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Protective clothing for protection against chemicals — Classification, labelling and performance requirements

Vêtements de protection contre les produits chimiques — Classification, étiquetage et exigences de performances

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Contents

Page

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 16602 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 range of general, industrial chemical protective clothing by designating specific design types and providing classification of clothing, material, and component performance. This International Standard is intended to provide comprehensive requirements for the performance classification and labelling of chemical protective clothing.

The selection of appropriate chemical protective clothing should be based on a risk assessment in which the user organization identifies the hazards, determines the potential for contact with individual workers, the consequences of exposure, and the type of practices or controls needed to eliminate or minimize exposure. When it is determined that chemical protective clothing is needed, the risk assessment should identify the type of chemical protective clothing needed in terms of its overall type and performance. This International Standard is intended to assist user organizations with these determinations.

Protective clothing for protection against chemicals — Classification, labelling and performance requirements

1 Scope

This International Standard establishes minimum performance classification and labelling requirements for protective clothing designed to provide protection against chemicals. Protective clothing items covered by this International Standard include, but may not be limited to, totally encapsulating suits, liquid-tight or spray-tight suits, coveralls, jackets, trousers, aprons, smocks, hoods, sleeves, and shoe and boot covers.

Chemical protective clothing for protection against airborne particles is addressed by ISO 13982-1, which is referenced in this International Standard. This International Standard does not address protection against solid chemicals in forms other than airborne solid particulates (e.g. it does not address the challenge of penetration of chemical dust and powders through materials and clothing by rubbing or flexing or by simple direct contact of dust or powders onto the clothing surface).

This International Standard does not address gloves, boots, eye/face protection devices and respiratory protective devices unless they are an integral part of the protective clothing. This International Standard does not address protection against biological or thermal (hot or cold) hazards, ionizing radiation, or radioactive contamination. This International Standard also does not address the specialized clothing used in hazardous chemical emergencies.

NOTE Chemical protective clothing used in hazardous chemical emergencies is addressed in other standards, such as EN 943-2, NFPA 1991 and NFPA 1992.

This International Standard is intended to provide chemical protective clothing manufacturers with minimum requirements for testing, classifying, and labelling chemical protective clothing. To assist the users of products covered under this International Standard, this document provides descriptions of referenced test methods, guidelines for conducting hazard and risk assessments and suggested performance levels for certain applications. It is not the intent of this International Standard to address all situations.

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 3758, *Textiles — Care labelling code using symbols*

ISO 6529:2001, *Protective clothing — Protection against chemicals — Determination of resistance of protective clothing materials to permeation by liquids and gases*

ISO 6530, *Protective clothing — Protection against liquid chemicals — Test method for resistance of materials to penetration by liquids*

ISO 7854:1995, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing*

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

ISO/TR 11610, *Protective clothing — Vocabulary*

ISO 12947-2, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown*

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 13938-1, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*

ISO 13982-1, *Protective clothing for use against solid particulates — Part 1: Performance requirements for chemical protective clothing providing protection to the full body against airborne solid particulates (type 5 clothing)*

ISO 13982-2, *Protective clothing for use against solid particulates — Part 2: Test method of determination of inward leakage of aerosols of fine particles into suits*

ISO 13994:2005, *Clothing for protection against liquid chemicals — Determination of the resistance of protective clothing materials to penetration by liquids under pressure*

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

ISO 17491:2002, *Protective clothing — Protection against gaseous and liquid chemicals — Determination of resistance of protective clothing to penetration by liquids and gases*

EN 136:1998, *Respiratory protective devices — Full face masks — Requirements, testing, marking*

EN 13274-3:2001, *Respiratory protective devices — Methods of test — Determination of breathing resistance*

EN 13274-4:2001, *Respiratory protective devices — Methods of test — Part 4: Flame tests*

EN 14594:2005, *Respiratory protective devices — Continuous flow compressed air line breathing apparatus — Requirements, testing, marking*

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
assemblage
permanent fastening between two or more different garments, or between chemical protective clothing and accessories

EXAMPLE Permanent fastening may be obtained by sewing, welding, vulcanizing, gluing.

3.2
chemical protective suit
clothing worn to protect against chemicals that covers the whole, or greater part of the body

NOTE 1 A chemical protective suit can consist of garments combined together to provide protection to the body. A suit can also have various types of additional protection such as hood or helmet, boots and gloves joined with it.

NOTE 2 These garments are full-body protective clothing, i.e. covering trunk, arms and legs, such as one-piece coveralls or two-piece suits, with or without hood or visors, with or without foot protection.

3.3
closure
device to close openings for donning of protective clothing

EXAMPLE A zipper, “touch and close” fastener.

3.4
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 For the purpose of this International Standard, protective clothing materials include those materials used in the construction of the suit or clothing which 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. Materials used in the construction of integral visors, gloves and footwear are tested for performance separately either in this International Standard or to standards specific to the items being evaluated.

4 Classification and minimum testing of chemical protective clothing

4.1 General

All chemical protective clothing shall be tested for integrity and material chemical resistance and shall be classified by type based on its minimum integrity and material chemical resistance according to the categories of performance given in Table 1.

Each type of chemical protective suit and clothing item shall also meet the other requirements for the overall item, component, and material performance as specified in this International Standard.

Table 1 — Classification by type of chemical protective clothing

General performance	Sub-clause	Specific performance test	Type of chemical protective clothing							
			1a	1b	1c	2	3[a]	4[a]	5	6[a]
Whole chemical protective clothing item integrity	5.4	Leak tightness	X	X	X	—	—	—	—	—
	5.5	Inward leakage	—	X[b]	X	X	—	—	—	—
	5.6	Liquid jet test	—	—	—	—	X	—	—	—
	5.7	Liquid spray test	—	—	—	—	—	X	—	—
	5.8	Particle aerosol inward leakage test	—	—	—	—	—	—	X	—
	5.9	Limited liquid spray test	—	—	—	—	—	—	—	X
Chemical resistance of protective clothing material[c]	6.5	Permeation resistance	X	X	X	X	X	X	—	—
	6.6	Resistance to penetration by liquid under pressure	—	—	—	—	—	X[d]	—	—
	6.7	Particulate penetration resistance	—	—	—	—	—	—	—[e]	—
	6.8	Liquid penetration resistance	—	—	—	—	—	—	—	X
	6.9	Liquid repellency	—	—	—	—	—	—	—	X

a When not providing coverage of the torso, arms, and legs, Types 3, 4, and 6 clothing are partial body protective clothing meeting only the material chemical resistance requirements for the respective type.

b Applicable to Type 1b chemical protective suits when the face piece is not permanently attached to the suit.

c Applicable to primary material used in construction of chemical protective clothing item; may or may not be applicable to seams (see Clause 7).

d Either permeation resistance test or test for resistance to penetration by liquid under pressure shall be applied.

e A test for evaluating the performance of protective clothing materials against particles is not recommended at this time.

4.2 Type 1: "Gas-tight" chemical protective suit

Gas-tight suits shall cover the whole body, including hands, feet and head. Type 1 chemical protective suits are further classified as Types 1a, 1b and 1c, as follows.

a) **Type 1a:** Gas-tight chemical protective suit with a breathing air supply that is independent of the ambient atmosphere worn inside the suit.

EXAMPLE A chemical protective suit with a self-contained breathing apparatus worn *inside* the suit.

b) **Type 1b:** Gas-tight chemical protective suit with a breathing air supply that is independent of the ambient atmosphere worn outside the suit.

EXAMPLE A chemical protective suit with the self-contained breathing apparatus worn *outside* the suit.

NOTE When chemical protective suits are used with respiratory protective equipment, it is advisable that respiratory protective equipment selection be in accordance with the respective local regulations for respiratory protection.

c) **Type 1c:** Gas-tight chemical protective suit with an external source of breathable air providing positive pressure inside the suit.

EXAMPLE A gas-tight airline chemical protective suit.

All Type 1 chemical protective suits shall be evaluated for leak tightness and shall pass a pressure test. In addition, Type 1c chemical protective suits shall be evaluated for inward leakage and pass the inward leakage test. All Type 1 chemical protective suits shall have materials that demonstrate chemical permeation resistance.

4.3 Type 2: "Non-gas-tight" chemical protective suit

Gas-tight suits shall cover the whole body, including hands, feet and head. A "non-gas-tight" chemical protective suit with breathable air providing positive pressure inside the suit from an independent source.

EXAMPLE An airline suit which is not gas-tight.

Type 2 chemical protective suits shall be evaluated for inward leakage and shall pass the inward leakage test, and shall have materials that demonstrate chemical permeation resistance.

4.4 Type 3: "Liquid-tight" chemical protective clothing

Full body chemical protective clothing with liquid-tight connections between different parts of the clothing, and to gloves and boots to protect the wearer against liquid chemicals.

EXAMPLE One-piece coverall, or two-piece suit, with or without hood or visor, with or without boot-socks.

Type 3 chemical protective clothing shall be evaluated for resistance to penetration by liquids and shall pass the continuous liquid jet test, and shall have materials that demonstrate chemical permeation resistance.

4.5 Type 4: "Spray-tight" chemical protective clothing

Full body chemical protective clothing with spray-tight connections between different parts of the clothing, and to gloves and boots to protect the wearer against liquid chemicals.

EXAMPLE One-piece coverall, or two-piece suit, with or without hoods or visors, with or without boot-socks.

Type 4 chemical protective clothing shall be evaluated for resistance to penetration by liquids and shall pass the liquid spray test, and shall have materials that demonstrate liquid penetration resistance under pressure or chemical permeation resistance.

4.6 Type 5: Chemical protective clothing providing protection against airborne solid chemicals

Full body chemical protective clothing, with or without gloves and boots to protect the wearer against airborne solid chemicals.

