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BSI Standards Publication

Protective clothing against chemicals — Test methods and performance classification of chemical protective clothing materials, seams, joins and assemblages

bsi.

National foreword

This British Standard is the UK implementation of EN 14325:2018+A1:2024. It supersedes BS EN 14325:2018, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1.

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English Version

Protective clothing against chemicals - Test methods and performance classification of chemical protective clothing materials, seams, joins and assemblages

Habillement de protection contre les produits chimiques - Méthodes d'essai et classification de performance des matériaux, coutures, jonctions et assemblages des vêtements de protection chimique

Schutzkleidung gegen Chemikalien - Prüfverfahren und Leistungseinstufung für Materialien, Nähte, Verbindungen und Verbünde

This European Standard was approved by CEN on 16 October 2017 and includes Amendment approved by CEN on 8 April 2024.

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European foreword

This document (EN 14325:2018+A1:2024) has been prepared by Technical Committee CEN/TC 162 “Protective clothing including hand and arm protection and lifejackets”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2024, and conflicting national standards shall be withdrawn at the latest by November 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 8 April 2024.

This document supersedes [A1] EN 14325:2018 [A1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [A1].

[A1] *deleted sentence* [A1]

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the performance classification and test methods for materials used in chemical protective clothing, including gloves and footwear. The gloves and boots should have the same chemical protective barrier requirements as the fabric when an integral part of the clothing. This is a reference standard to which chemical protective clothing performance standards may refer in whole or in part, but this standard is not exhaustive in the sense that product standards may well require testing according to test method standards which are not included in this standard.

While these performance levels are intended to relate to the usage to which the chemical protective clothing is to be put, it is essential that the chemical protective clothing manufacturer or supplier indicate the intended use of the protective clothing and that the user (specifier) carries out a risk assessment in order to establish the correct performance level for the intended task.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 863:1995, *Protective clothing - Mechanical properties - Test method: Puncture resistance*

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

〖A1〗 EN ISO 811:2018, *Textiles - Determination of resistance to water penetration - Hydrostatic pressure test (ISO 811:2018)* 〖A1〗

EN ISO 139:2005, *Textiles - Standard atmospheres for conditioning and testing (ISO 139:2005)*

EN ISO 6530:2005, *Protective clothing - Protection against liquid chemicals - Test method for resistance of materials to penetration by liquids (ISO 6530:2005)*

EN ISO 7854:1997, *Rubber- or plastics-coated fabrics - Determination of resistance to damage by flexing (ISO 7854:1995)*

〖A1〗 EN ISO 9073-4:2021, *Nonwovens - Test methods - Part 4: Determination of tear resistance by the trapezoid procedure (ISO 9073-4:2021)* 〖A1〗

CEN ISO/TR 11610:2004, *Protective clothing — Vocabulary (ISO/TR 11610:2004)*

EN ISO 12947-2:2016, *Textiles - Determination of the abrasion resistance of fabrics by the Martindale method - Part 2: Determination of specimen breakdown (ISO 12947-2:2016)*

EN ISO 13934-1:2013, *Textiles - Tensile properties of fabrics - Part 1: Determination of maximum force and elongation at maximum force using the strip method (ISO 13934-1:2013)*

EN ISO 13935-2:2014, *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 13935-2:2014)*

ISO 6529:2013, *Protective clothing — Protection against chemicals — Determination of resistance of protective clothing materials to permeation by liquids and gases*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CEN ISO/TR 11610 and the following apply.

3.1
abrasion rub
one revolution of the outer drives of the Martindale abrasion tester

[SOURCE: EN ISO 12947-1:1998]

3.2
abrasion cycle
completion of all the translational abrasion movements tracing a Lissajous figure comprising 16 rubs, i.e. 16 revolutions of the two outer drives and 15 revolutions of the inner drive of the Martindale abrasion tester

[SOURCE: EN ISO 12947-1:1998]

3.3
material
one or several substances, in form of flexible planar structure, of which an item of clothing is made, excluding hardware and labels

3.3.1
single layer material
material consisting of only one layer

3.3.2
multilayer material
material consisting of several layers, which may be either permanently bonded together or intimately combined prior to the garment manufacturing stage, or which can be separated without any damage to each individual layer

Note 1 to entry: By “permanently bonded together” is meant for example by coating, laminating, gluing. By “intimately combined” is meant for example by weaving, quilting.

3.3.3
multilayer material consisting of separate layers
multilayer material, where individual layers that are neither permanently bonded together nor intimately combined, can be separated without any damage to the individual layers

3.4
specimen breakdown
in abrasion resistance or flex cracking resistance testing, the visually observed deterioration in a specimen after exposure to a specified number of abrasion rubs or cycles of flexing

EXAMPLE

— In woven fabrics, when two separate threads are completely broken;

— in knitted fabrics, when one thread is broken down;

— in pile fabrics, when the pile is fully worn off;

— in nonwovens, when the first hole resulting from the wear is of a diameter at least equal to 0,5 mm;

— in coated material, when coating surface has the first hole resulting from the wear of a diameter at least equal to 0,5 mm.

Note 1 to entry: The hole does not have to be through all materials for it to be a specimen breakdown.

[SOURCE: EN ISO 12947-2:2016]

4 Performance classification of materials

4.1 Determination of property value for performance classification

A number of performance classification levels are identified for the various properties of materials to be found in this standard.

The value of each property defined in 4.4 to 4.15 and which shall be used for performance classification, shall be determined in accordance with ⟦A1⟩ Annex B ⟨A1⟧ including the calculation of uncertainty of measurement for all the results.

If not specified otherwise within 4.4, 4.5, 4.6, 4.7, 4.9 or within the specific test method itself, a material with different behaviour in the length and cross directions, shall be tested for its performance in both directions. The performance classification shall be based on the results obtained for the direction resulting in the lower performance classification when evaluated according to ⟦A1⟩ Annex B ⟨A1⟧.

For a material with different surface characteristics, the fabric side that will appear on the outside of the apparel shall be tested for all test methods that are linked to surface performance (i.e. 4.4, 4.5, 4.6, 4.8, 4.11, 4.12, 4.13, 4.14, 4.15,) and the performance classification shall be based on the results for this side.

If the chemical protective clothing consists of multiple layers of materials, with or without separable layers, all layers shall be tested together with the chemical protective clothing outer surface being tested for those properties which are linked to surface performance.

For materials, which require pre-treatment, the performance classification shall be based on the lowest performance classification obtained on either testing new (not pre-treated) and/or pre-treated materials based on evidence. The performance classification tests shall be performed on the worst case. If insufficient evidence is available to determine whether the test shall be performed as new or pre-treated, the test shall be performed in both conditions.

4.2 Pre-treatment

4.2.1 Pre-treatment by cleaning and disinfection

Before each test, all chemical protective clothing material samples, with the exception of limited-use chemical protective clothing, shall undergo pre-treatment by cleaning and disinfection as applicable.

If the manufacturer's instructions indicate that cleaning or disinfection is not allowed, i.e. limited use garments, then testing shall be carried out on new material.

