INTERNATIONAL STANDARD

ISO 27065

Second edition
2017-09

Protective clothing — Performance requirements for protective clothing worn by operators applying pesticides and for re-entry workers

Habillement de protection — Exigences de performance pour les vêtements de protection portés par les opérateurs appliquant des pesticides et pour les travailleurs de rentrée

Reference number
ISO 27065:2017(E)

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Contents

Page

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 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 on 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 the following URL: www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 27065:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— major changes have been made to Levels 1 and 3 requirements;

— protective clothing for re-entry workers has been included in the scope.

Introduction

This document addresses the performance requirements for protective clothing worn by operators handling liquid pesticide products as well as protective clothing worn by re-entry workers. It includes requirements for protective clothing (e.g. shirts, jackets, trousers, and coveralls) and partial-body protective clothing (e.g. aprons, smocks, protective sleeves, hoods/caps, and material placed below knapsack/backpack sprayers). Requirements for protective clothing, including partial-body, constructed with multiple layers or materials are also included in this document.

This document classifies protective clothing, including partial-body, into three performance levels. A brief description for the three levels is given below.

Level C1 protective clothing, including partial-body, is suitable when the potential risk is relatively low. Level C1 protective clothing provides the least protection and is not suitable for use with concentrated pesticide formulations. It can be used as the base protective clothing with additional items worn when the potential risk is relatively higher. See Annex F for additional information on risk assessment and use of PPE for risk mitigation.

Level C2 protective clothing, including partial-body, is suitable when it has been determined that the protection required is higher than that provided by Level C1 protective clothing. Level C2 protective clothing typically provides a balance between comfort and protection. This protective clothing is not suitable for use with concentrated pesticide formulations. It can be used as the base protective clothing with additional items worn when the potential risk is relatively higher.

Level C3 protective clothing, including partial-body, is suitable for use when it has been determined that the potential risk is high. Precautionary measures such as short duration for use are necessary for Level C3 suits/coveralls that may cause heat build-up resulting in heat exhaustion/stress. Level C3 protective clothing, including partial-body, is suitable for use with diluted as well as concentrated pesticides.

Personal Protective Equipment (PPE) is often used for risk mitigation. See Annex F for information on risk assessment and use of PPE for risk mitigation. Since protective clothing can be contaminated in various ways (e.g. fine spray, contact with wet surface, contact with pesticide product sprayed under pressure, contact between the protective clothing and a contaminated surface), laboratory test methods used in the standard rate materials and clothing rather than simulate the various field conditions.

ISO 16602 focuses on industrial chemicals, whereas this document focuses on protection against pesticides that are frequently applied in aqueous solutions. Penetration, permeation, and repellency tests in ISO 16602 are typically done with neat chemicals not used in pesticide application. In this document, penetration, permeation, and repellency tests are conducted with a mixture. The test chemical selected for testing is an emulsifiable concentrate that is representative of a worst case scenario for penetration and repellency. Testing for penetration is conducted with diluted formulation. For permeation, the standard provides a provision for testing with diluted formulation and concentrate. In additional, it allows for testing with additional pesticide products, if required, based on risk assessment conducted for the required pesticide product.

This document is intended for fabric and protective clothing manufacturers and pesticide product manufacturers, as well as 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 pesticides and for re-entry workers

1 Scope

This document establishes minimum performance, classification, and marking requirements for protective clothing worn by operators handling pesticide products as well as re-entry workers. For the purpose of this document, the term pesticide applies to insecticides, herbicides, fungicides, and other substances applied in liquid form that are intended to prevent, destroy, repel, or reduce any pest or weeds in agricultural settings, green spaces, roadsides, etc. It does not include biocidal products used for agricultural and non-agricultural settings.

Pesticide handling includes mixing and loading, application, and other activities such as cleaning contaminated equipment and containers. Concentrated pesticides are typically handled during mixing and loading. Protective clothing covered by this document includes, but is not limited to, shirts, jackets, trousers, coveralls, aprons, protective sleeves, caps/hats and other headwear (excluding hard hats made of rigid materials, e.g. hats worn by construction workers), and accessories used under knapsack/backpack sprayers.

This document does not address items used for the protection of the respiratory tract, hands, and feet. This document does not address protection against fumigants.