EXAMPLES One-piece coveralls, or two-piece suits, with or without hoods or visors, with or without boot-socks.

Type 5 chemical protective clothing shall meet the requirements of ISO 13982-1.

NOTE This International Standard does not address protection against solid chemicals in forms other than airborne solid particulates (e.g. it does not address the challenge of penetration of chemical dust and powders through materials and clothing by rubbing or flexing or by simple direct contact of dust or powders onto the clothing surface).

4.7 Type 6: Chemical protective clothing with "limited protective performance against liquid chemicals"

Full body chemical protective clothing with limited spray-tight connections between different parts of the clothing, and to gloves and boots to provide limited protection of the wearer against liquid chemicals.

EXAMPLE One-piece coverall or two-piece suit, with or without hood or visor, with or without boot-socks or overbooties.

Type 6 chemical protective clothing shall be evaluated for resistance to penetration by liquids and pass the limited liquid spray test, and shall have materials that demonstrate liquid penetration resistance and repellency.

4.8 Partial body ("PB") chemical protective clothing

Chemical protective clothing that does not provide full body coverage.

EXAMPLES Aprons, boot/shoe covers, gowns, hoods, jackets, labcoats, sleeve protectors and smocks.

Type 3, Type 4, or Type 6 shall be designated as partial body chemical protective clothing, when covering only part of the body. The abbreviation “PB” shall preceed the designation for these clothing types in parentheses.

EXAMPLES Type PB(3), Type PB(4) and Type PB(6).

Partial body chemical protective clothing shall have materials which demonstrate permeation resistance for Type PB(3), resistance to penetration by liquid under pressure or permeation resistance for Type PB(4), or liquid penetration resistance and repellency for Type PB(6). Integrity requirements for partial body chemical protective clothing shall not apply.

5 Performance requirements of overall chemical protective clothing

5.1 General

Chemical protective clothing shall be tested to the requirements specified in Table 2 for its classified type when tested as a complete suit or clothing item.

Table 2 — Performance requirements for whole suits and clothing items

Sub-clause	Specific requirement	Chemical protective clothing type[a]							
		1a	1b	1c	2	3	4	5[b]	6
5.4	Leak tightness	X	X	X	—	—	—	—	—
5.5	Inward leakage	—	X[c]	X	X	—	—	—	—
5.6	Liquid penetration resistance (jet test)	—	—	—	—	X	—	—	—
5.7	Liquid penetration resistance (spray test)	—	—	—	—	—	X	—	—
5.8	Resistance to penetration by airborne solid particles	—	—	—	—	—	—	X[b]	—
5.9	Limited liquid penetration resistance (modified spray test)	—	—	—	—	—	—	—	X
5.10	Practical performance	X	X	X	X	—[d]	—[d]	—	—[d]
5.11	Face piece	X	X	—	—	—	—	—	—
5.12	Airline pass-through for use with self-contained breathing apparatus	X	—	—	—	—	—	—	—
5.13	Air-supply system	—	—	X	X	—	—	—	—
5.14	Breathing hose and ventilation hose	—	X[e]	X	X	—	—	—	—
5.15	Air flow rate	—	—	X	X	—	—	—	—
5.16	Exhaust assemblage	X	X[f]	X	X	—	—	—	—
5.17	Pressure in chemical protective suit	X	X[g]	X	X	—	—	—	—
5.18	Inhalation air	—	—	X	X	—	—	—	—

[a] Partial body chemical protective clothing is not evaluated to any of the requirements listed in this table.

[b] Type 5 chemical protection clothing demonstrates resistance to penetration by solid airborne particles by meeting the requirements of ISO 13982-1.

[c] Inward leakage test is required for Type 1b chemical protective suits when the facemask is not permanently attached.

[d] Practical performance of Type 3,4 and 6 chemical protective clothing is evaluated during conditioning by wearing prior to testing of the whole suit.

[e] Type 1b chemical protective suits shall be evaluated for specific requirements related to the external ventilating hose when the self-containing breathing apparatus is worn outside the suit and air from the breathing apparatus cylinder is fed into the suit for ventilation.

[f] Type 1b chemical protective suits shall be fitted with an exhaust assemblage if the exhalation valve of the respiratory protective equipment is not free to discharge directly to atmosphere, or where supplementary air for ventilation is supplied to the suit.

[g] Type 1b chemical protective suits shall only be tested when an exhaust assemblage is fitted.

5.2 Temperature conditioning

When temperature conditioning is specified for an overall chemical protective clothing test, the complete clothing item shall be exposed:

a) for no less than 4 h to a temperature of (−30 ± 3) °C and allowed to return to ambient conditions; followed by

b) for no less than 4 h to an atmosphere of (60 ± 3) °C at 95 % relative humidity.

The clothing item shall then be allowed to return to ambient temperature. If these temperatures are incompatible for the clothing item, the manufacturer shall select alternative conditions and provide the following statement in the product technical information for the protective clothing item along with a specific temperature range for use of the product:

"This product has been conditioned at a different set conditions than specified in ISO 16602. Conditioning has been performed at [list conditions in terms of temperature (°C) and relative humidity (%)]."

5.3 Conditioning by wearing

When conditioning by wearing is specified for an overall chemical protective clothing test, the chemical protective clothing shall be worn and the test subjects shall perform three series of the exercises in Procedure C of Annex A. Testing shall be performed using test subjects whose body measurements correspond to ± 5 % of the upper width limit and to ± 2 % of the upper height limit on the size range marking of the chemical protective clothing being tested.

5.4 Leak tightness

When tested in accordance with ISO 17491:2002, Method A2, Type 1a, Type 1b and Type 1c chemical protective suits shall not have a pressure drop of more than 20 % after the pressure/inflation period. Leak tightness testing shall be performed on two chemical protective suits.

5.5 Inward leakage

When tested for inward leakage as specified in the ISO 17491:2002, Method B1 or B2, Type 1c and Type 2 chemical protective suits shall not have an inward leakage greater than 0,05 %. Type 1b chemical protective suits shall be tested for inward leakage when the facemask is not permanently joined to the suit, and shall not have an inward leakage greater than 0,05 % in the ocular cavity of the mask. Inward leakage testing shall be performed on two sample clothing items. A separate test subject shall be used for each test.

5.6 Liquid penetration resistance (jet test)

Type 3 chemical protective clothing shall be conditioned by wearing according to Procedure C of Annex A and, when subsequently tested for liquid penetration resistance using a jet test in accordance with ISO 17491:2002, Method C, shall show no penetration greater than three times the total calibrated stain area. Liquid penetration resistance testing shall be performed on two sample clothing items using a separate test subject for each test.

5.7 Liquid penetration resistance (spray test)

Type 4 chemical protective clothing shall be conditioned by wearing according to Procedure C of Annex A and, when subsequently tested for liquid penetration resistance using a spray test in accordance with ISO 17491:2002, Method D1, shall show no penetration greater than three times the total calibrated stain area. Liquid penetration resistance testing shall be performed on two sample clothing items using a separate test subject for each test.

5.8 Resistance to penetration by airborne solid particles

Type 5 chemical protective clothing shall meet the requirements of ISO 13982-1, when tested according to ISO 13982-2.

5.9 Limited liquid penetration resistance (modified spray test)

Type 6 chemical protective clothing shall be conditioned by wearing according to Procedure C of Annex A and, when subsequently tested for limited liquid penetration resistance using a modified spray test in accordance with ISO 17491:2002, Method F, using a 1 min exposure, shall show no penetration greater than three times the total calibrated stain area. Liquid penetration resistance testing shall be performed on two sample clothing items using a separate test subject for each test.

5.10 Practical performance

When tested for practical performance using both Procedures A and B in accordance with Annex A, Type 1 or 2 chemical protective suits and clothing shall meet the following criteria.

a) All chemical protective suits and full-body chemical protective clothing shall not restrict the test subject from performing any task.

b) During the practical performance test, the test subject shall be asked to read a sign with four letters 100 mm high and 20 mm wide selected at random at a distance of 6 m. For chemical protective clothing with hoods that are not at a fixed distance from the wearer's eyes, the hood/visor shall be worn in the typical wearing position.

c) The following attributes shall be subjectively assessed by the wearer and recorded, only if any of the following items prevent the wearer from carrying out any exercise of the practical performance test:

   — harness comfort;

   — security of fastenings and couplings;

   — accessibility of controls and pressure gauge (if fitted);

   — clarity of vision from the face piece or visor;

   — peripheral vision in case of chemical protective suits and clothing fitted with visors

   — clothing comfort;

   — ease of speech transmission;

   — any other comments volunteered by the wearer.

The practical performance test shall be performed on two separate chemical protective suits or clothing items with one of the tests performed on the chemical protective suit or clothing item after temperature conditioning (see 5.2). Testing shall be permitted at other conditions when needed for the intended use area.

Type 1a, Type 1b, Type 1c suits shall fulfil the leaktightness requirements of 5.4.

5.11 Face piece

If a Type 1a or Type 1b chemical protective suit uses a full face piece, the face piece shall meet the Class 2 or Class 3 requirements of EN 136:1998.

If a Type 1b chemical protective suit incorporates a full face piece bonded or fixed in such a way that the connection is integral to the suit, the system of joining the full face piece shall not interfere with the face to mask seal or any other function of the face piece when tested as specified in the practical performance test (see 5.10).

If the face piece is attached to a Type 1b chemical protective suit in a non-permanent manner, the sealing mechanism shall be tested for liquid penetration resistance using a jet test in accordance with ISO 17491:2002, Procedure C, and shall show no penetration greater than three times the calibrated stain area. Two samples of face piece to suit joints shall be tested after temperature conditioning (see 5.2).