Where applicable according to manufacturer's instruction, the cleaning and disinfection shall be in line with the manufacturer's instructions, on the basis of standardized procedures. If the number of cleaning and disinfection cycles is not specified, the tests shall be carried out after 5 cycles of pre-treatment, each consisting of one wash cycle, one dry cycle and one disinfection cycle carried out in the sequence as indicated by the manufacturer's instructions. This shall be reflected in the information supplied by the manufacturer. If the garment can be washed or alternatively dry-cleaned it shall only be washed, dried and disinfected. If only dry-cleaning is allowed, the garment shall only be dry-cleaned and disinfected in accordance with the manufacturer's instructions.

4.2.2 Pre-treatment by abrasion

Specimens, which have been pre-treated according to 4.2.1, may also be pre-treated by one of the numbers of abrasion rubs given in Table 1 in accordance with the method described in 4.4.1 and as specified in the product standard or as defined by the manufacturer, whichever is the larger, prior to testing according to 4.11.

4.2.3 Pre-treatment by flexing

Specimens, which have been pre-treated according to 4.2.1, may also be pre-treated by one of the numbers of flexing cycles given in Table 2 in accordance with the method described in 4.5.1 and as specified in the product standard or as defined by the manufacturer, whichever is the larger, prior to testing according to 4.11.

4.3 Conditioning

Unless otherwise indicated in the product standard, all specimens shall be conditioned by storage at (20 ± 2) °C and (65 ± 5) % relative humidity in accordance with EN ISO 139 for at least 24 h. If applicable, the tests shall be started within 5 min of removing the specimen from the conditioning atmosphere, unless otherwise indicated in the test method standard.

Conditioning may be omitted or aligned with the conditions of 4.3 if it can be shown that test results are not affected by the foreseeable changes of temperature and relative humidity.

4.4 Abrasion resistance

4.4.1 General

A set of four test specimens of a material sample, where each specimen shall consist of all layers, shall be tested in accordance with EN ISO 12947-2 in the inverted mode, i.e. a test specimen of at least 140 mm diameter placed on the abradant table and an abradant of at least 30 mm diameter mounted in the test piece holder, using abrasive paper specified in ⟨A1⟩ Annex A ⟨A1⟩ and with an applied downward pressure of 9 kPa. The abrasion resistance of the chemical protective clothing material shall be classified according to the levels of performance given in Table 1, using the highest number of abrasion rubs, determined according to 4.4.2, which do not cause damage to the material.

4.4.2 Determination of the highest number of abrasion rubs which does not cause damage to the material and which shall be used for the performance classification

4.4.2.1 General

To determine the level of performance, the leak tightness of each of the four test specimens of a material sample shall be determined after a number of abrasion rubs. An additional sample will be used to determine the leak tightness prior abrasion.

〈A1〉 There are three methods of leak tightness assessment, the pressure pot, the hydrostatic head and visual inspection.

- The pressure pot shall be used for materials holding the pressure according to 4.4.2.2.
- The hydrostatic head shall be used for air permeable materials which cannot hold the pressure according to 4.4.2.2, but can be tested according to 4.4.2.3.

  NOTE 1 When evidence is presented that air permeable materials cannot hold the pressure according to 4.4.2.2, this does not need to be re-confirmed.

- Visual inspection is permitted when the material does not permit either of the above quantitative assessment methods in this subclause to be performed. In this case, this shall be reported in the test report and also in the Instructions for Use indicating that the visual inspection is qualitative and does not provide evidence of liquid tightness after abrasion. If this assessment is performed through visual inspection, the maximum classification that can be claimed is a Class 3.

NOTE 2 When evidence is presented that neither of the above two quantitative assessment methods in this subclause can be performed due to the nature of the material, this does not need to be re-confirmed. 〈A1〉

Table 1 — Classification of abrasion resistance

Class	Number of rubs
6	> 2 000
5	> 1000
4	> 400
3	> 100
2	> 40
1	> 10

4.4.2.2 Pressure pot end-point determination

To verify if the use of the pressure pot method is possible, unabraded reference specimen shall be clamped in the round test pot apparatus, designed according to the specifications given in [A1] Annex D (see Figure D.1) [A1], with a diameter appropriate to hold the test specimen, and the pressure in the test pot shall then be reduced by 1 kPa from atmospheric pressure. [A1] Preferably the specimen's exterior face of the fabric shall not be exposed to the pressure; if this is not possible then reverse the face of the fabric. [A1] The increase of pressure after 1 min shall be measured and recorded. If the pressure increase for the unabraded specimens is less than 100 Pa, then the pressure pot method is applicable and the leak tightness shall be determined as follows:

For each test specimen, the tested area of the abraded specimen is clamped in the round test pot apparatus shown in [A1] Figure D.1 [A1] and the pressure in the test pot shall then be reduced by 1 kPa. The increase of pressure after 1 min shall be measured and recorded. The difference in the change of pressure in 1 min between a specimen prior to abrasion and the same specimen after abrasion shall be calculated. The maximum resultant value of the difference in the change of pressure in 1 min between abraded and non-abraded shall be determined for the set of specimens. If the maximum resultant value does not exceed 100 Pa in 1 min, a new set of test specimens shall be abraded to a higher level of number of rubs according to the levels of numbers of rubs in Table 1, until the level is reached at which the maximum resultant value exceeds 100 Pa in 1 min. The highest level of number of rubs, at which the sample still passes, shall be used for the performance classification.

NOTE The pressure pot method can typically not be applied in case of a too high level of air-permeability and/or breathability of the specimen prior to pre-treatment, e.g. such as flexing or abrasion.

4.4.2.3 Hydrostatic head end-point determination

[A1] The end point, i.e. the highest number of abrasion rubs which does not cause damage to the material, shall be determined by the measurement of hydrostatic head method according to EN ISO 811 using a rate of increase in pressure of (0,98 ± 0,05) kPa/min (or 10 cm/min). The hydrostatic head of the specimens of the set of four test specimens (prior to any abrasion) shall be measured and in order for this test method to be applicable, the hydrostatic head for each of the four test specimens shall be above 300 mm.

For each test specimen after abrasion, the tested area of the abraded specimen is clamped into the hydrostatic test apparatus and the hydrostatic head measured. If the hydrostatic head of all the specimens in a set of four test specimens exceeds 200 mm, a new set of specimens shall be abraded to a higher number of rubs according to the levels of numbers of rubs in Table 1, until the level is reached at which the hydrostatic head of any of the four specimens is less than 200 mm. The highest level of number of rubs, at which hydrostatic head of the set of all test specimens is still above 200 mm, shall be used for the performance classification. [A1]

4.4.2.4 Visual inspection end-point determination

〈A1〉 Visual inspection is permitted when the nature of the material does not permit the end point assessment to be performed by either the pressure pot, or hydrostatic head, as defined by 4.4.2.1. 〈A1〉 If one of the four test specimens shows a specimen breakdown (according to definition 3.40 after having been pre-treated by a number of abrasion rubs, the material is considered to have failed the abrasion resistance requirement for this number of rubs. The highest number of rubs at which any of the specimens does not show a specimen breakdown (according to definition 3.4), shall be used for the performance classification. Please see limitation to the performance classification and the requirements in the Instruction for Use in 4.4.2.1.

