INTERNATIONAL STANDARD

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Protective clothing — Performance requirements for protective clothing worn by operators applying liquid pesticides

Vêtements de protection — Exigences de performance pour les vêtements de protection portés par les opérateurs appliquant des pesticides liquides

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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 27065 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

Introduction

This International Standard addresses the performance requirements for protective clothing worn by operators applying liquid pesticide products diluted with water. These products are also known as crop protection and plant protection products in certain countries. Registration of pesticide products, such as insecticides, herbicides and fungicides, involves the assessment of operator exposure and risk, factors which determine the need for personal protective equipment. Protection needs to correspond to the identified risks in order to avoid loss of comfort due to over-protection. Actual field trials are used to determine the operator risk while spraying pesticides under different scenarios. For the performance specification, data from field studies are used to categorize the garment performance and determine the minimum performance limits for the different levels. Laboratory tests, including accelerated tests, are used to determine whether the garment met the minimum requirements for that level. The minimum penetration requirements, evaluated by laboratory tests, are based on extensive studies comparing field study data with laboratory data. Laboratory data are often derived from accelerated tests to differentiate between different levels of performance; therefore, laboratory data cannot be used for direct comparison with field data or acceptable mitigation factors.

This International Standard defines performance requirements for three levels of protective clothing with specified resistance to penetration by pesticide products. It is up to the manufacturer of a specific pesticide product to indicate on the label the recommended level of protection (no protective clothing, Levels 1a, 1b, 2, 3) for the respective exposure conditions. A brief description of the different levels is given below.

Level 1 garments are suitable when the potential risk of contamination is relatively low. The performance requirements for Level 1a garments have been developed in view of low spray drift landing on the operator, e.g. from tractor boom sprayers. The performance requirements for Level 1b garments have been developed based on the performance of cotton and polyester/cotton garments, which are widely used for operator exposure studies.

Level 2 garments are suitable when the potential risk of contamination is higher but not so high as to require the use of liquid-tight materials.

Level 3 garments are suitable for use when the potential risk of contamination requires use of garments made with liquid-tight materials. This level is suitable for high-exposure scenarios where it has been determined that garments that prevent liquids from penetrating/permeating provide adequate protection.

This International Standard is intended for fabric and garment manufacturers, for manufacturers of pesticide products, trainers, regulators and other individuals or organizations that make decisions regarding protective clothing for protection against pesticide products.

Protective clothing — Performance requirements for protective clothing worn by operators applying liquid pesticides

1 Scope

This International Standard establishes minimum performance, classification, and labelling requirements for protective clothing worn by operators applying liquid pesticide products diluted in water. Protective clothing covered by this International Standard includes, but is not limited to, shirts, jackets, trousers, coveralls, and spray-tight or liquid-tight garments. This International Standard addresses protection provided by protective accessories, with the exception of those used for the protection of the head, hands, and feet. This International Standard does not address protection against biocides, fumigants or highly volatile liquids.

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 6330:2000, *Textiles — Domestic washing and drying procedures for textile testing*

ISO 6529, *Protective clothing — Protection against chemicals — Determination of resistance of protective clothing materials to permeation by liquids and gases*

ISO 9073-4, *Textiles — Test methods for nonwovens — Part 4: Determination of tear resistance*

ISO 13688, *Protective clothing — General requirements*

ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2, *Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method*

ISO 13994, *Clothing for protection against liquid chemicals — Determination of the resistance of protective clothing materials to penetration by liquids under pressure*

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)*

ISO 22608, *Protective clothing — Protection against liquid chemicals — Measurement of repellency, retention, and penetration of liquid pesticide formulations through protective clothing materials*

EN 14786, *Protective clothing — Determination of resistance to penetration by sprayed liquid chemicals, emulsions and dispersions — Atomizer test*

3 Terms and definitions

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

3.1
biocide
non-agricultural pesticide

3.2
decontamination
removal of a contaminant or contaminants from the surface or matrix, or both, of chemical protective clothing to the extent necessary for its next intended action

3.3
fumigant
pesticide in the form of gas with the ability to spread to all areas of a sealed structure

3.4
garment
item of clothing such as a coverall or two-piece suit consisting of single or multiple layers

3.5
limited-use chemical protective clothing
chemical protective clothing for limited duration of use, intended to be worn until hygienic cleaning becomes necessary or contamination with pesticides has occurred and disposal is required

NOTE This includes protective clothing for single use and for limited re-use, according to the information supplied by the manufacturer.

