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Flexible cellular polymeric materials — Polyurethane foam for load-bearing applications excluding carpet underlay — Specification

Matériaux polymères alvéolaires souples — Mousse de polyuréthanne pour utilisations soumises à des charges, à l'exclusion des revers de tapis — Spécifications

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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

The committee responsible for this document is ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This third edition cancels and replaces the second edition (ISO 5999:2007), which has been technically revised.

Flexible cellular polymeric materials — Polyurethane foam for load-bearing applications excluding carpet underlay — Specification

1 Scope

This International Standard specifies requirements for flexible load-bearing polyurethane foam of the polyether type.

It is applicable to flexible polyurethane cellular materials manufactured in block, sheet and strip form, in moulded and fabricated shapes, and as reconstituted material, used for load-bearing applications in general, but excluding carpet backing and underlay. It, thus, primarily relates to the quality of polyurethane foam used for comfort cushioning purposes.

The foam is classified according to the type of foam, the performance during a fatigue test, and the indentation hardness index used as a means of grading materials.

This International Standard is not applicable to polyurethane foams foamed in place or to foams for use in heat-welded systems unless for load-bearing purposes.

Recommended applications for the range of flexible polyurethane foams covered by this International Standard are listed in Annex A.

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.

ISO 845, *Cellular plastics and rubbers — Determination of apparent density*

ISO 1798, *Flexible cellular polymeric materials — Determination of tensile strength and elongation at break*

ISO 1856, *Flexible cellular polymeric materials — Determination of compression set*

ISO 1923, *Cellular plastics and rubbers — Determination of linear dimensions*

ISO 2439:2008, *Flexible cellular polymeric materials — Determination of hardness (indentation technique)*

ISO 2440, *Flexible and rigid cellular polymeric materials — Accelerated ageing tests*

ISO 3385, *Flexible cellular polymeric materials — Determination of fatigue by constant-load pounding*

ISO 3582, *Flexible cellular polymeric materials — Laboratory assessment of horizontal burning characteristics of small specimens subjected to a small flame*

ISO 3795, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 8307, *Flexible cellular polymeric materials — Determination of resilience by ball rebound*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Classification

3.1 Type

For the purposes of this International Standard, flexible polyurethane foams are classified in accordance with Table 1.

Table 1 — Types of foam

Type		Description of foam
I	LB	Block foam, slabstock or contour cut [low resilience (known as "viscoelastic")]
	MB	Block foam, slabstock or contour cut (conventional)
	HB	Block foam, slabstock or contour cut (high resilience)
II	LM	Moulded [low resilience (known as "viscoelastic")]
	MM	Moulded (conventional)
	HM	Moulded (high resilience)
III	RE	Reconstituted or bonded

3.2 Class

3.2.1 Materials of the types of foam listed in Table 1, except for type MM (see footnote b to Table 7) and RE (see footnote a to Table 8), are subdivided into five classes based on the performance in the constant-load pounding test described in ISO 3385.

3.2.2 The five classes, their intended types of service and their intended hardness loss ratio are given in Table 2.

Table 2 — Classes and intended types of service

Class	Type of service	Hardness loss ratio P (%)
X	Exceptionally severe	$0 \leq P < 12$
V	Very severe	$12 \leq P < 22$
S	Severe	$22 \leq P < 32$
A	Average	$32 \leq P < 39$
L	Light	$39 \leq P < 45$