4.5 Compression-folding (Schildknecht) flex cracking resistance

4.5.1 General

A set of six test specimens of a material sample (three in machine and three in cross direction), where each specimen shall consist of all layers shall be tested. The specimens shall be tested in accordance with EN ISO 7854, method B. The compression folding flex cracking resistance of the chemical protective clothing material shall be classified according to the levels of performance given in Table 2 of 4.5.2, using the highest number of flexing cycles which do not cause damage the material's leak tightness according to 4.5.2.

4.5.2 Determination of the highest number of flexing cycles which does not cause damage to the material and which shall be used for the performance classification

4.5.2.1 General

To determine the level of performance, the leak tightness of each of the six test specimens of a material sample shall be determined after a number of flexing cycles. An additional sample will be used to determine the leak tightness prior flexing.

〈A1〉 There are three methods of leak tightness assessment, the pressure pot, the hydrostatic head and visual inspection.

- The pressure pot shall be used for materials holding the pressure according to 4.5.2.2.
- The hydrostatic head shall be used for air permeable materials which cannot hold the pressure according to 4.5.2.2, but can be tested according to 4.5.2.3.

  NOTE 1 When evidence is presented that air permeable materials cannot hold the pressure according to 4.5.2.2, this does not need to be re-confirmed.

- Visual inspection is permitted when the nature of the material does not permit either of the above quantitative assessment methods in this subclause to be performed. In this case, this shall be reported in the test report and also in the Instructions for Use indicating that the visual inspection is qualitative and does not provide evidence of liquid tightness after flex cracking. Visual inspection shall not be used for the performance classification of "Type 1" through "Type 3" (EN 943-1, EN 943-2, EN 14605).

  NOTE 2 When evidence is presented that neither of the above requirements in this subclause can be met, these do not need to be re-confirmed.

The specimen shall be clamped in a rectangular test pot apparatus, designed according to the specifications given in Annex D (see Figure D.2), with the rectangular dimensions appropriate to hold the test specimen. 〈A1〉

Table 2 — Classification of leak tightness after compression-folding (Schildknecht) flex cracking resistance

Class	Number of cycles
6	> 50 000
5	> 20 000
4	> 8 000
3	> 3 000
2	> 1250
1	> 500

4.5.2.2 Pressure pot end-point determination

To verify if the use of the pressure pot method is possible, unflexed reference specimen shall be placed in the pressure pot, and the pressure in the test pot shall then be reduced by 1 kPa from atmospheric pressure. Preferably the specimen's exterior face of the fabric shall not be exposed to the pressure, if this is not possible then reverse the face of the fabric prior to reverting to testing using the hydrostatic head. The increase of pressure after 1 min shall be measured and recorded. If the pressure increase for the unflexed specimens is less than 100 Pa, then the pressure pot method is applicable.

For each test specimen, the tested area of the flexed specimen is clamped in a rectangular test pot apparatus and the pressure in the test pot shown in [A1] Figure D.2 [A1] shall then be reduced by 1 kPa. The increase of pressure after 1 min shall be measured and recorded. The difference in the change of pressure in 1 min between a specimen prior to flexing and the same specimen after flexing shall be calculated. The maximum resultant value of the difference in the change of pressure in 1 min between flexed and non-flexed shall be determined for the set of specimens. If the maximum resultant value does not exceed 100 Pa in 1 min, a new set of test specimens shall be flexed to a higher level of number of flexing cycles according to the levels of numbers of flexing cycles in Table 2, until the level is reached at which the maximum resultant value does not exceed 100 Pa in 1 min. The highest level of number of cycles, at which the sample still passes, shall be used for the performance classification.

NOTE The pressure pot method can typically not be applied in case of a too high level of air-permeability and/or breathability of the specimen prior to pre-treatment, e.g. such as flexing.

4.5.2.3 Hydrostatic head end-point determination

[A1] The end point, i.e. the number of flexing cycles which cause compression-folding damage to the material, shall be determined by the measurement of hydrostatic head method according to EN ISO 811 using a rate of increase in pressure of (0,98 ± 0,05) kPa/min (or 10 cm/min). The hydrostatic head of the specimens of the set of the six test specimens prior to any flexing shall be measured and in order for this assessment test method to be applicable, the hydrostatic head for each of the six test specimens shall be above 300 mm.

For each test specimen, after flexing, the tested area of the flexed specimen is clamped into the hydrostatic test apparatus and the hydrostatic head measured. If the hydrostatic head of all the specimens in a set of six test specimens exceeds 200 mm, a new set of specimens shall be flexed to a number of flexing cycles according to the levels of numbers of flexing cycles in Table 2, until the level is reached at which the hydrostatic head of any of the six specimens is less than 200 mm. The highest level of number of cycles, at which the hydrostatic head of the set of all test specimens is still above 200 mm, shall be used for the performance classification. [A1]

An adaptor head of diameter 45mm to 60mm may be required for hydrostatic test apparatus. The test piece for hydrostatic-head testing shall be taken from the central portion of the flexed specimen symmetrically.

4.5.2.4 Visual inspection end-point determination

〉A1〈 Visual inspection is permitted when the nature of the material does not permit the end point assessment to be performed by neither the pressure pot nor hydrostatic head as defined by 4.5.2.1. 〉A1〈 If one of the six test specimens shows a specimen breakdown (according to definition 3.4) after having been pre-treated by a number of flexing cycles, the material is considered to have failed the flex cracking resistance requirement for this number of cycles. The highest number of flex cracking cycles, at which all the specimens still do not show specimen breakdown (according to definition 3.4), shall be used for the performance classification. Please see limitation to the performance classification and the requirements in the Instruction for Use in 4.5.2.1.

4.6 Compression-folding (Schildknecht) flex cracking resistance at –30 °C

The determination of the compression-folding flex cracking resistance at –30 °C shall be carried out like the determination of the flex cracking resistance according to 4.5, but with the following modifications:

a) testing shall be carried out at –30 °C;

b) classification shall be carried out according to the number of cycles in Table 3.

Table 3 — Classification of compression-folding (Schildknecht) flex cracking resistance at low temperatures

Class	Number of cycles
6	> 4 000
5	> 2 000
4	> 1 000
3	> 500
2	> 200
1	> 100

4.7 Trapezoidal tear resistance

Test specimens shall be tested in accordance with EN ISO 9073-4. If the chemical protective clothing consists of multiple layers of materials, with or without separable layers, all layers shall be tested together. Each specimen shall be tested with a pre-extension of 2 N. 〉A1〈 The force applied to each of the five specimens shall be recorded as arithmetic mean of the maximum force of each specimen taken during testing. The maximum force of each specimen is rounded to the nearest 0,1 N. Calculate the arithmetic mean of the maximum force in both the machine and cross-machine directions respectively, round the arithmetic mean to the nearest 0,1 N, the results are expressed as the arithmetic mean. 〉A1〈

The chemical protective clothing material shall be classified according to the levels of performance given in Table 4. The arithmetic mean trapezoidal tear resistance value, determined according to 〉A1〈 Annex B 〉A1〈, shall be used for the purpose of performance rating and classification.