5.12 Airline pass-through for use with self-contained breathing apparatus

If the Type 1a chemical protective suit is fitted with an airline pass-through, the pass-through and connections to the suit and body shall be evaluated as part of the practical performance test (see 5.10) and shall not impede the test subject from completing any tasks.

If the Type 1a chemical protective suit is fitted with an airline pass-through, the pass-through shall be tested for installation strength as specified in the pass-through and assemblage strength test in Annex B, and shall not separate from the suit material under an applied force of 1 000 N. Two specimen pass-throughs shall be tested.

5.13 Air-supply system

5.13.1 General

The air supply system for Type 1c and Type 2 chemical protective suits shall be evaluated for specific performance requirements related to the air supply system and its components, including the couplings and connections.

If a mobile high-pressure air supply is to be used, it shall comply with EN 14594:2005, 6.10. If a stationary high-pressure air supply is to be used, it shall comply with the performance criteria specified by the manufacturer of the chemical protective suit. Two separate chemical protective suits shall be evaluated.

The air delivered by the air supply system should conform to local regulations for breathing air quality.

5.13.2 Couplings

The equipment shall be constructed so that any twisting of the hoses and tubes does not affect the fit or performance of the suit or respiratory equipment, or cause the hoses or tubes to become disconnected. The design of the coupling shall be such as to prevent unintentional interruption of the air supply. Where a hand-operated connection is fitted to the outlet of the compressed air tube, it shall incorporate a self-sealing coupling to seal the air supply to the suit.

Couplings shall be evaluated as part of the practical performance (see 5.10).

5.13.3 Connections

Components of the respiratory protective equipment shall be readily separated for cleaning, examination and testing. All demountable connections shall be readily connected and secured, where possible by hand. Any means of sealing used shall be retained in position when the joints and couplings are disconnected using normal maintenance.

Connections shall be evaluated as part of the practical performance (see 5.10).

5.13.4 Connections strength

The connection between the compressed air supply tube and the chemical protective suit, including attachments, thread parts, belt, or other parts, or means of stabilizing the suit to the body shall not separate when tested in accordance with EN 14594:2005, 7.2 and 7.6. Two separate connections shall be evaluated.

This evaluation should be performed before the inward leakage test.

5.13.5 Performance of pass-through system

The complete pass-through system shall deliver a minimum of 300 l/min at 550 kPa (5,5 bar). If the manufacturer specifies a minimum flow rate and pressure, the pass-through system shall be evaluated at the alternative flow rate and pressure. Two separate pass-through systems shall be evaluated.

5.14 Breathing hose and ventilating hose

5.14.1 General

Type 1c and Type 2 chemical protective suits shall be evaluated for specific performance requirements related to the breathing hose. If provided on Type 1c and Type 2 chemical protective suits, the breathing hose may be fitted internally and/or externally.

Type 1b chemical protective suits shall be evaluated for specific requirements related to the external ventilating hose when the self-containing breathing apparatus is worn outside the suit and air from the breathing apparatus cylinder is fed into the suit for ventilation.

Two sample chemical protective suits shall be evaluated

5.14.2 External breathing hose

If fitted with an external breathing hose, the external breathing hose for Type 1c and Type 2 chemical protective suits shall be of sufficient flexibility to enable the wearer to carry out all tasks and permit free head movement when evaluated as part of the practical performance test (see 5.10).

The hose should not be of a length that would enable it to be easily caught on obstructions.

When tested for strength in accordance with EN 14594:2005, 7.4, the connections between the suit and the external breathing hose shall withstand a pull test of 250 N. One system shall be tested as received. A second system shall be tested after temperature conditioning (see 5.2).

5.14.3 Resistance to collapse of external breathing hose

When tested at a force of (50 ± 2,5) N in accordance with EN 14594:2005, 7.5, the air flow through the external breathing hose shall not be reduced by more than 5 %. The external breathing hose shall not show a permanent deformation greater than 20 % of the original diameter. Two external breathing hoses shall be evaluated for this performance after temperature conditioning (see 5.2).

5.14.4 Internal breathing hose

When tested at a force of (50 ± 2,5) N with the method described in EN 14594:2005, 7.6, the connections of the internal breathing hose shall withstand a pull test of (50 ± 2,5) N both before and after temperature conditioning (see 5.2). One specimen for each condition shall be tested.

5.14.5 Resistance to collapse of internal breathing hose

When tested at a force of (50 ± 2,5) N in accordance with EN 14594:2005, 7.5, the air flow through the internal breathing hose shall not be reduced by more than 5 %. The internal breathing hose shall not show a permanent deformation greater than 20 % of the original diameter. At least two internal breathing hoses shall be evaluated for this performance after temperature conditioning (see 5.2).

5.14.6 External ventilating hose

If fitting with an external ventilated hose, the external ventilating hose of Type 1b chemical protective suits shall be of sufficient flexibility to enable the wearer to carry out all tasks and permit free head movement when evaluated as part of the practical performance test (see 5.10).

The hose should not be of a length that would enable it to be easily caught on obstructions.

When tested for strength in accordance with EN 14594:2005, 7.4, the connections between the suit and the external ventilating hose shall withstand a pull test of 250 N both before and after temperature conditioning (see 5.2). Two specimens shall be tested.

5.14.7 Resistance to collapse of external ventilating hose

When tested at a force of (50 ± 2,5) N in accordance with EN 14594:2005, 7.5, the air flow through the external ventilating hose shall not be reduced by more than 5 %. The external ventilating hose shall not show a permanent deformation greater than 20 % of the original diameter. Two external ventilating hoses shall be evaluated for this performance after temperature conditioning (see 5.2).

5.15 Air flow rate

5.15.1 General

The flow rate and distribution of air into the Type 1c and Type 2 chemical protective suits shall not cause distress to the wearer by local cooling when evaluated as part of the practical performance test (see 5.10). Two devices shall be tested with one of the devices tested after temperature conditioning (see 5.2).

5.15.2 Continuous flow valve

A continuous flow valve, when fitted in Type 1c and Type 2 chemical protective suits, shall be easily adjusted by the wearer to supply air as required when evaluated as part of the practical performance test (see 5.10). The minimum air flow rate shall be measured at the delivery pressure specified by the manufacturer. The maximum air flow rate shall be measured at the delivery pressure specified by the manufacturer. The maximum and minimum length of the compressed air supply tube shall be used for the evaluation of the minimum and maximum flow, respectively. The continuous flow valve shall not be able to deliver less than the minimum design flow rate specified by the manufacturer when tested as specified in overall suit air flow test in Annex C. The control valve shall enable the wearer to adjust the air flow rate in the limits of the minimum and the maximum air flow rate specified by the manufacturer when tested.

5.15.3 Warning and measuring facilities

Type 1c and Type 2 chemical protective suits shall be provided with a means to check that the manufacturer's minimum design flow rate is exceeded prior to each use. Type 1c and Type 2 chemical protective suits shall be fitted with a warning device that immediately draws the attention of the wearer to the fact that the manufacturer's minimum design flow rate is not being achieved. The air-supply system of Type 1c and Type 2 chemical protective suits shall provide a means for checking the correct functioning of the warning facility.

If an audible warning device is fitted to the air supply system of Type 1c and Type 2 chemical protective suits, the sound pressure level at the wearer’s ears of the warning device shall be in the range of 85 dB to 90 dB (A-weighted). The frequency range of the warning device shall be between 2 000 Hz and 4 000 Hz.

The warning and measuring facilities shall be evaluated as part of the practical performance test (see 5.10) and in accordance with EN 14594:2005, 6.11. A total of two devices shall be tested with one of the devices subjected to temperature conditioning (see 5.2) prior to testing.

5.15.4 Compressed air supply tube

The compressed air supply tube for Type 1c and Type 2 chemical protective suits shall comply with EN 14594:2005, 6.12.

5.16 Exhaust assemblage

Type 1a, Type 1c and Type 2 chemical protective suits shall be provided with an exhaust assemblage that may consist of one or more exhalation valves. Type 1b chemical protective suits shall be fitted with an exhaust assemblage if the exhalation valve of the respiratory protective equipment is not free to discharge directly to atmosphere, or where supplementary air for ventilation is supplied to the suit.

NOTE It may be necessary to add an exhaust valve to Type 1b suits, even if the respiratory air does not discharge into the suit, to release air trapped in the suit when it is donned.

When individual exhaust valves are tested as specified in the exhalation valve leakage test in Annex D, the pressure change shall not exceed 0,1 kPa in 1 min. Two exhaust valves shall be tested.

5.17 Pressure in chemical protective suit

When Type 1a chemical protective suits are tested as specified in the overall suit airflow test in Annex C, the maximum internal suit pressure shall not exceed 100 mm water column height (1,0 kPa) and the chemical protective suit shall not have a pressure drop of more than 20 % during the 4 min test period during the post-air flow test leak tightness test. Two chemical protective suits shall be tested after temperature conditioning (see 5.2). Type 1b chemical protective suits shall only be tested when an exhaust assemblage is fitted.

5.18 Inhalation air

5.18.1 Breathing resistance

If the breathing air is taken directly from Type 1c and Type 2 chemical protective suits, the breathing resistance shall meet 6.18.2.1 and 6.18.2.2 of EN 14594:2005 when tested in accordance with EN 13274-3:2001, method 2, adjustment E, when the suit is fitted over the appropriate headform and manikin body. If the air is supplied to a full facemask, the breathing resistance shall meet 6.18.1.1 and 6.18.1.2 of the requirements specified in EN 14594:2005 when tested in accordance with EN 13274-3:2001, method 2, adjustment E.

5.18.2 Carbon dioxide content of inhalation air

The carbon dioxide content of the inhalation air shall comply with EN 14594:2005, 6.19, when the suit is fitted over the appropriate headform and manikin body.