NOTE The hardness loss ratio is calculated from the following formula:

$$P = \frac{H - F}{H} \times 100$$

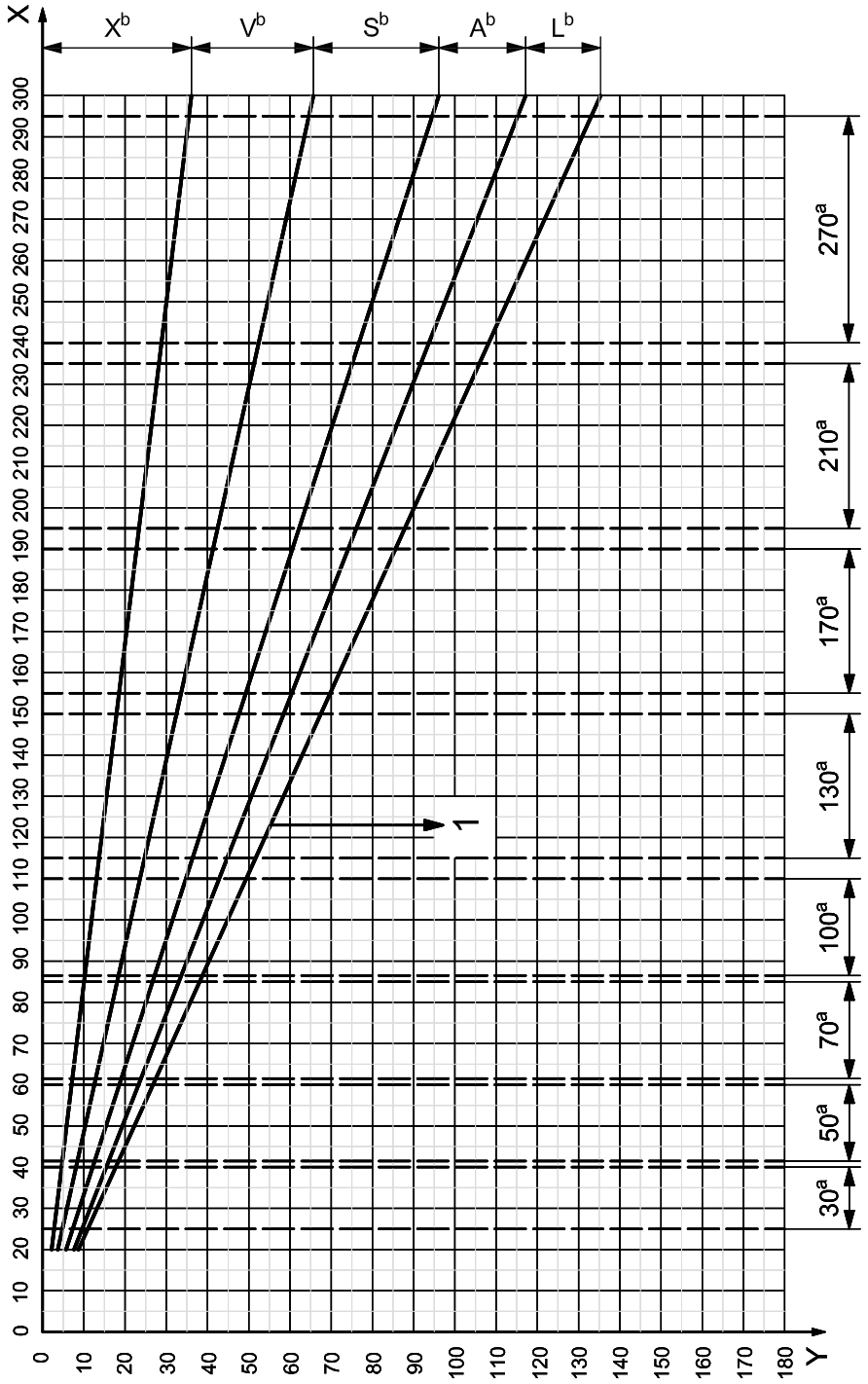
where

P is the hardness loss ratio (%);

H is the initial hardness index (N);

F is the final hardness index (N).

3.2.3 Classes X, V, S, A and L are defined by the indentation hardness loss over the range of hardness index values from 0 N to 650 N, as shown in Figures 1 and 2, provided the requirements for physical properties specified in Table 6, Table 7 and Table 8 are met.



