either by repelling or retaining liquid pesticides, the measurement of these properties is also important. This test method is used to measure the repellency, retention, and penetration of liquid pesticides through protective clothing materials.

For repeatability and reliability, see [Annex A](#).

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Protective clothing — Protection against liquid chemicals — Measurement of repellency, retention, and penetration of liquid pesticide formulations through protective clothing materials

1 Scope

This document specifies a test method to measure the repellency, retention and penetration of a known volume of liquid pesticide when applied to a protective clothing material. No external hydrostatic or mechanical pressure is applied to the test specimen during or after the application of the liquid pesticide.

The degree of contamination depends on numerous factors such as the type of exposure, application technique, and pesticide formulation. As the level of exposure can vary considerably, this method is designed to rate the relative performance of personal protective equipment (PPE) materials at two levels of contamination. Low level of contamination is achieved by applying 0,1 ml of liquid formulation and high level by applying 0,2 ml.

This test method does not measure the resistance to permeation or degradation.

This test method is suitable for field strength and concentrated pesticide formulations. This method may not be suitable for testing protective clothing materials against volatile pesticide formulations.

This document is applicable to the evaluation of materials that are new or those that have undergone treatment such as laundering or simulated abrasion. Details of the treatment shall be reported. This test method can also be used to determine the resistance provided by protective clothing materials against penetration of new pesticide formulations.

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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 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 <http://www.electropedia.org/>

3.1 analytical technique

procedure whereby the concentration of the test chemical in a collection medium is quantitatively determined

Note 1 to entry: The procedure selected is based on the test liquid to be analysed. Applicable techniques include, but are not limited to, gas chromatography, high pressure liquid chromatography, gravimetric analysis, and radionuclide tagging/detection counting.

3.2 test liquid

mixture of raw materials, including but not limited to, active ingredients, inert ingredients, and a base solvent used in *pesticide* (3.5) formulation

Note 1 to entry: Additional ingredients could include emulsifiers and surfactants. Solvents used in the formulation could be water, isopropyl alcohol or petroleum distillate. Solid materials (powders, granules, etc.) may be dissolved or emulsified to form a liquid or a suspension. These formulations may be ready to use or be concentrates that require dilution to field strength.

3.3 penetration

flow of a chemical through closures, porous materials, seams, holes or other imperfections in a *protective clothing material* (3.6) on a non-molecular level

3.4 permeation

process by which a chemical moves through a *protective clothing material* (3.6) on a molecular level

Note 1 to entry: Permeation involves

- a) sorption of molecules of the chemical into the contacted (outside) surface of a material,
- b) diffusion of the sorbed molecules in the material, and
- c) desorption of the molecules from the opposite (inside) surface of the material.

3.5 pesticide

substance or mixture of substances intended for preventing, destroying, repelling or reducing any pest or weeds

Note 1 to entry: Pesticides (plant protection products) approved for use in one country may not be approved in another country.

3.6 protective clothing material

any material or combination of materials used in an item of clothing for the purpose of isolating parts of the body from a potential hazard

Note 1 to entry: For the purposes of this document, protective clothing materials include those materials used in the construction of the suit or clothing that serves as the primary barrier for the wearer. Protective clothing materials do not include materials used in the construction of integral visors, gloves, and footwear.

3.7 repellency

characteristic to resist wetting and *penetration* (3.3) by a liquid

3.8 retention

liquid retained in the *protective clothing material* (3.6) under the conditions of this test

4 Principle

A test liquid is applied using a pipettor to the surface of the test assembly, which consists of single or multiple layer protective clothing material (test specimen) and an absorbent paper backed by polyethylene film (collector layer).

After a specified time, another absorbent paper backed by polyethylene film (top layer) is placed on the surface of the test specimen to remove the remaining liquid.

The top layer, contaminated test specimen, and collector layer are separated.

The amount of test liquid in each layer is measured either by gravimetric analysis (weighing) or by other appropriate analytical techniques.

Method A is a gravimetric method that measures the mass of the test liquid in each layer, whereas Method B is an analytical method that requires extraction of the test liquid and measures the mass of the active ingredient.

Data is obtained to calculate percent repellency, pesticide retention, and penetration.

5 Apparatus

5.1 Apparatus and materials for contamination of test specimen

5.1.1 Test liquid, to contaminate the test specimen.

A magnetic or other stirrer shall be used for liquids that may settle during application.

NOTE Pesticide surrogate and commercially available pesticides are examples of test chemicals. Concentrates with high viscosity can be difficult to pipette using this method.

5.1.2 Pipettor, with disposable pipette tip, mounted on a support stand, for pipetting $(0,100 \pm 0,002)$ ml of liquid for low contamination level and $(0,200 \pm 0,004)$ ml for high contamination level (see [Figure 1](#)).

Multi-dispensing pipettors shall not be used for test liquids that may settle during application.

NOTE Liquid viscosity, user experience, and temperature can affect accuracy and precision. Pipetting done in reverse mode is recommended to avoid losses of test liquid in the tip. The last drop in reverse pipetting is not dispensed. With conventional pipettors, care must be taken to prevent the last drop from affecting the volume dispensed. Additional information on selection of pipettor can be obtained from the pipette manufacturer.

5.1.3 Test specimen holder, consisting of a 100 mm × 100 mm base plate (see [Figure 2](#)) and a 100 mm × 100 mm cover plate with a 60 mm × 60 mm opening in the centre (see [Figure 3](#)).

The test specimen holder is made of polymethyl methacrylate or other suitable material with ≥6 mm thickness. The mass of the cover plate shall be 40 g to 45 g.

NOTE The test specimen holder can be made of other suitable materials (e.g., other rigid plastics) that meet the thickness and weight requirements, are rigid and can be easily cleaned.

5.1.4 Thin, transparent 100 mm × 100 mm plastic cover sheet.

NOTE A cover sheet is placed over the cover plate with the 60 mm × 60 mm opening to prevent evaporation loss. A clear PVC cover used for reports is an example of plastic material that can be used to make the cover sheet.

5.1.5 Timer, accurate to the nearest 1 s.

5.1.6 Absorbent paper, two 80 mm × 80 mm Benchkote® Plus¹⁾ squares, one square of which is used to measure penetration, and the other to measure repellency.

5.1.7 Container, to discard contaminated materials.

5.2 Apparatus for analysis using Method A

5.2.1 Balance, accurate to the nearest 0,001 g.

5.2.2 Tweezers.

5.3 Apparatus and materials for analysis using Method B

5.3.1 Solvent, appropriate for extraction of chemical to be analysed.

NOTE The selection of the solvent is dependent on the test liquid and analytical method used. A minimum extraction efficiency of 90 % is required. The procedure to calculate the extraction efficiency is given in [10.2](#). Solvents with high volatility cannot be appropriate, as there can be evaporation loss during handling operations.

5.3.2 Bottles, airtight chemically resistant flasks or bottles suitable for extraction. Airtight chemically resistant bottles are also used for storage.

5.3.3 Tweezers.

5.3.4 Timer, accurate to the nearest 1 s.

5.3.5 Graduated cylinder, (50,0 ± 0,2) ml bottle-top dispenser or other apparatus for accurate measurement of solvent.

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1) Benchkote® Plus is cellulose backed by polyethylene film. The typical data provided by the manufacturer is: base mass: 161 g/m²; thickness: 590 µm at 53 kPa; and water absorption value: 75 mg/cm². Substitutions are not recommended because of differences in sorptive properties; use of absorbent papers other than that specified may affect the test results. Benchkote® Plus 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.