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

ISO 13688:2013, *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 13937-3, *Textiles — Tear properties of fabrics — Part 3: Determination of tear force of wing-shaped test specimens (Single tear method)*

ISO 13996, *Protective clothing — Mechanical properties — Determination of resistance to puncture*

ISO 17491-4:2008, *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 19918, *Protection against chemicals — Measurement of cumulative permeation of chemicals with low vapour pressure through materials*

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

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:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
analytical technique
procedure whereby the concentration of the chemical is determined quantitatively

Note 1 to entry: These techniques are often specific to individual chemical and collection medium combinations. Applicable techniques include, but are not limited to, flame ionization, photo ionization, electro-chemical, ultraviolet and infrared spectrophotometry, gas and liquid chromatography, and colourimetry.

3.2
cumulative permeation mass
total amount of chemical that permeates during a specified time from the time the material specimen is first contacted with the test chemical

3.3
decontamination
removal of a contaminant or contaminants from the surface or matrix, or both, of protective clothing to the extent necessary for its next intended action

3.4
fumigant
pesticide in the form of gas

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

Note 1 to entry: Limited-use protective clothing shall not be cleaned.

Note 2 to entry: This includes protective clothing for single use and for limited re-use, according to the information supplied by the manufacturer.

3.6
partial-body protective clothing
protective clothing that does not provide full-body coverage

Note 1 to entry: Partial-body protective clothing may be used separately or in combination with other protective clothing to increase the protection level of specific parts of the body. Examples applicable to this document include items such as aprons, overshoes, sleeve protectors, material placed below knapsack/backpack sprayers, and smocks.

3.7
penetration
process by which a pesticide moves through porous materials, seams, pinholes, or other imperfections in a material on a non-molecular level

3.8
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

3.9
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.

3.10
pesticide operator
person handling pesticides in agricultural settings, green spaces, roadsides, etc.

Note 1 to entry: Handling includes tasks such as mixing, loading, transferring, or applying pesticides; cleaning, adjusting, or repairing the parts of mixing, loading, or application equipment that may contain pesticide residues; assisting with the application of pesticides; and disposing of pesticides or pesticide containers.

Note 2 to entry: Farm, forest, nursery, and greenhouse are examples of agricultural settings.

3.11
protective clothing
clothing which covers or replaces personal clothing and which is designed to provide protection against one or more hazards

3.12
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. Protective clothing materials do not include materials used in the construction of integral visors, gloves, and footwear

Note 1 to entry: For the purpose of this document, protective clothing materials include those materials used in the construction of whole or partial-body protective clothing that serve as the barrier for the wearer.

3.13
re-entry worker
person who can be in contact with a plant protection product in an area that has previously been treated

3.14
re-usable protective clothing
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

3.15
seam
permanent junction between two or more pieces of material created by sewing, welding, or another method

3.16
test chemical
liquid that is used to challenge the specimen of protective clothing material

3.17
toxicity
propensity of a substance to produce adverse biochemical or physiological effects

4 Classification and testing requirements

All protective clothing complying with this document shall fulfil the applicable requirements of ISO 13688 and shall be tested and classified by level of protection in accordance with the material, seam, and whole-body protective clothing requirements in Clauses 6, 7, and 8.

Level C1 protective clothing, including partial-body: The materials and seams shall demonstrate a minimum level of liquid penetration resistance. The protective clothing, including partial-body, shall pass a practical performance test. A Level C1 item is not suitable for use with concentrated pesticide formulations. It can be used as the base protective clothing with additional items worn when the potential risk is relatively higher.

Level C2 protective clothing, including partial-body: The material and seams shall demonstrate a higher level of liquid penetration resistance than Level C1 protective clothing. The protective clothing, including partial-body, shall pass the practical performance test. The whole-body protective clothing shall pass the low-level spray test. A Level C2 item is not suitable for use with concentrated pesticide formulations. It can be used as the base protective clothing with additional items worn when the potential risk is relatively higher.

Level C3 protective clothing, including partial-body: The materials and seams shall demonstrate a minimum level of resistance to permeation. The concentration of the test chemical and duration of testing shall be based on the intended use claimed by the manufacturer and included in information provided by the manufacturer [see Clause 10 c)]. The protective clothing, including partial-body, shall pass the practical performance test. The whole-body protective clothing shall pass a high-level spray test. A Level C3 item is suitable for use with concentrated as well as diluted pesticide formulations.