5.18.3 Noise associated with the air supply to the suit

The noise associated with the air supply shall comply with the requirements of EN 14594:2005, 6.16.2.5, when tested at the manufacturer's maximum design flow rate. Two air supply systems shall be evaluated.

6 Performance requirements of chemical protective clothing materials

6.1 General

Chemical protective clothing materials shall be tested in accordance with the requirements provided in Table 3 for its classified type.

Table 3 — Performance requirements for materials

Sub-clause	Specific requirement	Type of chemical protective clothing							
		1a	1b	1c	2	3	4	5[a]	6
6.5	Permeation resistance	X	X	X	X	X	— X[b]	—	—
6.6	Resistance to penetration by liquid under pressure	—	—	—	—	—	X[b]	—	—
6.7	Particulate penetration resistance	—	—	—	—	—	—	—	—
6.8	Liquid penetration resistance	—	—	—	—	—	—	—	X
6.9	Liquid repellency	—	—	—	—	—	—	—	X
6.10	Tensile strength	X	X	X	X	X	X	—	X
6.11	Tear (trapezoidal) resistance	X	X	X	X	X	X	—	X
6.12	Puncture resistance	X	X	X	X	X	X	—	X
6.13	Burst strength	X	X	X	X	X	X	—	X
6.14	Abrasion resistance[c]	X	X	X	X	X	X	—	X
6.15	Flex cracking resistance[c]	X	X	X	X	X	X	—	X
6.16	Resistance to flame	X	X	X	X	X	X	—	X

a Type 5 performance is defined by ISO 13982-1.

b Either permeation resistance test or test for resistance to penetration by liquid under pressure shall be applied.

c Abrasion and flex cracking resistance are conducted using an end point consistent with the expected integrity of the clothing material. Types 1, 2 and 3 clothing materials are evaluated for an end point using a pressure test; Types 4 and 6 clothing materials are evaluated for visual damage.

6.2 Preconditioning

All chemical protective clothing materials shall undergo five cycles of cleaning in accordance with the manufacturer's instructions before testing if the manufacturer's instructions indicate that the clothing can be cleaned. However, clothing and assemblies, which according to the manufacturer's instructions can be cleaned only less than five times, shall undergo only as many cycles of cleaning as indicated by the manufacturer's instructions.

6.3 Conditioning

All samples shall be conditioned by storage at (23 ± 3) °C and (60 ± 10) % relative humidity for at least 24 h. Testing of samples shall commence within 10 min of removing the sample from the conditioning atmosphere.

6.4 Testing temperature

Unless otherwise specified, all testing shall be conducted at the same conditions used for conditioning, (23 ± 3) °C and (60 ± 10) %, as specified in 6.3.

6.5 Permeation resistance

6.5.1 General

When tested in accordance with ISO 6529:2001, Method A (liquids) or Method B (gases), the chemical protective clothing material average time to reach a cumulative permeation of 150 µg/cm^2 shall be classified according to the

levels of performance provided in Table 4 for each chemical tested. If Class 6 performance is achieved, the total cumulative permeation at 480 min shall be reported.

NOTE Information on the use of cumulative permeation mass is provided in Annex E.

Materials used in Types 1, 2 and 3 chemical protective clothing shall achieve at least Class 3 performance against at least one of the chemicals listed in ISO 6529:2001, Annex A. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

Permeation resistance data should be reported for at least all the chemicals listed in ISO 6529:2001, Annex A.

Where testing is performed against chemicals known to have high levels of skin toxicity, a lower cumulative permeation mass shall be specified and the time to reach that cumulative permeation mass shall be reported with the notation that a different cumulative permeation mass is used for the reporting of chemical permeation resistance.

Materials used in Type 4 chemical protective clothing – unless tested and classified according to 6.6 for resistance to penetration by liquid under pressure – shall achieve at least permeation resistance Class 1 performance against the specific chemicals indicated by the manufacturer. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

If requested, the chemical protective clothing material may also be tested for other liquid chemicals with the results classified to the levels of performance provided in Table 4 and reported in the manufacturer's product technical information as specified in 10.3.

Table 4 — Classification of permeation resistance according to time to cumulative permeation of 150 µg/cm^2

Class	Time to cumulative permeation of 150 µg/cm^2 min
6	$\geqslant$ 480
5	$\geqslant$ 240
4	$\geqslant$ 120
3	$\geqslant$ 60
2	$\geqslant$ 30
1	$\geqslant$ 10

6.5.2 Classification of permeation resistance by breakthrough time (optional)

In addition to classifying the permeation resistance of the chemical protective clothing material according to average time to reach a cumulative permeation of 150 µg/cm^2, the option of classifying the material according to the normalized breakthrough time using a permeation rate of 0,1 µg/cm^{2}min, or the normalized breakthrough time using a permeation rate of 1,0 µg/cm^{2}min, or both normalized breakthrough times, may be chosen. The chemical protective clothing material average normalized breakthrough times shall be classified according to the levels of performance provided in Table 5. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

Table 5 — Classification of permeation resistance according to normalized breakthrough time (optional)

Class	Normalized breakthrough detection time min
6	> 480
5	> 240
4	> 120
3	> 60
2	> 30
1	> 10

6.6 Resistance to penetration by liquid under pressure

When tested in accordance with ISO 13994:2005, Method E, the chemical protective clothing material average penetration pressure shall be classified according to the levels of performance provided in Table 6. Materials used in Type 4 chemical protective clothing – unless tested and classified according to 6.5 for permeation resistance against specific chemicals indicated by the manufacturer – shall achieve at least Class 3 performance against three of the liquid chemicals listed in ISO 6529:2001, Annex A. The manufacturer shall indicate which three of the liquid chemicals shall be tested. These results shall be reported in the manufacturer's product technical information as specified in 10.3.

If requested, the material may also be tested for other liquid chemicals with the results classified to the levels of performance provided in Table 6 and reported in the manufacturer's product technical information as specified in 10.3.

Table 6 — Classification of penetration pressure

Class	Penetration pressure kPa
6	> 35
5	> 28
4	> 21
3	> 14
2	> 7
1	> 3,5

6.7 Particulate penetration resistance

Particulate performance of chemical protective clothing materials is not evaluated.

6.8 Liquid penetration resistance

When tested in accordance with ISO 6530, using a liquid splash application within 10 s, the chemical protective clothing material average penetration index shall be classified according to the levels of performance provided in Table 8 for each chemical tested in Table 7. Performance of at least Class 3 for at least one of the chemicals listed in Table 7 shall be required in order for a material to be classified as a Type 6 material. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

If requested, the material may also be tested for liquid chemicals other than those specified in Table 7 with the results classified to the levels of performance provided in Table 8 and reported in the manufacturer's product technical information as specified in 10.3.

Table 7 — List of minimum chemicals for penetration and repellency testing

Chemical	Concentration mass fraction, %	Temperature of chemical °C (± 2 °C)
Sulfuric acid	30 (aqueous)	20
Sodium hydroxide	10 (aqueous)	20
Butan-1-ol	undiluted	20
o-Xylene	undiluted	20
NOTE It is advisable that chemicals be of analytical purity grade.		

Table 8 — Classification of liquid penetration resistance

Class	Penetration index %
3	< 1
2	< 5
1	< 10

6.9 Liquid repellency

When tested in accordance with ISO 6530, using a liquid splash application within 10 s, the chemical protective clothing material average repellency index shall be classified according to the levels of performance provided in Table 9 for each chemical tested in Table 7. Performance of at least Class 3 for at least one of the chemicals listed in Table 7 shall be required in order for a material to be classified as a Type 6 material. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

If requested, the material may also be tested for liquid chemicals other than those specified in Table 7 with the results classified to the levels of performance provided in Table 9 and reported in the manufacturer's product technical information as specified in 10.3.

Table 9 — Classification of liquid repellency

Class	Repellency index %
3	> 95
2	> 90
1	> 80

6.10 Tensile strength

When tested in accordance with ISO 13934-1, the average chemical protective clothing material tensile strength shall be classified according to the levels of performance provided in Table 10 based on the lowest performing material direction. The results shall be reported in the manufacturer's product technical information as specified in 10.4.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the tensile strength shall be classified as described above unless the layer with the highest chemical barrier ruptures during testing. In this latter case, the tensile load at which rupture occurs shall be used for classification.

Materials used in Types 1 and 2 limited use chemical protective clothing shall achieve at least Class 3 performance. Materials used in Types 1 and 2 reusable chemical protective clothing shall achieve at least Class 4 performance. Materials used in Types 3, 4 and 6 chemical protective clothing shall achieve at least Class 1 performance.

Table 10 — Classification of tensile strength

Class	Tensile strength N
6	> 1 000
5	> 500
4	> 250
3	> 100
2	> 60
1	> 30

6.11 Tear resistance

When tested in accordance with ISO 9073-4, the chemical protective clothing material average tear resistance shall be classified according to the levels of performance provided in Table 11 for each material direction. The results shall be reported in the manufacturer's product technical information as specified in 10.4.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the tear strength shall be classified as described above unless the layer with the highest chemical barrier tears during testing. In this latter case, the tear load of this barrier layer shall be used for classification.

Materials used in Types 1 and 2 chemical protective clothing shall achieve at least Class 3 performance. Materials used in Types 3, 4 and 6 chemical protective clothing shall achieve at least Class 1 performance.

Table 11 — Classification of tear resistance

Class	Tear resistance N
6	> 150
5	> 100
4	> 60
3	> 40
2	> 20
1	> 10

6.12 Puncture resistance

When tested in accordance with ISO 13996, the chemical protective clothing material average puncture resistance shall be classified according to the levels of performance provided in Table 12. The results shall be reported in the manufacturer's product technical information as specified in 10.4.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the puncture resistance shall be classified as described above unless the layer with the highest chemical barrier is punctured during testing. In this latter case, the load at which puncture of this layer occurs shall be used for classification.