Key

X initial indentation hardness index (N)

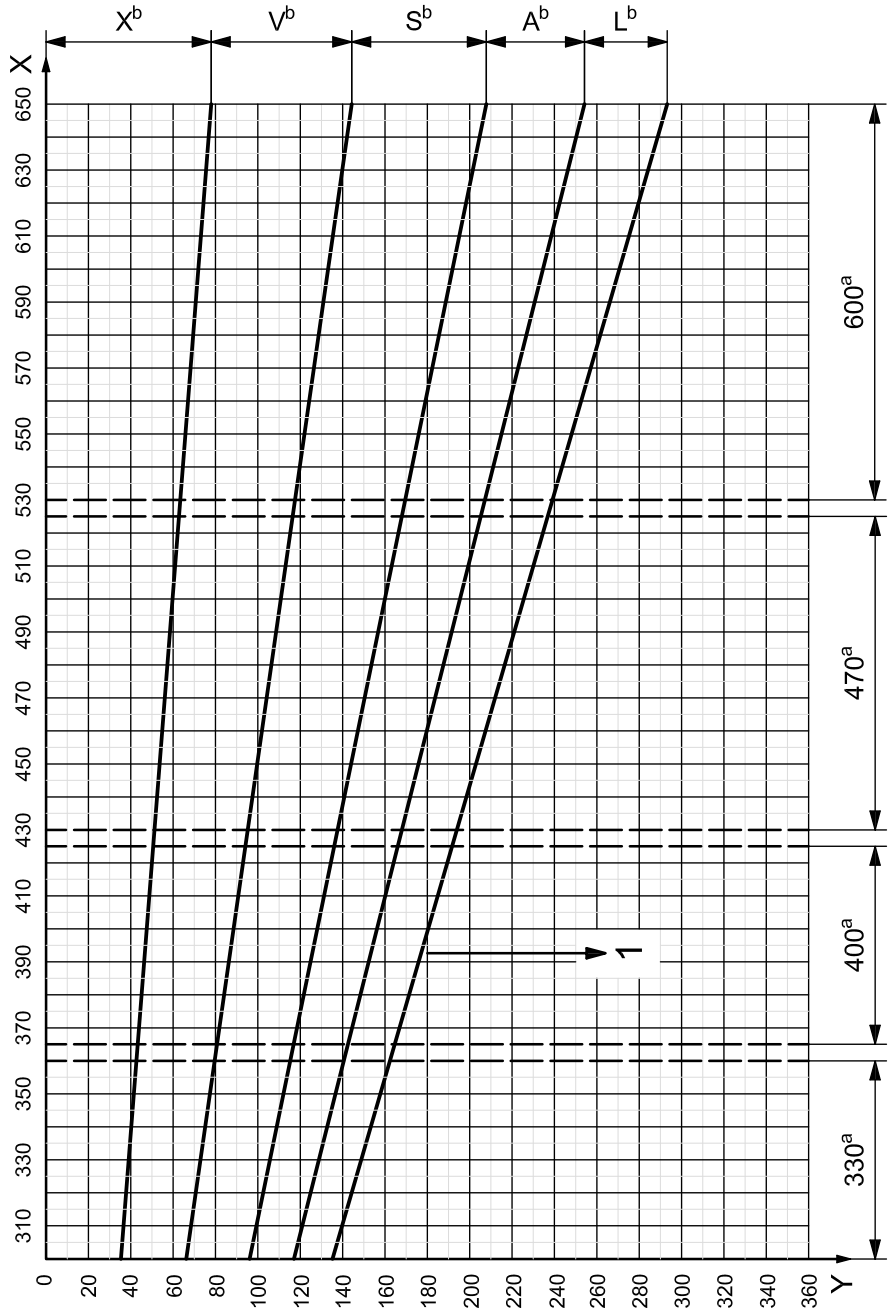
Y indentation hardness loss, ($H - F$) (see the Note to Table 2) (N)

1 below lowest line, material does not comply with this International Standard

a Hardness index grades.

b Classes of material.