Table 4 — Classification of trapezoidal tear resistance

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

4.8 Bursting resistance – deleted requirement

Clause deliberately left blank to maintain continuity of numbering with previous edition.

4.9 Tensile strength

When tested in accordance with EN ISO 13934-1 the chemical protective clothing material shall be classified according to the levels of performance given in Table 5. If the chemical protective clothing consists of multiple layers of materials, with or without separable layers, all layers shall be tested together. The resultant arithmetic mean of the maximum force for 5 specimens of a sample set (e.g. 5 machine and 5 cross), determined according to EN ISO 13934-1 and in accordance with ⟦A1⟩ Annex B ⟨A1⟧, shall be used for the purpose of performance rating and classification.

Table 5 — Classification of tensile strength

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

4.10 Puncture resistance

Five representative specimens of the chemical protective clothing material shall be tested in accordance with EN 863 and classified according to the levels of performance given in Table 6. Where there are multiple force peaks, the highest peak shall be taken as the result. The arithmetic mean puncture resistance value, determined according to ⟦A1⟩ Annex B ⟨A1⟧, shall be used for the purpose of performance rating and classification.

Table 6 — Classification of puncture resistance

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

4.11 Resistance to permeation by chemicals

4.11.1 General

Specimens intended to be reused shall be pre-treated by cleaning and disinfection according to 4.2.1 and, if required and indicated in the manufacturer's instructions, may be pre-treated by abrasion according to 4.2.2 and/or flexing according to 4.2.3.

4.11.2 Classification of permeation resistance by breakthrough time

Testing shall be carried out in accordance with ISO 6529, Method A (liquids) or Method B (gases), at a temperature of (23 ± 1) °C. Using a normalized permeation rate of 1,0 µg/(cm²·min), the chemical protective clothing material shall be classified according to the levels of performance given in Table 7 for each chemical tested.

The resultant average normalized breakthrough time value, determined according to ISO 6529 and in accordance with ▌A1⟩ Annex B ⟨A1▐, shall be used for the purpose of performance rating and classification.

In addition to the breakthrough time permeation resistance class, also the cumulative mass at the time corresponding to the claimed breakthrough time class shall be determined and reported.

Table 7 — Classification of permeation resistance by normalized breakthrough time

Class	Normalised breakthrough time
6	≥ 480 min
5	≥ 240 min
4	≥ 120 min
3	≥ 60 min
2	≥ 30 min
1	≥ 10 min

NOTE 1 It can be dangerous to base considerations of safe wear time of given chemical protective clothing only on the value of normalized breakthrough time for a specific tested chemical.

NOTE 2 For example, in the case that the permeation rate for a given clothing material and tested chemical remains slightly below 1,0 µg/(cm²·min) for greater than or equal to 480 min, this material can be rated class 6 for this chemical according to Table 7, but the cumulative permeated mass during the 480 min will be only slightly below 480 µg/cm². This level of permeation can be dangerous depending of the toxicity of the chemical.

NOTE 3 Chemical protective clothing materials should thus be better evaluated with respect to cumulative permeation and classified by cumulative permeation time, i.e. by the time to the amount of cumulative permeated mass, to which the skin can be exposed with regard to the skin/dermal toxicity of the tested chemical/mixture.

4.11.3 Classification of permeation resistance by cumulative permeation time

When tested in accordance with ISO 6529, Method A (liquids) or Method B (gases) the average time to reach the cumulative permeated mass determined based on the skin/dermal toxicity classification of the chemical (see [A1] Annex C, Table C.1 [A1]), to be tested, shall be classified according to the levels of performance given in Table 8.

The resultant average value for the time to cumulative permeation, determined according to ISO 6529 and in accordance with [A1] Annex B [A1], shall be used for the purpose of performance rating and classification.

Table 8 — Classification of permeation resistance by cumulative permeation

Class	Chemical skin/dermal toxicity based cumulative permeated mass (in µg/cm²), classification based to time to reach cumulative permeated mass		
	Very toxic (see [A1] Annex C [A1])	**Toxic (see [A1] Annex C [A1])**	**Other chemicals (see [A1] Annex C [A1])**
	Cumulative Mass 20 µg/cm²	**Cumulative Mass 75 µg/cm²**	**Cumulative Mass 150 µg/cm²**
6	≥ 480 min	≥ 480 min	≥ 480 min
5	≥ 240 min	≥ 240 min	≥ 240 min
4	≥ 120 min	≥ 120 min	≥ 120 min
3	≥ 60 min	≥ 60 min	≥ 60 min
2	≥ 30 min	≥ 30 min	≥ 30 min
1	≥ 10 min	≥ 10 min	≥ 10 min

NOTE 1 Category of skin/dermal toxicity of chemicals/mixtures and the related cumulative permeated mass values are based on Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures.

NOTE 2 Information on the use of cumulative permeated mass is provided in [A1] Annex C [A1].

NOTE 3 The above is based on skin/dermal toxicity only and does not take into account oral or inhalation toxicity.

4.12 Repellency to liquids

When tested in accordance with EN ISO 6530 for repellency to the liquid chemicals given in Table 9, the material shall be classified according to the levels of performance given in Table 10 for each chemical tested. In accordance with [A1] Annex B [A1], the lowest single value of the specimens of the sample set shall determine the performance classification for each chemical-material combination.

The material may be tested in addition with other liquid chemicals than those specified in Table 9 and results may be reported.

Chemicals shall be of analytical purity grade.

Table 9 — List of reference chemicals for absorption, penetration and repellency testing

Chemical	Concentration weight %	Temperature of chemical °C (±2 °C)
H_2SO_4	30 (aqueous)	20
NaOH	10 (aqueous)	20
o-Xylene	Undiluted	20
Butan-1-ol	Undiluted	20

Table 10 — Classification of repellency to liquids

Class	Repellency index
3	> 90 %
2	> 80 %
1	> 70 %

NOTE Liquid penetration testing relates to products intended for the lowest level of chemical protection. Such products are intended to protect from a potential exposure to small quantities of spray or accidental low volume splashes.

4.13 Resistance to penetration by liquids

When tested in accordance with EN ISO 6530 for penetration by the liquid chemicals given in Table 9, the material shall be classified according to the levels of performance given in Table 11 for each chemical tested. In accordance with ▌A1⟩ Annex B ⟨A1▐, the highest single value of the specimens of the sample set shall determine the performance classification for each chemical-material combination.

Table 11 — Classification of resistance to penetration by liquids

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

The material may be tested in addition with other liquid chemicals than those specified in the Table 9 and the results may be reported.

NOTE It may be dangerous to base considerations of safe wear time of a given chemical protective clothing only on the value of the penetration index for a specific tested chemical. For example, a material with a penetration index of class 3 could allow the penetration of approximately 0,1 ml of chemical assuming a spill of 10 ml, i.e. an amount which might be dangerous depending of the toxicity of the chemical.