3.6
penetration
process by which a pesticide moves through porous materials, seams, pinholes, or other imperfections in a material on a non-molecular level

3.7
permeation
process by which a pesticide moves through a material on a molecular level, involving

— sorption of the molecules of the chemical into the contacted (outside) surface of a material,

— diffusion of the sorbed molecules in the material, and

— desorption of the molecules from the opposite (inner) surface of the material

3.8
pesticide
substance or mixture of substances intended for preventing, destroying, repelling, or reducing any pest

NOTE The term pesticide applies to insecticides, herbicides, fungicides, and various other substances used to control pests.

3.9
protective clothing
clothing which covers or replaces personal clothing and which is designed to provide protection against one or more hazards

3.10
protective clothing material
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 For the purpose of this International Standard, protective clothing materials include those materials used in the construction of the suit or garment that serve as the primary barrier for the wearer. Protective clothing materials do not include materials used in the construction of integral visors, gloves, and footwear.

3.11
re-usable chemical protective clothing
chemical protective clothing that is constructed from materials which allow the clothing to be cleaned after repeated exposure to pesticides such that it remains suitable for continued use

3.12
seam
permanent junction between two or more pieces of material created by sewing, welding, or another method

3.13
test chemical
liquid that is used to challenge the specimen of protective clothing material

3.14
toxicity
propensity of a substance to produce adverse biochemical or physiological effects

4 Classification and testing requirements

All protective clothing complying with this International Standard shall fulfil the requirements of ISO 13688 and shall be tested and classified by level of protection in accordance with the material, seam and garment requirements in Clauses 5, 6 and 7. Table 1 provides a summary of the tests to be conducted for each level of protection.

NOTE The stringency in testing requirements increases for each level. Therefore, any Level 2 garment necessarily meets Level 1a and Level 1b requirements, and so does not need to be tested to achieve that level of protection. Similarly, any Level 3 garment necessarily meets Level 1a, Level 1b, and Level 2 requirements.

The materials and seams of Level 1a and Level 1b garments shall demonstrate a minimum level of liquid penetration resistance when tested in accordance with the tests specified in Table 1. The mechanical strength performance requirements are the same for all levels of garments. Garments shall pass a practical performance test.

The material and seams of Level 2 garments shall demonstrate a higher level of liquid penetration resistance than Level 1 garments. The mechanical strength performance requirements are the same for all levels. The garments shall pass a practical performance test prior to being submitted to a low-level spray test of the whole garment.

The materials and seams of Level 3 garments shall demonstrate a minimum level of resistance to penetration by liquids under pressure. If, for a particular pesticide, additional testing is required to fully characterize the material (this shall be decided on the basis of the risk assessment provided for the registration of the specific pesticide), the material shall also be tested for permeation resistance using the pesticide in question. When tested with specific pesticide formulations, information regarding the test liquid shall be included in the information provided with the garment. The mechanical strength performance requirements are the same for all levels. The garments shall pass a practical performance test prior to being submitted to a high-level spray test of the whole garment, which is more severe than the test for Level 2 garments. Level 3 protective clothing includes accessories, such as aprons, protective sleeves, and material placed below knapsack/backpack sprayers, which are worn over garments (any level) for extra protection during spraying, mixing and loading. Whole-body testing is not required for accessories worn over whole-body garments.

Table 1 — Testing requirements for Level 1, 2 and 3 garments

Requirements	Sub-clause	Performance Test	Level			
			1a	1b	2	3
Material requirements	5.2.1	Liquid penetration resistance (EN 14786)	x			
	5.2.2	Liquid penetration resistance (ISO 22608)		x[a]	x[a]	
	5.3	Resistance to penetration by liquid under pressure (ISO 13994, Procedure E)				x
	5.4	Resistance to permeation (ISO 6529:2001, Method A)				x[b]
	5.5	Tensile strength (ISO 13934-1)	x	x	x	x
	5.6	Tear resistance (ISO 9073-4)	x	x	x	x
Seam requirements	6.2.1	Seam penetration resistance (EN 14786)	x			
	6.2.2	Seam penetration resistance (ISO 22608)		x[a]	x[a]	
	6.3	Seam resistance to penetration by liquid under pressure (ISO 13994, Procedure E)				x
	6.4	Seam resistance to permeation (ISO 6529:2001, Method A)				x[b]
	6.5	Seam tensile strength (ISO 13935-2)	x	x	x	x
Whole-garment requirements	7.2	Practical performance test	x	x	x	x
	7.3.1	Low-level spray test (ISO 17491-4, Method A)			x	
	7.3.2	High-level spray test (ISO 17491-4, Method B)				x

[a] The minimum performance requirement for Level 2 is significantly higher than that for Level 1b (see 5.2.2).

[b] If, for a particular pesticide, additional testing is required to fully characterize the material (this shall be decided on the basis of the risk assessment provided for the registration of the specific pesticide), the material shall also be tested for permeation resistance using the pesticide in question.