Figure 1 — Fatigue classes and indentation hardness index grades — Low hardness values



Key

X initial indentation hardness index (N)

Y indentation hardness loss, (H – F) (see the Note to Table 2) (N)

1 below lowest line, material does not comply with this International Standard

a Hardness index grades.

b Classes of material.

NOTE 1 Class A and class L materials might not be available at all high hardness levels.

NOTE 2 Reconstituted foam (type RE), because of its good fatigue properties combined with poorer compression set, tensile strength and elongation at break properties, is specified separately in Table 8. It is generally used as thin, firm padding or to provide reinforcement for the other foams.

Figure 2 — Fatigue classes and indentation hardness index grades — High hardness values

3.2.4 As an example, in Figure 1, a material of initial hardness indentation index 140 N,

— with an indentation hardness loss greater than or equal to 0 N and less than 17 N is a class X material,

— with a hardness loss greater than or equal to 17 N and less than 31 N is a class V material,

— with a hardness loss greater than or equal to 31 N and less than 45 N is a class S material,

— with a hardness loss greater than or equal to 45 N and less than 55 N is a class A material, and

— with a hardness loss greater than or equal to 55 N and less than 63 N is a class L material,

provided, in all cases, the other property levels are achieved.

3.2.5 Any material having an initial indentation hardness index of 140 N and a hardness loss greater than 63 N does not comply with the requirements of this International Standard (see key item 1 of Figures 1 and 2).

3.3 Grade

Polyurethane foams are further graded by indentation hardness index, as determined by method A described in ISO 2439, in accordance with Table 3.

Table 3 — Grading by indentation hardness index

Grade	Indentation hardness index N
30	25 to 40
50	41 to 60
70	61 to 85
100	86 to 110
130	115 to 150
170	155 to 190
210	195 to 235
270	240 to 295
330	300 to 360
400	365 to 425
470	430 to 520
600	525 to 650

NOTE It can be impossible to manufacture foam falling into all these grades in each of the material classes. To control the hardness of foam within the above-mentioned grades, the selection of material can be carried out, since the typical variation of the hardness of foam within and between productions can be of the order of ±16 %.

4 Requirements

4.1 Material

Flexible polyurethane foam shall consist of a network of cells which are essentially open and interconnecting. It shall be free from abnormalities that are likely to adversely affect its performance.

4.2 Construction

4.2.1 Flexible polyurethane foams may be supplied in block, sheet or strip form, or in moulded or fabricated shapes, which may be cavitied or profiled.

4.2.2 Depending on the manufacturing conditions, the foam may have to be corrected or repaired. Repaired or corrected foam shall be considered to comply with this International Standard if the foam used in such repairs or corrections is of the same composition and quality as the original product, and provided such corrections do not adversely affect performance or alter the size and shape beyond the tolerances agreed upon between the purchaser and the supplier.

4.2.3 When components are repaired, corrected or fabricated, any adhesives used shall be such as to be non-injurious to the foam, and the resulting bonds shall be at least as strong as the foam itself.

4.2.4 The area of the bond should be sufficient to withstand the service conditions, and a thin overlay should be bonded over a large enough area to prevent rucking or wrinkling in service.

4.3 Surface condition

There shall be no loose skin on agreed significant surfaces. Mould parting marks and other surface blemishes shall be no worse than those on standard initial samples agreed upon between the purchaser and the supplier.

4.4 Odour

The odour of the foam shall not be objectionable.

NOTE Tests for odour have been investigated, but none has yet (at the time of publication of this International Standard) been found to be of practical use in this context.

4.5 Colour

The colour shall be as agreed upon between the purchaser and the supplier.

4.6 Component mass and density

4.6.1 The mass of a component, when required, shall be as agreed upon between the purchaser and the supplier, with a tolerance of ±15 %, unless otherwise stated.

4.6.2 The density of a component, when required, shall be as agreed upon between the purchaser and the supplier, with a tolerance of ±15 %, unless otherwise stated. The density shall be determined by the method indicated in 5.4.