4.14 Resistance to ignition

The test for resistance to ignition specified in 4.14 is intended to evaluate only that a material is not of a highly flammable nature. A set of three test specimens shall be tested in accordance with EN 13274-4, method 3, with the outer side of the clothing material exposed to the flame. The size of the specimen shall be 105 mm x 50 mm. The test specimen shall be mounted in such a way, so that the 105 mm edge of the specimen is perpendicular to the direction of travel of the specimen above the flame and the path length of the specimen above the flame is 50 mm. All test specimens of the 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 shall not continue to burn for more than 5 s after removal from the flame, determined according to [A1] Annex B [A1].

A material which passes this ignition evaluation may not offer sufficient protection against heat and flame. If resistance to heat and flame is required the chemical protective clothing should be tested and marked according to the appropriate European Standard.

4.15 Resistance to flame

The test for resistance to flame is a more demanding test than resistance to ignition, as in order to pass the pressure pot test must also be conducted in order to qualify if the material sample passes or fails. A set of three test specimens shall be tested in accordance with EN 13274-4, method 3, with the outer side of the clothing material exposed to the flame. The size of the specimen shall be 105 mm x 50 mm. The test specimen shall be mounted in such a way, so that the 105 mm edge is perpendicular to the direction of travel of the specimen above the flame and the path length of the specimen above the flame is 50 mm.

NOTE 1 A slightly larger specimen size can be used if shrinkage of the sample prevents the pressure pot test from being used.

All test specimens of the 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 shall not continue to burn for more than 5 s after removal from the flame. The resultant maximum flaming time value, determined according to [A1] Annex B [A1], shall not be greater than 5 s after removal from the flame.

The resistance to flame of the chemical protective clothing material shall be classified according to the levels of performance given in Table 12, using the longest flame exposure, at which the above flame exposure requirements are fulfilled, and which does not cause damage to the leak-tightness of the material.

To determine the level of performance, the leak tightness of each of the test specimens of a material sample shall be determined before and after flame exposure.

For each test specimen, the test area of the specimen prior and after to flame exposure shall be clamped in the rectangular test pot apparatus, designed according to the specifications given in [A1] Annex D [A1] (see [A1] Figure D.2 [A1]), with the rectangular dimensions appropriate to hold the test specimen and the pressure in the test pot shall then be reduced by 1 kPa (10 mbar). The increase of pressure after 1 min shall be measured and recorded.

The difference in the change of pressure in 1 min between a specimen prior to flame exposure and the same specimen after flame exposure shall be calculated. The maximum resultant value of the difference in the change of pressure in 1 min between new and exposed shall be determined for the set of specimens according to [A1] Annex B [A1]. If the maximum resultant value does not exceed 100 Pa (1 mbar) in 1 min, the test shall be repeated with new specimens, which shall be exposed to the next higher level of flame exposure according to the levels of exposures in Table 12, until the level is reached at which the maximum resultant value exceeds 100 Pa in 1 min. The highest level of flame exposure, at which the sample still passes, shall be used for the performance classification.

NOTE 2 When using the pressure pot, additional sealing (e.g. by use of jelly for ultrasonic analysis) on the edges is suggested.

NOTE 3 The pressure pot method can typically not be applied in case of a too high level of air-permeability and/or breathability of the specimen prior to pre-treatment, e.g. such as flexing.

Table 12 — Classification of resistance to flame

Class	Flame exposure
3	specimen stops for 5 s in the flame
2	specimen stops for 1 s in the flame
1	specimen passes through the flame without stopping

5 Performance requirements for seams, joins and assemblages

5.1 Determination of property value for rating and classification

A number of performance classification levels are identified for the various properties of seams, joins and assemblages to be found in this standard.

The value of each property defined in 5.4 to 5.6 and which shall be used for performance classification, shall be determined in accordance with [A1] Annex B [A1] including the calculation of uncertainty of measurement for all the results.

For materials, which require pre-treatment, the performance classification shall be based on the lowest performance classification obtained on either testing new (not pre-treated) and/or pre-treated materials based on evidence. The performance classification tests shall be performed on the worst case. If insufficient evidence is available to determine whether the test shall be performed as new or pre-treated, the test shall be performed in both conditions.

NOTE The performance requirements for whole garments and for accessories such as gloves, boots or respiratory protective equipment, which are or are not an integral part of a chemical protective clothing, are given in other European Standards. The requirements of this clause of this European Standard are intended to apply to all construction seams of all the integral parts of a chemical protective garment and to all joins and assemblages between chemical protective garment parts and/or garment accessories.

5.2 Pre-conditioning

All specimens containing seams, joins and/or assemblages shall undergo the same pre-conditioning as specified in 4.2.1.

5.3 Conditioning

All specimens shall be conditioned as specified in 4.3.

5.4 Resistance to liquids

5.4.1 General

Seams of chemical protective clothing are constructed and/or sealed to provide protection against passage of liquid through stitch holes or through other components of a seam. The performance in these respects may be different to that of the material from which it is made, but shall meet the concrete performance requirements according to the relevant product standard.

5.4.2 Resistance to penetration

No specific testing of specimens of seams, joins and assemblages is required as testing of the performance of resistance of seams, joins and assemblages to penetration by liquids is part of the whole suit testing, where required in chemical protective clothing performance standards.

5.4.3 Resistance to permeation

If required by the relevant chemical protective clothing standard, resistance of seams, joins and assemblages to permeation by liquid and gaseous chemicals shall be tested in accordance with 4.11. Classification shall be done according to the levels of performance given in that clause.

NOTE Permeation testing of seams, joins or assemblages may require some modifications to the test cell or to the test procedure, e.g. sealing of the edges.

5.5 Seam strength

A sample of each type (e.g. stitched or bound seam) of straight seam construction of a garment shall be tested in accordance with EN ISO 13935-2. Three specimens, of each type of seam construction shall be tested and the arithmetic mean of each set of the three specimens calculated. For the purpose of classification, the seam strength shall be reported regardless of where the sample breaks, i.e. regardless of whether the test specimen, containing the seam, breaks in the material or in the seam.

The garment seam performance shall be classified according to the levels of performance given in Table 13, using the result for the weakest seam type.

The product standard shall indicate which seams shall be tested (e.g. suit to zipper, suit to visor, etc.).

NOTE According to the scope of the test method described in EN ISO 13935-2, this test method applies to straight seams joining two pieces of woven textiles. Experience has shown that it can be used also for seams joining two pieces of chemical protective clothing materials other than woven textiles.

Table 13 — Classification of seam strength

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

5.6 Pull strength of joins and assemblages

5.6.1 General

The strength of joins (e.g. between a sleeve and a glove, a boot and a trouser leg, or a bonded-in face mask and the garment) between the body of a chemical protective garment and any assemblages (e.g. not designed to be removed, one time attachments) and detachable parts (e.g. designed to be attached and removed multiple times) shall be tested in accordance with EN ISO 13935-2, according to the procedures described below.

All detachable parts and assemblages shall be assembled according to the manufacturer's instructions.