Materials used in Types 1 and 2 chemical protective clothing shall achieve at least Class 2 performance. Materials used in Types 3, 4 and 6 chemical protective clothing shall achieve at least Class 1 performance.

Table 12 — Classification of puncture resistance

Class	Puncture resistance N
6	> 250
5	> 150
4	> 100
3	> 50
2	> 10
1	> 5

6.13 Burst strength

When tested in accordance with ISO 13938-1, with a test ring of 50 cm^2, the average burst strength of the chemical protective clothing material shall be classified according to the levels of performance given in Table 13. There is no requirement to measure height at burst or volume at burst. The results shall be reported in the manufacturer’s product technical information as specified in 10.4.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the burst strength shall be classified as described above unless the layer with the highest chemical barrier bursts during testing. In this latter case, the pressure at which bursting occurs of this layer shall be used for classification.

Materials shall achieve at least Class 1 performance.

Table 13 — Classification of burst strength

Class	Burst strength KPa
6	> 850
5	> 640
4	> 320
3	> 160
2	> 80
1	> 40

6.14 Abrasion resistance

When tested in accordance with ISO 12947-2, using abrasive paper specified in Annex F and with an applied pressure of 9 kPa, the chemical protective clothing material abrasion resistance shall be classified using the number of abrasion cycles which cause damage to the material according to the levels of performance provided in Table 14. Four specimens shall be tested and the performance classified according to the lowest single result.

For Types 1, 2 and 3 chemical protective clothing material, material damage shall be determined as specified in the material specimen leakage test in Annex G. The material shall be considered to be damaged when the difference between unabraded material and abraded material exceeds 0,1 kPa (10 mm water column height) for 1 min.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the abrasion resistance shall be classified as described above unless the layer with the highest chemical barrier fails first during testing. In this latter case, the number of abrasion cycles at which failure of this layer occurs shall be used for classification.

For Types 4, and 6 chemical protective clothing materials, material damage shall be determined as wear which would impact the required integrity of the chemical protective clothing.

The performance of the material shall be classified according to the lowest level of performance of any single specimen. The results shall be reported in the manufacturer's product technical information as specified in 10.4.

Materials used in Types 1 and 2 chemical protective clothing shall achieve at least Class 3 performance. Materials used in Types 3, 4 and 6 chemical protective clothing shall achieve at least Class 1 performance.

Table 14 — Classification of abrasion resistance

Class	Abrasion cycles to specified damage
6	> 2 000
5	> 1 500
4	> 1 000
3	> 500
2	> 100
1	> 10

6.15 Flex cracking resistance

When tested in accordance with ISO 7854:1995, Method B, the chemical protective clothing material flex cracking resistance shall be classified using the number of flexing cycles which cause damage to the material according to the levels of performance provided in Table 15. Six specimens (three in longitudinal and three in transversal direction) shall be tested and the performance classified according to the lowest single result.

Additional testing at a test temperature of −30 °C with classification of the material's performance to Table 16 shall be permitted as an option.

For Types 1, 2 and 3 chemical protective clothing material, material damage shall be determined as specified in the material specimen leakage test in Annex G. The material shall be considered to be damaged when difference between unflexed material and flexed material exceeds 0,1 kPa (10 mm water column height) for 1 min.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the flex cracking resistance shall be classified as described above unless the layer with the highest chemical barrier fails first during testing. In this latter case, the number of flexing cycles at which failure of this layer occurs shall be used for classification.

For Types 4 and 6 chemical protective clothing material, material damage shall be determined visually as wear which would affect the required integrity of the chemical protective clothing.

The performance of the material shall be classified according to the lowest level of performance of any specimen. The results shall be reported in the manufacturer's product technical information as specified in 10.4. Materials used in Types 1 and 2 limited use chemical protective clothing shall achieve at least Class 1 performance for flex cracking resistance, and at least Class 2 for flex cracking resistance at −30 °C if this additional, optional testing is carried out.

Materials used in Types 1 and 2 reusable chemical protective clothing shall achieve at least Class 4 performance for flex cracking resistance, and at least Class 2 for flex cracking resistance at −30 °C if this additional, optional testing is carried out.

Materials used in Type 3, 4 and 6 chemical protective clothing shall achieve at least Class 1 performance for flex cracking resistance, and at least Class 1 for flex cracking resistance at −30 °C if this additional, optional testing is carried out.

Table 15 — Classification of flex cracking resistance

Class	Flexing cycles to specified damage
6	> 100 000
5	> 40 000
4	> 15 000
3	> 5 000
2	> 2 500
1	> 1 000

Table 16 — Classification of flex cracking resistance at −30 °C

Class	Flexing cycles to specified damage
6	> 4 000
5	> 2 000
4	> 1 000
3	> 500
2	> 200
1	> 100

6.16 Resistance to flame

When tested in accordance with EN 13274-4:2001, Method 3 modified to the sample exposure time given in Table 17, the chemical protective clothing material shall not form droplets and shall prove to be "self-extinguishing", i.e. it shall not be of a highly flammable nature and when tested shall not continue to burn for more than 5 s after removal from the flame. Three specimens shall be tested.

The chemical protective clothing material shall be classified for resistance to flame based on the sample exposure time as specified in Table 17. For the respective performance class, the protective clothing material shall not form molten droplets and shall not continue to burn for more than 5 s following removal from the flame.

Table 17 — Classification of resistance to flame

Class	Sample exposure time	Observed ignition performance
3	Sample is held in flame for 5 s	No formation of molten droplets; burning does not continue for more than 5 s following removal from flame
2	Sample is held in flame for 1 s	
1	Sample is passed through the flame	

To achieve the classification, the test sample shall pass the following leak tightness test after flame exposure.

For Types 1, 2 and 3 chemical protective clothing material, material damage shall be determined as specified in the material specimen leakage test in Annex G. The material shall be considered to be damaged when difference between unexposed material and exposed material exceeds 0,1 kPa (10 mm water column height) for 1 min.

If the chemical protective clothing consists of a combination of separate layers of materials, all layers shall be tested together and the flame resistance shall be classified as described above unless the layer with the highest chemical barrier fails first during testing. In this latter case, the sample exposure time at which failure of this layer occurs shall be used for classification.

For Types 4 and 6 chemical protective clothing material, ignition performance shall be determined visually as indicated in Table 17 above. No material specimen leakage test is required and even formation of large holes into the material by the flame does not disqualify the material.

7 Performance requirements of chemical protective clothing components and assemblies

7.1 General

The components and assemblies of chemical protective suits and clothing shall be tested in accordance with the following requirements as applicable.

7.2 Preconditioning

All chemical protective clothing components and assemblies shall undergo five cycles of cleaning according to the manufacturer's instructions before testing if the manufacturer's instructions indicate that the garment can be cleaned. However, clothing and assemblies which according to the manufacturer's instructions can be cleaned only less than five times shall undergo only as many cycles of cleaning as indicated by the manufacturer's instructions.

7.3 Conditioning

All samples shall be conditioned by storage at (23 ± 3) °C and (60 ± 10) % relative humidity for at least 24 h. Testing of samples shall commence within 10 min of removing the sample from the conditioning atmosphere.

7.4 Testing temperature

Unless otherwise specified, all testing shall be conducted at (23 ± 6) °C and (60 ± 20) % relative humidity.

7.5 Seams

7.5.1 General

Seams used in the construction of chemical protective clothing shall be tested for strength as specified in 7.5.2.

Seams used in the construction of Type 1a, Type 1b, Type 1c, Type 2, and Type 3 chemical protective suits and clothing shall be tested for permeation resistance as specified in 7.5.3.

Seams used in the construction of Type 4 chemical protective clothing shall be tested for permeation resistance as specified in 7.5.3 or for penetration pressure as specified in 7.5.4.

Chemical resistance testing of seams shall not be required for Types 5 or 6 chemical protective clothing.

7.5.2 Seam strength

A sample of each type of straight seam construction shall be tested in accordance with ISO 13935-2. Seam performance shall be classified according to the levels of performance given in Table 18 using the lowest measured seam strength for all types of seams tested. The results shall be reported in the manufacturer's product technical information as specified in 10.4.

NOTE The test method described in ISO 13935-2 only is applicable to seams joining two pieces of material.

Table 18 — Classification of seam strength

Class	Seam strength N
6	> 500
5	> 300
4	> 125
3	> 75
2	> 50
1	> 30

7.5.3 Seam permeation resistance

When tested as specified in 6.5 for permeation resistance, the average seam cumulative permeation shall be classified according to the levels of performance provided in Table 4 for each chemical tested.

Seams used in Types 1, 2 and 3 chemical protective clothing shall achieve at least Class 3 performance on the same chemicals listed in ISO 6529:2001, Annex A, as shown in the permeation testing of the protective clothing material. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

Seams used in Type 4 chemical protective clothing – unless tested according to 6.6 for resistance to penetration by liquid under pressure – shall achieve at least Class 1 performance against specific chemicals indicated by the manufacturer. The results shall be reported in the manufacturer’s product technical information as specified in 10.3.

Special gasketing, such as expandable PTFE sealant material, may be required in the test of samples that have uneven profiles that create difficulties in sealing the permeation test cell.

7.5.4 Seam penetration resistance

When tested as specified in 6.6 for resistance to penetration by liquid under pressure, the average seam penetration pressure shall be classified according to the levels of performance provided in Table 6 for each chemical tested.