4.7 Dimensions

The dimensions of flexible polyurethane foam components shall be as specified by the purchaser, subject to the tolerances given in Tables 4 and 5, unless otherwise agreed between the purchaser and the supplier.

NOTE The trimming allowances are the sole responsibility of the designer. The actual dimensions of a flexible polyurethane foam article used in upholstering are normally greater than the nominal dimensions by a small amount in order to allow the foam to be compressed slightly by a cover made to the nominal dimensions.

Table 4 — Tolerances on length and width

Dimensions in millimetres

Length and/or width	Tolerance
Up to and including 250[a]	$^{+5}_{0}$
Up to and including 250[b]	$^{+10}_{0}$
Over 250 up to and including 500	$^{+10}_{0}$
Over 500 up to and including 1 000	$^{+20}_{0}$
Over 1 000	$^{+30}_{0}$

[a] Excluding fabricated components.

[b] Fabricated components only.

Table 5 — Tolerances on thickness

Dimensions in millimetres

Thickness	Tolerance
Up to and including 25	$^{+3}_{0}$
Over 25 up to and including 100	$^{+4}_{0}$
Over 100	$^{+6}_{0}$

4.8 Physical properties

4.8.1 When tested in accordance with the method described in ISO 3385, the median value of indentation hardness loss of the three test pieces shall be no greater than the maximum specified in Figures 1 or 2 for the class and indentation hardness index of the material supplied. If this requirement is not met, the fatigue test may be repeated with a further four test pieces. In this case, the median indentation hardness loss of all seven test pieces shall be used for the classification.

4.8.2 Flexible polyurethane foam shall comply with the requirements given in Tables 6, 7 or 8, where appropriate, when tested by the methods indicated.

4.8.3 The standard test pieces required for the tests listed in Table 6 shall not include the surface skin, the adjacent layer of denser material or any portion where there is an obvious defect.

The depth of skin to be removed during test piece preparation may vary considerably, depending on the general configuration of the moulded shape. A minimum of 5 mm shall be removed.

Test pieces of moulded materials with skin can be used if the thickness of the moulding is too low to yield test pieces of appropriate size after removal of 5 mm of surface material, or if surface effects are of particular interest. In such cases, the surface condition of the test pieces shall be stated in the test report.

4.8.4 Reconstituted or bonded foam shall conform to cleanliness requirements agreed upon between the purchaser and the supplier.

Table 6 — Requirements for type I

Property	Test method	Type I														
		Class														
		LB					MB					HB				
		X	V	S	A	L	X	V	S	A	L	X	V	S	A	L
Hardness loss ratio, %	ISO 3385	Under 12	12 and over under 22	22 and over under 32	32 and over under 39	39 and over under 45	under 12	12 and over under 22	22 and over under 32	32 and over under 39	39 and over under 45	under 12	12 and over under 22	22 and over under 32	32 and over under 39	39 and over under 45
Compression set[a], %, max	ISO 1856	8	8	12	15	15	–[b]	6	10	10	10	8	8	12	15	15
Elongation at break, %, min	ISO 1798	100	90	90	90	90	–[b]	150	150	150	150	100	90	90	90	90
Tensile strength, kPa, min	ISO 1798	50	50	50	40	40	–[b]	70	70	70	60	50	50	50	50	50
Tensile strength after humidity ageing[c], kPa, min	ISO 2440 ISO 1798	35	25	25	15	15	–[b]	55	55	55	50	35	35	35	35	35
Change in tensile strength after humidity ageing[c], %, max	ISO 2440 ISO 1798	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Tensile strength after heat ageing[d], kPa, min	ISO 2440 ISO 1798	35	35	35	35	35	–[b]	55	55	55	50	35	35	35	35	35
Change in tensile strength after heat ageing[d], %, max	ISO 2440 ISO 1798	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Resilience, %	ISO 8307	15 max					–[e]					–[e]				

[a] At 75 % compression for 22 h at 70 °C.

[b] Not applicable.

[c] Maintaining the test pieces at 105 °C and 100 % relative humidity for 3 h.