5.6.2 Boots and Gloves (excluding Booties)

a) Securely clamp the sleeve (or leg) of the garment.

b) Securely clamp the glove (or boot).

c) Ensure that one of the clamps is fixed to an immovable point.

d) Apply a fixed pull force of X N to the moveable clamp (where X is defined in the appropriate product standard), such that the direction of pull is in the direction of the sleeve (or leg), and that the two components are in the same horizontal or vertical plane

e) Hold the constant pull force for Y s (where Y is the pull time defined in the appropriate standard).

f) Inspect the area of attachment between the sleeve and the glove (or the leg and the boot), and record if there is continuous attachment between the sleeve and the glove (or the leg and the boot).

g) The attachment join shall be recorded as having failed if there is not continuous attachment between the sleeve and the glove (or the leg and the boot). Or if there is any observable deformation, change, hole formation or cracking at the join.

5.6.3 Body Harness or Belts

Where a body harness or belt is provided to which the compressed air supply tube is fitted, the strength of the coupling shall be tested in accordance with the methods and requirements set out in EN 14594:2005, 7.6.

5.6.4 Lifelines

Where a lifeline is fitted, the strength of the coupling shall be tested in accordance with the methods and requirements set out in EN 14594:2005, 7.6. In this case the line is pulled at an angle of 90° to the dummy torso.

5.6.5 Exhalation Valves

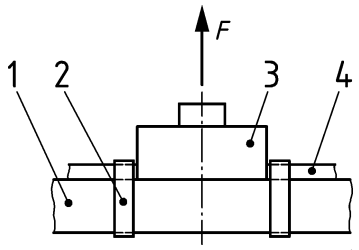
Where fitted, the connection between the exhalation valve (exhaust assembly) and the chemical protective garment material shall be tested in the following way. Two samples shall be tested in the state in which they were received.

a) Clamp the suit fabric to a base plate and apply a load of X N (where X is defined in the appropriate product standard) axially to the exhalation valve in accordance with Figure 1.

b) Examine the attachment point mechanism and area for any signs of damage (e.g. deformation, cracking) or loosening in the suit.

c) Record any observable damage (e.g. deformation, cracking) or loosening in the suit.

d) There shall be no observable damage or loosening in the suit.



Key
1 base plate
2 clamping straps
3 exhalation valve
4 suit fabric
F force

Figure 1 — Connection between exhalation valve and chemical protective clothing material

6 Test report

The test report(s) shall include:

a) reference to this European Standard;

b) test date;

c) environmental conditions of the laboratory;

d) for each of the test clauses, which are referred to by the chemical protective clothing standard according to the intended use indicated by the manufacturer's instructions, the test reports shall include the following information:

   1) description of the sample or the garment from which the test specimens were taken; Including details of any pre-treatment undertaken;

   2) the test chemical in case of any test for resistance to penetration or permeation by chemicals;

e) for each set of specimens tested, the individual and where applicable average value of the specimen set test results and the performance class achieved for the appropriate test clause(s).

7 Instructions for use

Instructions for use shall comply with the requirements of EN ISO 13688 and shall include the required information listed in 4.4.2.1 and 4.5.2.1.

Annex A
(normative)

Abrasive paper

A.1 Quality of materials

〈A1〉

A.1.1 Abrasive

The abrasive used shall be of grit A65 (APEX or Structured Abrasive).

A.1.2 Backing

The backing shall have minimum breaking strength such as to withstand the rigours of the Martindale test method.

A.1.3 Adhesive

The adhesive shall be of good quality, suitable for the purpose.

NOTE The abrasive paper of reference is Trizact A65 from 3M. 〈A1〉

Annex B
(normative)

Assessment, evaluation and determination of the property values for rating and for performance classification

B.1 Expression of results

All of the test methods called-up in this standard require that several specimens be tested. In some cases the number of specimens called for in this standard differs from the number specified in the test method. In such cases this standard shall take precedence.

Some of the test methods called up in the standard include details on how the final result shall be calculated from the results from the individual specimens. In such cases the final result shall be calculated in this matter and this value alone shall be reported.

Where the test method does not detail how the final result shall be calculated, the result may be expressed as the arithmetic mean (average) of the results from the individual specimens, for reporting purposes but the result for the lowest-performing specimen shall also be reported for classification according to B.4.

NOTE The lowest-performing specimen is that which gives the least-favourable result. In cases such as tensile strength, this is the specimen which gives the lowest numerical result (*i.e.* the lowest breaking force). In cases such as resistance to liquid penetration this is the specimen which gives the highest numerical result (i.e. the highest amount of liquid penetration).

B.2 Outlying data

When testing a series of specimens taken from a homogenous sample any test method may, from time to time, generate a single inconsistent result. These inconsistent single results shall be termed “outliers”. Such outliers are significantly higher or lower than the results for the other specimens. The responsibility for deciding whether a result is significantly higher or lower than the results for the other specimens shall rest with the test house. Typically results are considered outliers when their distance from the mean value is greater than 3 standard deviations. However, this can depend on the test method concerned.

It is quite possible that an outlier may lie within a different classification-band from the band in which the other results lie. Having said that, the lowest-performing result is not automatically an outlier. If this result is close to the results from other specimens within the sample then the lowest-performing result is not an outlier.

Some of the test methods include details on how outliers shall be treated. In such cases the test method shall be followed. In cases where the test method does not include details on how outliers shall be treated the following procedure shall be followed:

— A second set of specimens shall be tested

— If there is no outlier in this second set of tests the result of the tests on this second set of specimens shall be reported

— If there is an outlier in the second set of tests the set of results that includes the lower-performing outlier shall be reported.

Example 1, if the first set of results from a tensile strength test is: 200 N, 198 N, 210 N, 195 N, 126 N, 212 N, then the figure of 126 N is clearly an outlier. In this case a second set of specimens shall be

tested. If the second set of results is 201 N, 212 N, 197 N, 195 N, 205 N, 201 N, then there is no outlier in this second set of figures. The final result shall therefore be calculated from this second set of figures.

Example 2, if the first set of results is 200 N, 198 N, 210 N, 195 N, 126 N, 212 N, and the second set is 201 N, 212 N, 197 N, 195 N, 118 N, 201 N, there is clearly an outlier in both sets of results. The final result shall therefore be calculated from the second set of data because the figure of 118 N is lower tensile strength performance than 126 N.

B.3 Uncertainty of measurement

The uncertainty of measurement associated with every test result shall be reported. The uncertainty of measurement for a specified test method shall have been evaluated according to the guidance given in EA-4/16 (Guidelines on the expression of uncertainty in quantitative testing), for example by help of one of the two following approaches:

— a statistical method, e.g. that given in ISO 5725-2.

— a mathematical method, e.g. that given in ISO/IEC Guide 98-3.

The expanded uncertainty of measurement reported shall correspond to at least a 90 % confidence limit and should ideally correspond with a 95 % confidence limit.

NOTE For further information on uncertainty of measurement, please see, e.g. JCGM 100:2008.

B.4 Classification of results

Classification shall be based upon either:

— the lowest single value, if the test method only requests to report all the measured results, or

— if the test method provides a method to combine the results, the result of this calculation shall be used for the purposes of classification.

In cases where the result is very close to a lower-performing class boundary it may be prudent to either claim a lower level of performance or carry out additional testing to further increase confidence in the performance level claimed.