Seams used in Type 4 chemical protective clothing – unless tested as specified in 6.5 for permeation resistance against specific chemicals indicated by the manufacturer like for the testing of the clothing material – shall achieve at least Class 3 performance on the same liquid chemicals listed in ISO 6529:2001, Annex A, as shown in the penetration pressure testing of the material. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

7.6 Integral visors

7.6.1 General

Where a visor is fitted as an integral part of a chemical protective suit or item of clothing, as distinct from a respirator face piece that is joined to the suit or clothing, the visor shall meet the requirements provided in 7.6.3, 7.6.4, and 7.6.5. Integral visors of Type 1a, Type 1b, Type 1c, Type 2, and Type 3 chemical protective suits or clothing shall also meet the requirement provided in 7.6.2.

7.6.2 Permeation resistance

When tested as specified in 6.5 for permeation resistance, the visor average time to reach a cumulative permeation of 150 µg/cm^2 shall be classified according to the levels of performance provided in Table 4 for each chemical tested. Visors used in Types 1, 2 and 3 chemical protective clothing shall achieve at least Class 3 performance on the same chemicals listed in ISO 6529:2001, Annex A, as shown in the permeation testing of the material. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

7.6.3 Distortion of vision and field of vision

The visor shall not distort the test subject's vision. It shall provide an acceptable field of vision when tested as specified in 5.10 for the practical performance test.

7.6.4 Impact resistance

When tested for impact in accordance with EN 14594:2005, 7.16, the visor shall not be damaged, i.e. the visor material shall not be broken.

7.6.5 Resistance to ignition

When tested in accordance with the procedure described in EN 13274-4:2001, Method 3, the visor material shall not continue to burn after passing through the flame.

7.7 Integral gloves

The permeation resistance of gloves, which are attached to Type 1a, Type 1b, Type 1c, Type 2 or Type 3 chemical protective suits or clothing, shall be measured as specified in 6.5 for permeation resistance and the average time to reach a cumulative permeation of 150 µg/cm^2 shall be classified according to the levels of performance provided in Table 4 for each chemical tested. Integral gloves used in Types 1, 2 and 3 chemical protective clothing shall be tested against the same chemicals as the clothing material, and shall meet the same permeation resistance performance requirement. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

Standards related to other properties of gloves including those for general performance and mechanical properties shall be reviewed to determine other appropriate performance levels.

7.8 Integral footwear

When footwear are attached to Type 1a, Type 1b, Type 1c, Type 2 or Type 3 chemical protective suits or clothing, the permeation resistance of footwear materials shall be measured as specified in 6.5 for permeation resistance. The thinnest portions of the chemical protective materials shall be tested. The average time to reach a cumulative permeation of 150 µg/cm^2 shall be classified according to the levels of performance provided in Table 4 for each chemical tested. Integral footwear used in Types 1, 2 and 3 chemical protective clothing shall be tested against the same chemicals as the clothing material, and shall meet the same permeation resistance performance requirement. The results shall be reported in the manufacturer's product technical information as specified in 10.3.

Special gasketing, such as expandable PTFE sealant material, may be required in the test of samples that have uneven profiles that create difficulties in sealing the permeation test cell.

Standards related to other properties of footwear including those for general performance and mechanical properties shall be reviewed to determine other appropriate performance levels.

7.9 Glove and footwear assemblage strength

When tested as specified in Annex B for the pass-through strength and assemblage strength test, the strength of joints and assemblies between the chemical protective suit or clothing and detachable parts, such as between gloves and sleeves, and footwear and trouser ends, shall provide passing performance. The results shall be reported in the manufacturer's product technical information as specified in 10.4.

8 Labelling

The protective clothing shall include a label that shall be permanently attached to the chemical protective clothing in a conspicuous location and shall include at least the following information in letters at least 1,5 mm high:

a) the name, trade mark, or other means for identifying the manufacturer;

b) the manufacturer's type number, identification, or model number for the suit or clothing;

c) the type of chemical protective clothing [e.g. Type 1a; Type PB(3); etc.];

d) a reference to this International Standard (ISO 16602);

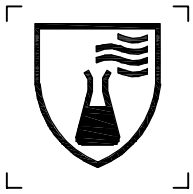
e) the year of manufacture, and also the month of manufacture if the expected shelf-life of the clothing is less than 24 months: this information may be marked on every commercial packaging unit instead of being marked on every item of clothing;

f) the size range as defined in ISO 13688;

g) the pictograms shown in Figure 1 showing that the protective clothing is for protection against chemicals and that the manufacturer's instructions should be read;

h) care pictograms in accordance with ISO 3758.

Consideration should be given to suitable additional marking.



ISO 7000-2414

ISO 7000-1641

Figure 1 — Pictogram for chemical protective clothing

9 Instructions for use

The manufacturer shall provide instructions with every chemical protective suit or clothing item or shall alternatively provide instructions with at least every commercial packaging unit. The purpose is to guarantee that the wearer is confronted with these instructions.

The instructions shall contain the information given on the label and at least the following information, as applicable:

a) pre-use information:

- safety considerations;
- limitations of use;
- methods for marking clothing for identification or visibility;
- type of respiratory protection with which the clothing is designed for use, if applicable (e.g. self-contained breathing apparatus);
- for Type 1c and Type 2 equipment, the manufacturer shall specify the required air supply pressure and flow range necessary to maintain adequate protection;
- if applicable, a statement to specify additional personal protective equipment with which the suit shall be worn, and how to attach or connect them, to achieve the claimed performance classification;
- closure lubricants, if applicable;
- visor/face piece antifog agents or procedures;
- recommended undergarments;
- expected shelf life if aging can occur;
- warranty information;

b) preparation for use:

- sizing and adjustment procedures;
- tests to be carried out by the wearer before use (if applicable);
- recommended storage practices;

c) inspection frequency and details;

d) don/doffing procedures;

e) maintenance and cleaning:

- cleaning instructions and precautions with a statement advising users not to use clothing or ensembles that are not thoroughly cleaned and dried;
- maintenance criteria and methods of repair where applicable;
- decontamination procedures, where practical and if applicable;
- all other relevant additional information on cleaning and disinfection (e.g. disinfecting agents to be used, maximum number of cleaning cycles, re-application of treatments);

f) retirement/disposal criteria and considerations:

— conditions or factors that significantly reduce the protective qualities of the chemical protective clothing;

— if applicable, disposal (contaminated chemical protective clothing may be harmful and should be disposed of as hazardous waste in accordance with national regulations).

The manufacturer shall provide illustrations, part numbers, technical information and other detail as necessary.

The manufacturer shall provide warnings, if appropriate, to provide information against possible problems with the use of the clothing or for misuse in unsuitable environments.

10 Product technical information

10.1 Information to be made available

Upon the request of the purchaser, the manufacturer shall make available all test results and classifications required by this International Standard. This information may be combined with the instructions for use (Clause 9).

10.2 General product information

A complete description of the product shall be given as to materials, component parts and assemblies.

10.3 Chemical resistance information

All chemical resistance test data shall be provided in a table for each material or seam tested. These data shall include a list of chemicals and chemical products (specifying the chemicals and their concentrations) to which the protective clothing has been tested or a reference to where this information can be obtained (e.g. manufacturer's telephone/fax number). Information on the chemicals should include the identification of those chemicals that are known to be readily absorbed through the skin.

Permeation resistance data shall include the average time to a cumulative permeation of 150 μg/cm^2 and the performance level for each chemical tested. Reporting of the average, maximum or steady-state permeation rate or normalized breakthrough time shall be optional.

Penetration pressure data shall include the average penetration pressure and the performance level for each chemical.

Penetration resistance data shall include the average penetration index and the performance level for each chemical.

Repellency data shall include the average repellency index and the performance level for each chemical.

In principle, the use of the clothing shall be restricted to the chemicals listed, but if the list represents only a selection of the available information, then this shall be clearly stated and the reference to where additional information can be obtained shall be mentioned (e.g. a separate brochure, the manufacturer's telephone or fax number, a web site on the internet).

10.4 Other test information

All other test data required by this International Standard shall be provided in a table of performance showing the test result(s) used for classification and the respective level of performance.

Annex A
(normative)

Test subject exercises for practical performance evaluation

A.1 Procedure A

The following exercises shall be performed as part of Procedure A:

a) Kneel on left knee, kneel on both knees, kneel on right knee, stand. Repeat exercise four times.

b) Duck squat, pivot right, pivot left, stand. Repeat exercise four times.

c) Stand erect. With arms at sides, bend body to left and return, bend body forward and return, bend body to right and return. Repeat exercise four times.

d) Stand erect. Extend arms overhead in the lateral direction, then bend elbows. Repeat exercise four times. Extend arms overhead in the frontal direction, then bend elbows. Repeat exercise four times.

e) Stand erect. Extend arms perpendicular to the sides of torso. Twist torso left and return, twist torso right and return. Repeat exercise four times.

f) Stand erect. Reach arms across chest completely to opposite sides. Repeat exercise four times.

g) Walk a distance of 100 m, or walk in place for a minimum duration of 3 min.

h) Crawl on hands and knees for a distance of 6 m, or crawl in place for a minimum duration of 1 min.

A.2 Procedure B

The following activities shall be performed as part of Procedure B:

a) Individually lift four standard shipping containers filled with a non-hazardous material weighing 10 kg. The boxes shall be constructed of fibreboard and have a volume of no less than 0,03 m^3.

b) Place a 200 l steel drum that is filled with 100 kg of non-hazardous material on a hand truck and move a distance of 8 m. Remove drum from hand truck. Replace drum on hand truck and move back to original location. Remove drum from hand truck.

c) Uncoil and coil two hoses, connect and disconnect both couplings. The hoses shall be 25 mm outside diameter rubber hoses. One hose shall have a screw-type connection on both ends. The other hose shall have a quick disconnect fitting on both ends.

d) Open and close an overhead valve. The valve shall have a diameter of 200 mm and shall be vertically positioned at the height of the test subject.

e) Remove and install a bolt with a wrench. A 250 mm long crescent wrench shall be used with a 12 mm diameter bolt.

f) Remove and install a screw with a screwdriver. A 250 mm long slotted screwdriver shall be used with a 9 mm diameter screw.

g) Climb to the fifth rung of a ladder. The ladder shall be a 3 m or longer ladder.