[d] Maintaining the test pieces at 140 °C for 16 h.

[e] Normally resilience of "MB" and "HB" is over 50 %.

Table 7 — Requirements for Type II

Property	Test method	Type II										
		Class										
		LM					MM	HM				
		X	V	S	A	L	–[a]	X	V	S	A	L
Hardness loss ratio, %	ISO 3385	under 12	12 and over under 22	22 and over Under 32	32 and over Under 39	39and over Under 45	–[b]	under 12	12 and over under 22	22 and over Under 32	32 and over Under 39	39 and over Under 45
Compression set[c], %, max	ISO 1856	8	8	12	15	15	–[b]	8	8	12	15	15
Elongation at break, %, min	ISO 1798	100	90	90	90	90	–[b]	100	90	90	90	90
Tensile strength, kPa, min	ISO 1798	50	50	50	40	40	–[b]	50	50	50	50	50
Tensile strength after humidity ageing[d], kPa, min	ISO 2440 ISO 1798	35	25	25	15	15	–[b]	35	35	35	35	35
Change in tensile strength after humidity ageing[d], %, max	ISO 2440 ISO 1798	30	30	30	30	30	30	30	30	30	30	30
Tensile strength after heat ageing[e], kPa, min	ISO 2440 ISO 1798	35	35	35	35	35	–[b]	35	35	35	35	35
Change in tensile strength after heat ageing[e], %, max	ISO 2440 ISO 1798	30	30	30	30	30	30	30	30	30	30	30
Resilience, %	ISO 8307	15 max					–[b]	–[f]				

[a] Requirements for type MM should be decided between the purchasers and the suppliers.

[b] Not applicable.

[c] At 75 % compression for 22 h at 70 °C.

[d] Maintaining the test pieces at 105 °C and 100 % relative humidity for 3 h.

[e] Maintaining the test pieces at 140 °C for 16 h.

[f] Normally resilience of "HM" is over 50 %.

Table 8 — Requirements for Type III

Property	Test method	Type III Class V or X RE
Hardness loss ratio, %	ISO 3385	Under 22
Compression set[b], %, max	ISO 1856	25
Elongation at break, %, min	ISO 1798	40
Tensile strength, kPa, min	ISO 1798	50
Tensile strength after humidity ageing[c], kPa, min	ISO 2440 ISO 1798	–[a]
Change in tensile strength after humidity ageing[c], %, max	ISO 2440 ISO 1798	30
Tensile strength after heat ageing[d], kPa, min	ISO 2440 ISO 1798	–[a]
Change in tensile strength after heat ageing[d], %, max	ISO 2440 ISO 1798	30
Resilience, %	ISO 8307	–[a]

[a] Not applicable.

[b] At 75 % compression for 22 h at 70 °C.

[c] Maintaining the test pieces at 105 °C and 100 % relative humidity for 3 h.

[d] Maintaining the test pieces at 140 °C for 16 h.

4.9 Burning properties

4.9.1 Flexible polyurethane foam, in common with many other materials, is combustible. The material specified in this International Standard may, however, by agreement between the purchaser and the supplier, be suitably formulated so that, under certain well-defined conditions, its tendency to burn is reduced.

4.9.2 Suitable tests to be the basis of such agreement are specified in ISO 3582 and ISO 3795. Other tests may be chosen depending on the application for which the foam is intended.

These test methods are used primarily for the purpose of monitoring the consistency of production of the flexible polyurethane foam. Their use gives an indication of a suitable formulation which influences burning, as measured by these test methods. In no circumstances are the test results thus obtained to be considered as an overall indication of the potential fire hazard presented by the foam under actual conditions of use (see also Annex B).