Table 1 provides a summary of the tests to be conducted for each level of protection. The stringency in testing requirements to determine protection increases for each level. Therefore, any Level C2 protective clothing necessarily meets Level C1 requirements, and so does not need to be tested to achieve that level of protection. Similarly, any Level C3 protective clothing necessarily meets Level C1 and Level C2 requirements. The strength requirements are the same for all levels of protection, and the puncture resistance test is not mandatory. If high puncture resistance is claimed, the item shall be tested as stated in Table 1 and the information supplied by the manufacturer shall include a statement informing the user that the item is suitable for scenarios where puncture risk exists.

NOTE The puncture resistance test may provide beneficial information for purchasers selecting protective clothing, including partial-body, for scenarios such as orchard spraying. It is not a mandatory requirement as puncture resistance may not be important for other scenarios.

Table 1 — Testing requirements for Level C1, C2, and C3 protective clothing, including partial-body

	Sub-clause	Performance test	Levels		
			C1	C2	C3
Material Requirements	6.2	Material resistance to penetration (ISO 22608)	x	x[a]	
	6.3	Material repellency (ISO 22608)		x	
	6.4	Material resistance to permeation (ISO 19918)			x[b]
	6.5	Tensile strength (ISO 13934-1)	x	x	x
	6.6	Tear resistance (ISO 9073-4 or ISO 13937-3 as applicable)	x	x	x
	6.7	Puncture resistance (ISO 13996)	x[c]	x[c]	x[c]
Seam requirements	7.2	Seam penetration resistance (ISO 22608)	x		
	7.3	Seam resistance to permeation (ISO 19918)			x[b]
	7.4	Seam tensile strength (ISO 13935-2)	x	x	X

[a] The minimum performance requirement for Level C2 is significantly higher than that for Level C1 (see 6.2).

[b] The permeation test is more severe than the penetration test. Therefore, material that meets 6.4 automatically meets the 6.2 penetration requirement. Also, if additional testing is required for a particular pesticide, the material shall also be tested for permeation resistance using the pesticide in question.

[c] Puncture resistance shall be tested if claimed by the manufacturer.

[d] Not required for partial-body protective clothing.

Table 1 *(continued)*

	Sub-clause	Performance test	Levels		
			C1	C2	C3
Whole protective clothing requirements	8.1	Practical performance test (Annex A)	x	x	X
	8.3.1	Low-level spray test (ISO 17491-4:2008, Method A)		x[d]	
	8.3.2	High-level spray test (ISO 17491-4:2008, Method B)			x[d]

[a] The minimum performance requirement for Level C2 is significantly higher than that for Level C1 (see 6.2).

[b] The permeation test is more severe than the penetration test. Therefore, material that meets 6.4 automatically meets the 6.2 penetration requirement. Also, if additional testing is required for a particular pesticide, the material shall also be tested for permeation resistance using the pesticide in question.

[c] Puncture resistance shall be tested if claimed by the manufacturer.

[d] Not required for partial-body protective clothing.

5 Pre-treatment and conditioning

5.1 Pre-treatment by cleaning

Specimens used for each test specified in Clauses 6, 7, and 8 shall be pre-treated by cleaning. The cleaning shall be in accordance with the manufacturer's instructions on the basis of standardized processes. If the manufacturer's instructions indicate that cleaning is not allowed, i.e. limited-use protective clothing, then testing shall be carried out on new material.

Testing shall be carried out for the number of cleaning cycles for which the manufacturer guarantees the performance. If the number of cleaning cycles is not specified, the tests shall be carried out after 30 cleaning cycles. In all cases, the number of cycles, after which testing was conducted, shall be included in accordance with Clause 10. If the manufacturer's instructions indicate that both dry cleaning and laundering are allowed, the test specimen shall undergo the laundering procedure only.

NOTE 1 One cleaning cycle consists of one washing and one drying.

NOTE 2 Drying can be omitted in the pre-treatment if the method specified by the manufacturer is not machine drying.

NOTE 3 Manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330, ISO 15797, ISO 3175-2 or equivalent as standardized processes for cleaning.

If re-treatment is required, detailed instructions shall also be provided in Clause 10.

5.2 Conditioning

All test specimens used for tests specified in Clause 6, Clause 7, and 8.2 shall be conditioned for at least 24 h in accordance with the conditions specified in the respective test standards.

6 Performance requirements of protective clothing materials

6.1 General

Specimens for testing shall be taken from the original garment or from material or materials used in the finished garment. The size, shape, and quantity shall be as required for each test procedure. If a material is constructed of multiple layers, the specimen shall be cut with the order of each layer maintained and tested with the outer layer on top. For protective clothing constructed from different types of materials in different body areas, each single material shall be tested separately.