A.3 Procedure C

The following activities shall be performed as part of Procedure C:

A practical test shall be carried out by a human test subject. If more than one size of chemical protective suit is manufactured, the test subject will be asked to select the appropriate size according to the manufacturer's information leaflet. If applicable, the test subject shall also wear additional personal protective equipment, as specified in the manufacturer's instructions.

The test shall comprise three repetitions, at moderate speed, of the "seven movements" sequence described below.

Starting from a standing position in each case, carry out the following movement sequence:

— **movement 1**: kneel on both knees, lean forward and place both hands on the floor (45 ± 5) cm in front of the knees; crawl forward and backwards on hands and knees for a distance of three metres in each direction;

— **movement 2**: climb a vertical ladder at least four steps, rungs to be as encountered on a typical ladder;

— **movement 3**: position hands at chest level, palms out; reach directly overhead; interlock thumbs, extend arms fully upwards;

— **movement 4**: kneel on right knee, place left foot on floor with left knee bent (90 ± 10)°; touch thumb of right hand to toe of left shoe; repeat movement with alternate posture, i.e. by kneeling on left knee and placing the right foot on the floor with knee bent at 90°;

— **movement 5**: extend arms fully in front of body, lock thumbs together, twist upper body (90 ± 10)° left and right;

— **movement 6**: stand with feet shoulder width apart, arms at side; raise arms until they are parallel to the floor in front of the body; squat down as far as possible;

— **movement 7**: kneel as in movement 4, left arm hanging loosely at side; raise arm fully overhead; repeat movement with alternate posture by alternating arms.

If the test subject is not able to perform one or several movements due to the hindrance of the suit or if the movements result in substantial damage to the suit, the suit will be disqualified for further testing.

Suits equipped with a visor shall also pass the tests specified in 7.6 before further testing. Failure will result in a disqualification for further testing.

Annex B
(normative)

Pass-through strength and assemblage strength test

B.1 Pass-through installation

The pass-through or assemblage shall be installed in accordance with the manufacturer's instructions. If a glove or footwear item is not strong enough to apply the necessary force, then an item that can withstand this force without damage shall be substituted.

B.2 Test specimens

For pass-through specimens, the specimen shall include the pass-through installed in a 150 mm circle of garment material. Glove assemblages shall include the glove, point of attachment and 300 mm of the clothing sleeve beyond the point of attachment. Footwear assemblages shall include the footwear item, point of attachment and 300 mm of the clothing trouser end beyond the point of attachment.

B.3 Specimen set-up on testing apparatus

The pass-through, glove, or footwear specimen shall be attached to the movable clamp of a constant rate-of-extension tensile testing machine while the other end shall be attached to the fixed clamp of the tensile testing machine. For gloves, the base of the glove shall be attached. For footwear, the footwear, the upper area shall be attached 50 mm away from the assemblage or joint. The garment material end of the pass-through specimen shall be secured in a circular clamp that holds the pass-through parallel to the direction of pull by the tensile testing machine. The sleeve or trouser end portions of glove and footwear assemblage specimens, respectively, shall be secured in a clamp so as to prevent slippage of the garment material and allow the glove or footwear item to be pulled parallel to the direction of pull by the tensile testing machine.

B.4 Procedure

Apply the specified force longitudinally at a rate of (300 ± 10) mm/min. Record the force measured at breakage. If the pass-through or assemble breaks or separates, the item shall fail the test. For pass-through installed in chemical protective suits, the applied force shall be at least 1 000 N. The force shall be at least 1 000 N for life-lines, 250 N for equipment attachment points, 150 N for exhalation valves and 100 N for boots and gloves.

Annex C
(normative)

Airflow resistance test

C.1 Principle

The chemical protective suit shall be subjected to an inward flow of air and the resulting pressure inside the suit shall be measured. Type 1a and Type 1b chemical protective suits shall be tested at an inward flow of 300 l/min. Type 1c and Type 2 chemical protective suits shall be evaluated at the maximum design airflow in addition to 300 l/min. The pressure in the suit shall not exceed 1,0 kPa.

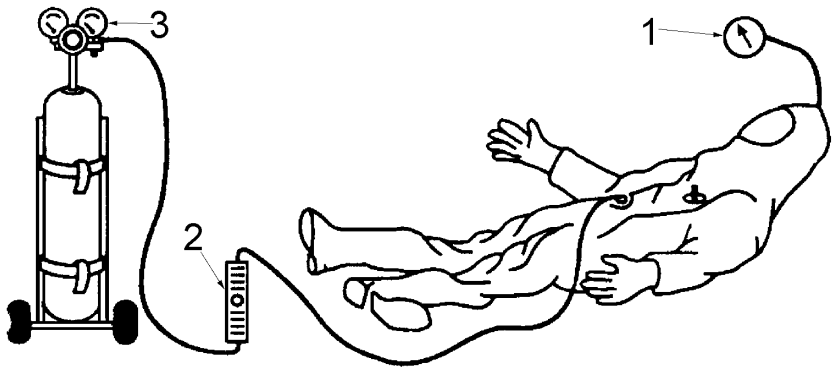
C.2 Test specimens

A minimum of two chemical protective suits shall be evaluated with one chemical protective suit tested after temperature conditioning (see 5.2).

C.3 Apparatus

C.3.1 Connections

A connector, installed in the chemical protective suit, capable of accommodating the attachment of an airline hose from a pressurized air source shall be installed for example in the mid-torso region of the chemical protective suit to be tested as indicated in Figure C.1. Alternatively, a fixture shall be installed through the sleeve end replacing the glove. The connector and airline hose shall allow an airflow rate of 600 l/min. The connector used in this test shall be permitted to be a standard airline connection that is used with airline respiratory equipment.



Key

1 pressure gauge
2 flow meter
3 compressed air source

Figure C.1 — Schematic test configuration for measuring maximum suit internal pressure

C.3.2 Flow meter

A flow meter capable of measuring airflow rates of 0 l/min to 1 000 l/min, with an accuracy of ± 25 l/min shall be used on the airline hose.

C.3.3 Pressure gauge

A pressure gauge capable of measuring pressures from 0 kPa to 2,5 kPa, with an accuracy of ± 0,025 kPa (0 mm to 250 mm water column) shall be attached via a second suit wall connector at the very top of the chemical protective suit.

C.4 Procedure

Install the two connectors in the suit at the locations described in C.3.1 and C.3.3.

During the test, attach the pressure gauge specified in C.3.3 to one connector on the chemical protective suit. Plug the other connector. During the test, apply a soapy water solution around the edges of the connectors to assure that no leakage occurs through the installed suit wall connectors.

Connect the suit to a pressurized air source capable of providing 1 000 l/min by attaching an air line to the installed mid-torso suit wall connector.

Beginning at time zero, allow air to flow into the suit at the rate specified for the type of chemical protective suit being tested.

After a period of 5 min, measure the pressure at the head connector.

C.5 Test report

The maximum internal suit pressure during the airflow period shall be reported.

Annex D
(normative)

Exhalation valve leakage test

D.1 Principle

A reduced pressure is applied to the internal side of the suit exhalation valve and the resulting pressure is measured to determine the level of leakage.

D.2 Test specimen

Individual exhalation valve including the means for their attachment to the chemical protective suit shall be evaluated. At least two exhalation valves shall be tested.

D.3 Test apparatus

A fixture for mounting the exhalation valve that allows for both the application of a reduced pressure to the valve interior side and the measurement of flow rate through the valve. The fixture shall be equipped with a pressure gauge capable of measuring 1 kPa (10 mbar) to an accuracy of $\pm$ 5%. The air volume between exhalation valve and pressure measurement device shall be (1 000 $\pm$ 50) ml.

D.4 Procedure

Create a pressure of -1 kPa (-10 mbar) at the inner side of the moistened exhalation valve. Close the valve to the source of reduced pressure. After 1 min, measure and record the residual pressure.

D.5 Test report

The pressure for each test shall be recorded. The average test pressure shall be used to determine compliance.

Annex E
(informative)

Use of time to cumulative mass for reporting material permeation resistance

E.1 General

The permeation testing protocols in this International Standard differ markedly from those in other CEN or ASTM standards. Previous protocols are based on the measurement of breakthrough time, which is defined as the time elapsed between initial chemical contact and the rate of chemical ingress reaching a reportable level.

Although this measurement has been loosely interpreted by many as a “safe wear time” for items of chemical protective clothing, it is entirely possible for significant, and possibly harmful, amounts of chemical to permeate though chemical protective clothing at a rate that is below this reportable level.

There are also historical differences between existing breakthrough reporting levels that make direct comparison of North American and European test results difficult. The move away from permeation breakthrough data provides an opportunity to begin to establish an international benchmark for permeation performance measurement.

E.2 Basis for classification system

This International Standard requires the reporting of the time taken for a defined mass of chemical to permeate through a known area of material. As such, the testing explicitly acknowledges that at the reported time a quantified degree of chemical permeation has taken place. This measurement can therefore be taken as a “time to failure” rather than a “safe wear time”.