5 Performance requirements of protective clothing materials

5.1 Preconditioning

All protective clothing materials or material assemblies shall be cleaned before testing if the manufacturer's instructions indicate that the garments can be cleaned. The cleaning and maintenance procedures described in the manufacturer's instructions shall be followed [see 8.3 a)], except for drying between wash cycles (it is not necessary for garments to be dried between cleaning cycles). For machine-washable garments, ISO 6330 shall be used. If the manufacturer requires special cleaning or maintenance conditions, the information shall be included as part of a warning label, in accordance with 8.2 h).

The number of cleaning cycles to be performed shall be the maximum number of cycles for which product properties can be maintained, as indicated in the manufacturer's instructions. If the number of cleaning cycles is not specified in the manufacturer's instructions, garments shall undergo 30 cleaning cycles. If the manufacturer's instructions indicate that the life of the garment is less than 30 cleanings, the information shall be included as part of the warning label, in accordance with 8.2 h).

NOTE The purpose of the warning label is to inform the user of special requirements which, if not followed, may impact the protective properties of the garment. Examples of special conditions include, but are not limited to, use of a specific detergent or use of heat such as tumble drying or ironing to reactivate the repellent finish.

5.2 Material penetration resistance

5.2.1 Liquid penetration resistance (atomizer test)

Materials for Level 1a garments shall be conditioned and tested in accordance with EN 14786 and the average of three readings of percent penetration shall be used to classify the material. If the average of three readings is within 10 % of the minimum requirement, the test shall be repeated for an additional set of three readings and the average of six readings shall be used to classify the material. If more than one type of material is used to construct the garment, three specimens of each material shall be tested. Prowl 3.3 EC, an emulsifiable concentrate with 37,4 % pendimethalin, diluted with distilled water to 5 % a.i., should be used.[1)] The test chemical may be substituted as long as it has been verified that the same performance rating for materials and seams is achieved. Test chemicals and contaminated waste shall be disposed of in accordance with local, regional and national laws.

If the garment consists of a combination of separate layers of materials, all layers shall be tested together with the outer fabric exposed to the test chemical. For single-layer garments constructed from different types of materials, each material shall be tested separately and the penetration classification based on the lowest performing level.

Materials for garments classified as Level 1a shall have an average penetration value of 5 % or less.

The results shall be reported in the manufacturer's product technical information, as specified in Clause 8.

5.2.2 Liquid penetration resistance (pipette test)

Materials for Level 1b and Level 2 garments shall be conditioned and tested in accordance with ISO 22608, Method A, using 0,2 ml of test liquid. The average of three percent penetration values shall be used to classify the material. If the average of three readings is within 10 % of the minimum requirement, the test shall be repeated for an additional set of three readings and the average of six readings shall be used to classify the material. If more than one type of material is used to construct the garment, three specimens of each material shall be tested. Prowl 3.3 EC, an emulsifiable concentrate with 37,4 % pendimethalin, diluted with distilled water to 5 % a.i., should be used. The test chemical may be substituted as long as it has been verified that the same performance rating for materials and seams is achieved. Test chemicals and contaminated waste shall be disposed of in accordance with local, regional and national laws.

If the garment consists of a combination of separate layers of materials, all layers shall be tested together with the outer fabric exposed to the test chemical. For single-layer garments constructed from different types of materials, each material shall be tested separately and the penetration classification based on the lowest performing level.

Materials for garments classified as Level 1b shall have an average penetration value ≤40 %. If the material fails to meet the requirement, ISO 22608, Method B, an analytic method, can be used to verify the results obtained for Method A.

Materials for garments classified as Level 2 shall have an average penetration value of 5 % or less. If the material fails to meet the requirement, ISO 22608, Method B, an analytic method, can be used to verify the results obtained for Method A.

NOTE 1 Some materials, such as those with a microporous membrane, may allow water, and not the active ingredient, to penetrate through the fabric. If bright yellow, the colour of pendimethalin, is not visible on the collector layer, analytical testing is carried out in accordance with ISO 22608, Method B.

NOTE 2 The pipette test is an accelerated laboratory test that differentiates the penetration performance of materials. The maximum allowable penetration of 40 % is derived from the pipette data analysis of cotton and cotton/polyester garment materials typically used for operator exposure studies. Therefore, it is not possible to substitute laboratory data from the pipette method for field penetration data. For this reason, the 40 % limit for the pipette method is used only to classify materials and is not appropriate for use in calculating default protection factors used for exposure mitigation in operator exposure and risk assessment.

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1) The test chemical Prowl 3.3 EC is an example of a suitable product available commercially. It is available from Testfabrics, Inc. at www.testfabrics.com. This information is given for the convenience of users of this International Standard and does constitute an endorsement by ISO of this product.