Annex C
(normative)

Use of time to cumulative mass for reporting material permeation resistance

C.1 Introduction

For each chemical tested, the skin/dermal toxicity category of the chemical, the value of cumulative permeated mass related to the skin/dermal toxicity classification of the chemical/mixture according to Table 8, the time in minutes to reach this value of cumulative permeated mass and the corresponding cumulative permeation time class shall be reported. If Class 6 performance is achieved, the total cumulative permeated mass at 480 min shall be reported.

Table C.1 — Value of cumulative permeated mass to be used as function of level of skin/dermal toxicity of the tested chemical/mixture

Category	Cumulative permeated mass µg/cm²
Very Toxic: - Category 1, or - Classified as carcinogen, mutagen, or reproductive toxicants (CMR) - Skin sensitizers	20
Toxic: - Category 2	75
All other chemicals: - Unknown classification, - Category 3, or 4	150

NOTE 1 Category of skin/dermal toxicity of chemicals/mixtures and the related cumulative permeated mass values are based on Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures.

NOTE 2 The above is based on skin/dermal toxicity only and does not take into account oral or inhalation toxicity.

C.2 General

The permeation testing reporting in this European Standard differs markedly from those in other EN or ASTM standards. Previous reporting 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 specified level.

Although this measurement has been loosely interpreted as indicative of a “safe wear time” for items of chemical protective clothing, it is entirely possible for significant, and possibly harmful, amounts of chemical to permeate through chemical protective clothing at a rate that is below this specified 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 time data provides an opportunity to begin to establish an international benchmark for permeation performance measurement.

C.3 Basis for classification system

Subclause 4.11.2 of this European 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.

The cumulative permeated 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 permeated mass of 150 µg/cm² 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/cm²/min and 1,0 µg/cm²/min, with the assumption that the measured breakthrough occurs at the end of a 480 min period. The cumulative permeated mass of 150 µg/cm² 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.

C.5 indicates, how the cumulative permeated mass of 150 µg/cm² relates to acute toxicity estimates (ATE) of chemicals classified as Category 4 or 3 according to the Regulation (EC) No 1272/2008.

C.4 Alternative cumulative permeated mass

This European Standard specifies the use of a cumulative permeated mass when testing is performed against chemicals known to have high levels of skin toxicity. For chemicals of Category 2 and 1, 4.11.3 specifies the cumulative permeated values 75 µg/cm² and 20 µg/cm² respectively. C.5 also indicates how the cumulative permeated mass values of 75 µg/cm² or 20 µg/cm² relate to acute toxicity estimates (ATE) of chemicals classified as Category 2 or 1 according to the EU Regulation No 1272/2008.

In principle, also values other than 150 µg/cm², 75 µg/cm² or 20 µg/cm² are permissible. In these cases, the time to the different specified cumulative permeated mass is reported and a notation shall be provided in the test report to indicate that a different cumulative permeated mass value for interpreting material chemical permeation resistance has been provided.

C.5 Conversion from permeation breakthrough time classification to classification by time to cumulative permeated mass

If the classification of permeation resistance would have been based on breakthrough time interpretation at a rate of 0,1 µg/cm²/min, no testing or reinterpretation of existing data are needed. Even with a breakthrough time > 480 min), the maximum cumulative permeation is 48 µg/cm^2, which is well below 150 µg/cm² used in the cumulative permeation classification system for - for example - Category 3 or 4 chemicals.

If the permeation resistance using normalized breakthrough time of a material has already been classified as "Class x" according to Table 7 of 4.11.2, its permeation resistance based on "time to cumulative permeated mass" "Class y" according to Table 8 of 4.11.3 can be derived from its "Class x" as indicated in ▌A1⟩ Table C.2 ⟨A1▐.

Table C.2 — Comparison between permeation resistance classified according to 4.11.2 and classified according to 4.11.3

4.11.2, Table 7 Class x	**Normalized breakthrough time (at 1,0 µg/cm^2/min)** min	**4.11.3, Table 8 Class y**	**Cumulative permeated mass** 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 and chemical with normalized breakthrough time of Class 6 (Class 5) according to Table 7 of 4.11.2, the corresponding maximum cumulative permeated mass is at the very most just below 480 µg/cm² (240 µg/cm²), and it is sure that it has been at most 120 µg/cm², therefore also < 150 µg/cm², after only 120 min. Consequently, Class 4 according to Table 8 of 4.11.3 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 breakthrough time "Class x" may eventually be rated better than cumulative permeation "Class y" indicated in ⟨A1⟩ Table C.2 ⟨A1⟩.

C.6 Cumulative permeated mass values as function of toxicity

The following information is based on the EU Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures as a basis to refer to the concept of skin toxicity (Specifically Table 3.1.1 (p. 81) and Table 3.9.2 and 3.9.3 (p. 124-125) referring to the acute and long term skin toxicity categories. A number of parameters and assumptions need to be defined to do a proper calculation to come to permeation limits:

— **Species:** For classification purposes, testing species like rats or rabbits are preferred. In order to account for species differences, one should apply factors to extrapolate appropriate toxic doses to Humans. In the present calculation of permeation limits, it was assumed the toxicity of chemicals is similar between all these species.

— **Body weight:** For different risk assessments, different body weight are used although most of these are in the same range. To take into account both male or female healthy worker population an average of 70 kg was used.

— **Human body surface:** Depending on the size of the person, the surface will vary an average of 20 000 cm² was used.

— **Skin permeation:** Permeation coefficient of the skin, as it is an additional barrier of protection of the human body. **This parameter has not been taken into consideration.**

— **Exposure duration:** An 8 hours exposure has been assumed for long term toxicity consideration. For acute toxicity, duration of exposure is not relevant in the calculation. However for the setting of conservative values, the permeation limits for acute toxicants are assumed to be valid for a period of 10 min.

— **Routes of exposure:** Finally, only the dermal route was considered as a first tier risk assessment. Also, an exposure over the entire body was assumed to represent worst case scenario. Together, these assumptions should deliver sensible and robust permeation limits. It is to be noted that depending the substance properties, the inhalation route may prevail. In such case, a refinement of the calculation could be warranted.

The values reported below were used to calculate worst case estimates of the permeation limits for skin toxicants.

Acute toxicity categories as defined in EU Regulation No 1272/2008 on classification, labelling and packaging of substances and mixtures, Table 3.1.1 (p. 81).

Specific target organ toxicity (long term toxicity following repeated exposure categories as defined EU Regulation No 1272/2008 on classification, labelling and packaging of substances and mixtures, Table 3.9.2 and Table 3.9.3 (p. 124-125).

The permeation limits from the Acute Toxicity Estimate (ATE) or critical dose (C) for the dermal route are:

— Permeation $_{acute}$(µg/cm^2) = ATE (mg/kg body weight) x avg body weight(kg) × 1000 µg/mg x 1// surface area

— Permeation $_{long\ term}$ (µg/cm^2) = C (mg/kg body weight/day) x avg body weight(kg) × 1000 µg/mg x 1/surface area x 8 hr/24hr

The above equations give below values.