The cumulative permeation mass represents the amount of chemical that permeates through a given area of material in a specific time. This value represents the potential maximum dose to the clothing wearer’s skin directly underneath the clothing material exposed to the chemical. A cumulative permeation mass of 150 µg/cm^2 is established as the basis for measuring permeation resistance, as this mass represents the resulting mass of chemical permeation that would occur when permeation resistance testing is performed with the determination of breakthrough time between the permeation rates of 0,1 µg/cm^2/min and 1,0 µg/cm^2/min, with the assumption that the measured breakthrough occurs at the end of a 480 min period. The cumulative permeation mass of 150 µg/cm^2 is arbitrary, but is considered to represent a conservative mass of permeating chemical with respect to the majority of industry chemicals that exhibit dermal effects.

E.3 Alternative cumulative permeation mass

This International Standard permits the use of a lower cumulative permeation mass when testing is performed against chemicals known to have high levels of skin toxicity. In these cases, the time to the lower specified cumulative permeation mass is reported and a notation is provided to indicate that a different method for interpreting material chemical resistance has been provided.

E.4 Conversion of permeation breakthrough time classifications

If the classification of permeation resistance is based on breakthrough time interpretation at a rate of 0,1 µg/cm^2/min, no testing or reinterpretation of existing data is needed. Even for Class 6 (i.e. breakthrough

time > 480 min), the maximum cumulative permeation is 48 µg/cm^2, which is well below 150 µg/cm^2 used in the ISO 16602 classification system.

If a material has already been classified according to EN 14325, permeation resistance "Class y" according to ISO 16602 can be derived from "Class x" according to EN 14325, as indicated in Table E.1.

Table E.1 — Comparison of EN 14325 permeation classes to ISO 16602 permeation classes

EN 14325 Class x	**Breakthrough time** min	**ISO 16602 Class y**	**Cumulative permeation** µg/cm^2
6	> 480	4	certain that < 150 only after 120 min
5	> 240	4	certain that < 150 only after 120 min
4	> 120	4	certain that < 150 after 120 min
3	> 60	3	certain that < 150 after 60 min
2	> 30	2	certain that < 150 after 30 min
1	> 10	1	certain that < 150 after 10 min

NOTE 1 For a material with EN Class 6 (Class 5), the actual cumulative permeation is at most just below 480 µg/cm^2 (240 µg/cm^2), and it is sure that it has been at most 120 µg/cm^2, therefore also < 150 µg/cm^2, after only 120 min. Consequently, ISO Class 4 can be claimed without an explicit knowledge of the permeation curve.

NOTE 2 If the permeation curve (i.e. the curve of permeation rate versus time) is not known with sufficient precision, new permeation testing is needed if an evaluation is to be done as to whether a material with EN breakthrough time "Class x" may eventually be rated better than ISO 16602 cumulative permeation "Class y", in accordance with Table E.1.

Annex F
(normative)

Abrasive paper specification

F.1 Quality of materials

F.1.1 Abrasive

The glass used shall be of good quality, conforming to the requirements of F.3.

F.1.2 Backing

The backing shall be of good quality paper or good quality cloth, plain weave.

F.1.3 Adhesive

The adhesive, which may be water soluble, shall be of good quality, suitable for the purpose.

F.2 Form and dimensions

The glass paper or cloth shall be supplied in sheets (230 ± 2) mm by (280 ± 3) mm, to the minimum mass specified in Table F.1.

Table F.1 — Mass of glass paper or glass cloth

Grade	Mass per ream kg
No. 00 glass paper	6,5
No. 00 glass cloth	8,0

When required, the glass paper or glass cloth may be supplied in rolls.

F.3 Abrasive grain

The abrasive grain used in the manufacture of glass paper or glass cloth shall be shown by the grade number on the back of each sample and shall comply with the grading requirements of Table F.2.

Table F.2 — Abrasive grain requirements

Grade	Requirement	Sieve aperture size µm
No. 00	All to pass	90

F.4 Breaking strength

The breaking strength of the finished glass paper or glass cloth, expressed in newtons per 50 mm of width, shall not be less than specified in Table F.3.

Table F.3 — Breaking strength

Type	Breaking strength N	
	Machine direction (warp)	Cross direction (fill)
glass paper	392	215
glass cloth	392	166

Annex G
(normative)

Material specimen leakage test

G.1 Principle

Samples of chemical protective clothing materials that have either been abraded or flexed are placed on a fixture and are then subjected to a reduced pressure. The resulting pressure is then measured. A comparison is made for the ending pressure between abraded or flexed and pristine samples.

G.2 Test specimens

A minimum of three abraded or three flexed specimens shall be evaluated. A minimum of three unabraded and unflexed specimens shall be evaluated for the pristine condition.

G.3 Test apparatus

The apparatus shown in Figure G.1 shall be used to measure leakage through the specimen. A suitable system of gasketing and tension shall be used to ensure that a seal is maintained between the material specimen sealing surfaces and the test apparatus. Clamps shall be provided to create a tight seal with the material and sealing surfaces.

G.4 Test environment

Testing shall be conducted in an environment where the test temperature does not vary more than 3 °C over the duration of testing.

G.5 Procedure

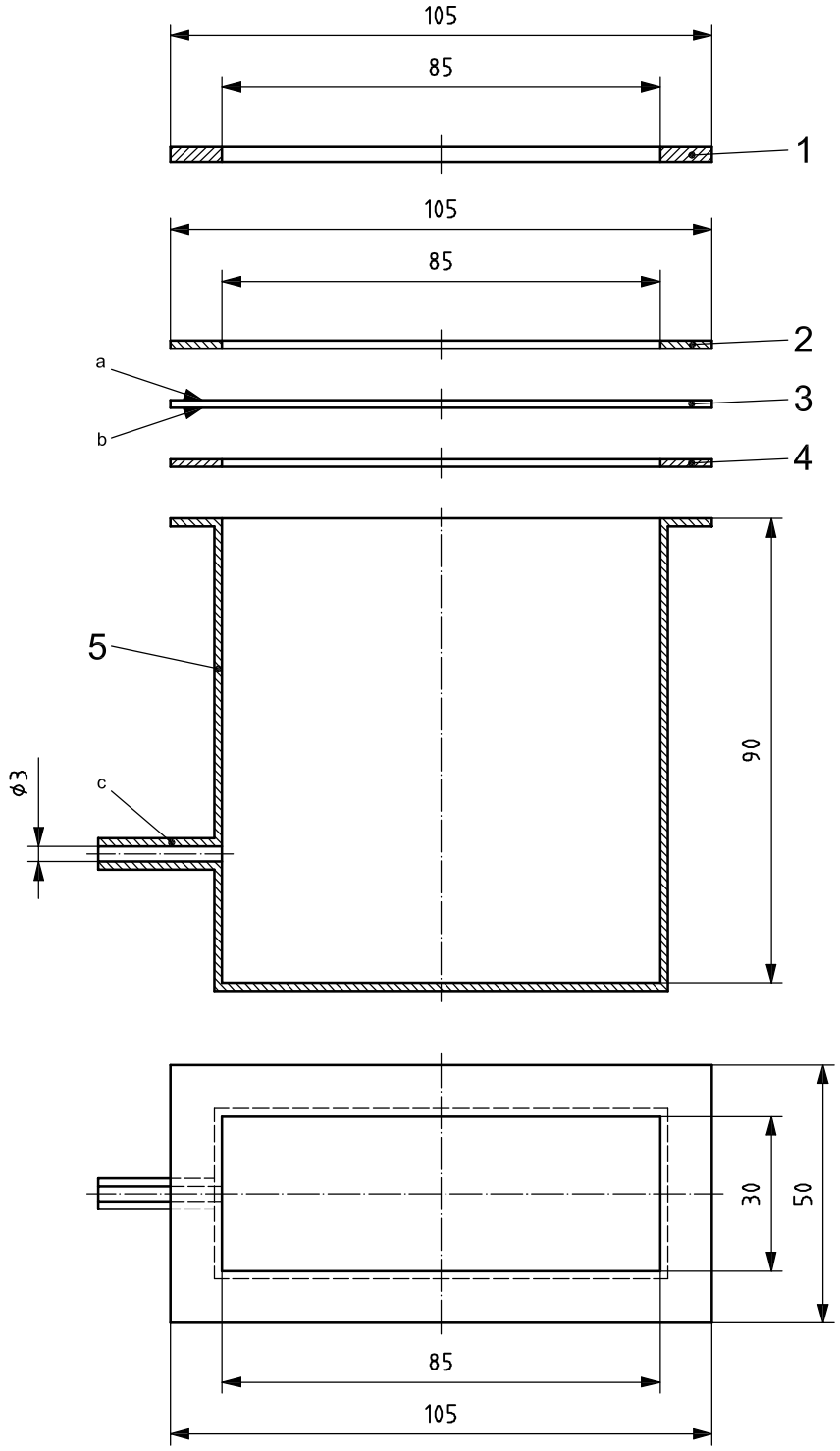
Clamp the abraded or flexed material specimen to the apparatus. Reduce the pressure inside the test apparatus by 1 kPa (10 mbar). Measure the pressure inside the test apparatus after 1 min.

A pristine material specimen shall be tested in the same manner and the difference between the abraded or flexed material specimen and the pristine material specimen shall be reported.

G.6 Test report

Calculate the averages of the abraded or flexed specimens and for unabraded or unflexed specimens. Determine the difference between the abraded or flexed specimens and the pristine specimens using the average measured pressures.

Dimensions in millimetres



Key

1 clamping ring (e.g. stainless steel)
2 gasket
3 test specimen
4 gasket
5 test pot (e.g. stainless steel) and measurement of pressure change

a Exterior (exposure) surface of test specimen.
b Interior (non-exposure) surface of test specimen.
c Connection for the generation of negative pressure and measurement of pressure change.

Figure G.1 — Apparatus to test for sample damage after materials testing

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