5 Test methods

5.1 Test conditions

5.1.1 The test pieces shall be prepared and conditioned in accordance with ISO 23529, unless otherwise specified.

5.1.2 Materials shall not be tested less than 72 h after manufacture unless it can be demonstrated that the mean results obtained at either 16 h or 48 h after manufacture do not differ by more than ±10 % from those obtained after 72 h, in which case testing is permitted at 16 h or 48 h, respectively. In the case of quality-control tests, however, test pieces may be taken down to a minimum of 12 h after manufacture and testing carried out after conditioning for a minimum of 6 h.

5.2 Mass

The mass shall be measured in accordance with ISO 845.

5.3 Dimensions

The dimensions shall be measured in accordance with ISO 1923.

5.4 Density

Density shall be measured in accordance with ISO 845.

5.5 Hardness

Hardness shall be measured in accordance with 7.3 (method A) of ISO 2439:2008.

5.6 Resilience

Resilience shall be measured in accordance with ISO 8307.

5.7 Compression set

Compression set shall be measured in accordance with ISO 1856.

5.8 Dynamic fatigue by constant-load pounding

Dynamic fatigue by constant-load pounding shall be measured in accordance with ISO 3385.

5.9 Tensile strength and elongation at break

Tensile strength and elongation at break shall be measured in accordance with ISO 1798.

5.10 Burning behaviour

Burning behaviour shall be measured in accordance with ISO 3582 and/or ISO 3795.

5.11 Heat ageing

The test pieces shall be maintained at 140 °C for 16 h in accordance with ISO 2440 for the purpose of heat ageing.

5.12 Humidity ageing

The test pieces shall be maintained at 105 °C and 100 % relative humidity for 3 h in accordance with ISO 2440 for the purpose of humidity ageing.

6 Inspection

6.1 General

The inspection consists of type inspection and shipping inspection and shall meet the requirements specified in Clause 4 and Clause 5. The sampling procedure and the frequency in each inspection shall be determined by agreement between the purchaser and the supplier.

The type inspection is carried out to obtain product approval as required when a new product is introduced, or changes are made in the materials, construction or production process.

The shipping inspection is carried out when a product is shipped to purchaser. This is to certify that the product meets the requirements.

6.2 Type inspection

Type inspection shall be carried out for the following particulars:

a) mass;

b) density;

c) dimensions;

d) hardness;

e) resilience;

f) compression set;

g) hardness loss after dynamic fatigue test;

h) tensile strength and elongation at break;

i) tensile strength after humidity ageing;

j) tensile strength after heat ageing.

6.3 Shipping inspection

Shipping inspection shall be carried out for the following particulars:

a) density;

b) dimensions;

c) hardness;

d) compression set;

e) tensile strength and elongation at break.

7 Marking

When specified by the purchaser, components shall be clearly and permanently marked, by means which are non-staining and non-injurious to the foam, with the following information:

a) manufacturer's identification;

b) manufacturer's date code;

c) type, class and indentation hardness grade;

d) indentor location, where applicable;

e) burning properties, where applicable;

f) reference to this International Standard, i.e. ISO 5999.

Annex A
(informative)

Typical applications for each class of material

Recommendations are given in Table A.1 for typical applications for the five classes of material; the class listed is the lowest recommended for that application (see Table 2).

As the classes of polyurethane foam are defined by the results of the specified constant-load pounding test, the performance ranking of a range of materials would be the same for any individual application. The different severity of various applications has been taken into account in framing these recommendations. The class alone is not sufficient indication for the type of service: the indentation hardness index and the thickness also have to be taken into account.

Table A.1 — Recommended applications

Class	Recommended application
X	Heavy-duty seats in continuous use by the public (contract furniture) Heavy-duty public transport seats
V	Private and commercial vehicle drivers' seats Public transport seats Cinema and theatre seats Office furniture seats or seats used by the public (contract furniture)
S	Private and commercial vehicle passenger seats Domestic furniture seats Public transport seat backs and armrests Cinema and theatre seat backs and armrests Contract (commercial) furniture backs and armrests
A	Private vehicle seat backs and armrests Domestic furniture backs and armrests
L	Padding Scatter cushions or throw pillows Other pillows

Annex B
(informative)

Burning properties of flexible polyurethane foam and recommendations regarding its use

B.1 Suitable limits of burning properties for quality-control purposes are:

— 125 mm burnt extent, when measured by the method specified in ISO 3582;

— 102 mm/min burning rate, when measured by the method specified in ISO 3795.