Short-term toxicity (Acute) **Dermal Route**	**Acute Toxicity Estimate upper value (ATE – mg/kg bw)**	**Permeation limit acute toxicant over 10 min (µg/cm^2)**
Category 1	50	≤ 175
Category 2	200	≤ 700
Category 3	1 000	≤ 3 500
Category 4	2 000	≤ 7 000

Long term toxicity (Repeated dose/Specific Target Organ) **Dermal Route**	**Critical dose upper value (C – mg/kg bw/day)**	**Permeation limit long term toxicant (µg/cm^2) over 8 hours**
Category 1	20	≤ 23
Category 2	200	≤ 233

An additional margin of safety of about 10 based on the short term toxicity was added to derive the permeation values.

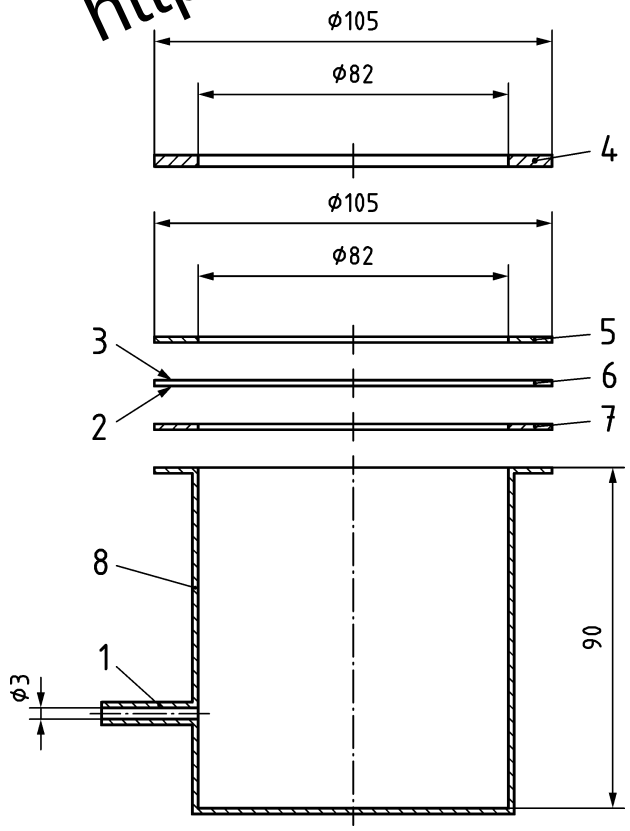
Annex D
(normative)

Specification for pressure pot and leak-tightness of equipment

D.1 Equipment specification

The dimensions of the round test pot apparatus, used for damage assessment after abrasion, are given in ⟨A1⟩ Figure D.1 ⟨A1⟩. The inner diameter shall be 82 mm and is appropriate to hold unabraded and abraded circular test specimens. The inner height of the test pot shall be 90 mm.

Dimension in millimetres



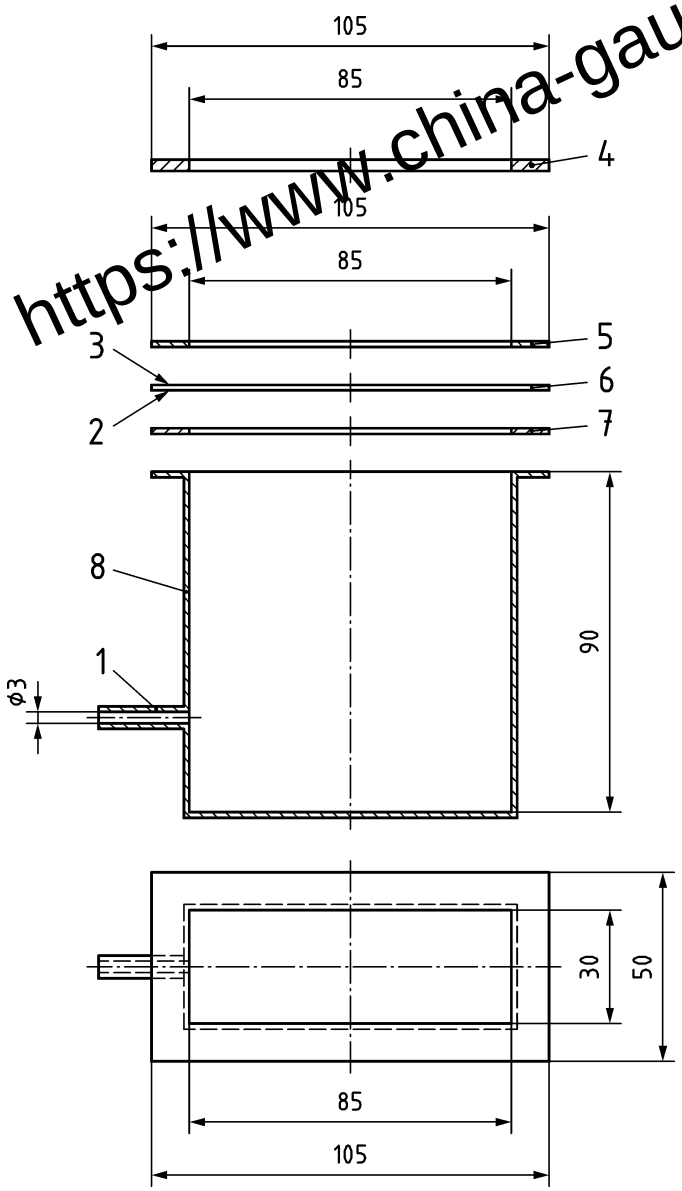
Key

1 connection for the generation of negative pressure and measurement of pressure change
2 lower surface
3 upper surface
4 clamping ring (e.g. stainless steel)
5 gasket
6 round specimen
7 gasket
8 round test pot (e.g. stainless steel)

Figure D.1 — Round test pot apparatus

The dimensions of the rectangular test pot apparatus, used for damage assessment after flexing or exposure to flame, are given in ⟨A1⟩ Figure D.2 ⟨A1⟩. The inner dimensions shall be 85 mm × 30 mm and are appropriate to hold unflexed and flexed, unexposed and flame exposed rectangular test specimens. The inner height of the test pot shall be 90 mm.

Dimensions in millimetres



Key

1 connection for the generation of negative pressure and measurement of pressure change
2 lower surface
3 upper surface
4 rectangular clamping (e.g. stainless steel)
5 rectangular gasket
6 rectangular specimen
7 rectangular gasket
8 rectangular test pot (e.g. stainless steel)

Figure D.2 — Rectangular test pot apparatus

When using the pressure pot, additional sealing (e.g. by use of jelly for ultrasonic analysis) on the edges is suggested.

D.2 Volume of pressure pot and apparatus

D.2.1 For flexcracking specimens

The total volume contained in the pressure pot cell (about 230 cm^3), pressure measuring device and piping, etc. shall be 300^{+0}_{-30} cm^3.

D.2.2 For abrasion specimens

〚A1〛 The total volume contained in the pressure pot cell (about 475 cm^3), pressure measuring device and piping, etc. shall be 570^{+0}_{-50} cm^3. 〈A1〉

D.3 Leak tightness test

Pre-testing pressure pot equipment for leakage or leak tightness using a suitable material (e.g. glass or a rubber coated material) shall be completed before each series of testing or at least once a day.

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