B.2 Work commissioned by the United Kingdom government and carried out by the Rubber and Plastics Research Association[1] covered, among other items, the behaviour of a range of flexible polyurethane foams when subjected to the test method in BS 4735:1974,[2] which is similar to ISO 3582 and other laboratory ad hoc ignition tests (for example exposure to a lighted cigarette, match, candle, paper or fibreboard crib, or to radiant heat), either alone or when covered with a range of furnishing fabrics. For the uncovered foam, it was concluded that some improved performance resulted from the use of a suitably modified formulation, but only if the ignition source was small and of limited duration of application.

In the case of fabric-covered foams, such differences were masked. The ignitability depended to a large extent on that of the fabric and, after ignition, the burning rate was affected by the presence of the fabric.

In the light of this evidence and of other experience in the industry, it is considered that, during storage, etc., prior to establishing the final completed applications, flexible polyurethane foams of which test pieces have a burnt extent of less than 125 mm when tested by the method of ISO 3582 may be expected to be less liable (than other grades not satisfying this requirement) to start a fire by spreading the flame from a low-energy source, such as a lighted match. In its final manufactured state, for example domestic furniture and transport seating, further protection in respect of flammability and tendency to smoulder can be afforded by the judicious choice of covering fabrics.

Once the early ignition phase of a fire has passed, many other factors are involved in the development of the fire, such as the availability of oxygen, the amount of material present and its calorific value, the position relative to the fire, the degree of protection, etc. In this case, the test conditions in ISO 3582 cease to be relevant and no correlation can be expected between the performance of test pieces in that test and the behaviour of the same material in an actual fire situation.

Also, the presence of many of the modifications likely to be incorporated to enable the material to meet the 125 mm burnt extent requirement contributes significantly to the level of smoke and the concentration of certain toxic gases in a developed fire.

For materials covered by this International Standard, the fire risk arising from low-energy flame sources of short duration is principally determined by the choice of covering fabric (if any), by the environment and by the formulation of the foam. The suitability of a formulation may be indicated by test pieces of the material giving a burnt extent of less than 125 mm when subjected to the test method described in ISO 3582.

On the basis of such evidence, Table B.1 provides guidance intended to minimize the fire hazards presented by these materials.

B.3 Technical Committee ISO/TC 136, Furniture, has developed tests for the ignitability of upholstered furniture.[3]

Table B.1 — Recommended actions to minimize fire hazards

Situation	Recommended action(s)
Manufacture, storage and fabrication	a) Maintain good housekeeping standards. b) Observe stringent fire precautions, for example no smoking except in designated areas. c) Ensure that employees are fully aware of the potential fire hazards presented by these materials. d) Consult the relevant authority for advice with respect to fire precautions during manufacture, storage and handling. e) Maintain well-established fire drill procedures in consultation with the fire authority. f) Inform the fire authority of the materials being used. g) Install suitable fire protection systems as required by the situation.
Finished products	h) Avoid the use of covering materials that are easily ignited by small flame sources or with a known ability to support smouldering combustion. i) Ensure that all users are fully aware of the potential fire hazards presented by the materials.

Bibliography

[1] PALMER, K.N., TAYLOR, W. *Fire hazards of plastics in furniture and furnishings: Ignition studies*. Current Paper 18/74. Building Research Establishment, Borehamwood, Herts, WD6 2BL, UK

[2] BS 4735:1974, *Laboratory method of test for assessment of the horizontal burning characteristics of specimens no larger than 150 mm × 50 mm × 13 mm (nominal) of cellular plastics and cellular rubber materials when subjected to a small flame*

[3] ISO 8191 (all parts), *Furniture — Assessment of the ignitability of upholstered furniture*

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