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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

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 5999 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This second edition cancels and replaces the first edition (ISO 5999:1982), which has been technically revised (for the main details, see Annex C).

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 performance during a fatigue test, indentation hardness index being used as a secondary means of grading the material.

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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 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 2439:1997, *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 purpose 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 above types (except type RE) are subdivided into five classes based on 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 %
X	Exceptionally severe	0 to 12
V	Very severe	12 to 22
S	Severe	22 to 32
A	Average	32 to 39
L	Light	39 to 45

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

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

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 that the requirements for physical properties specified in Table 7 are met.

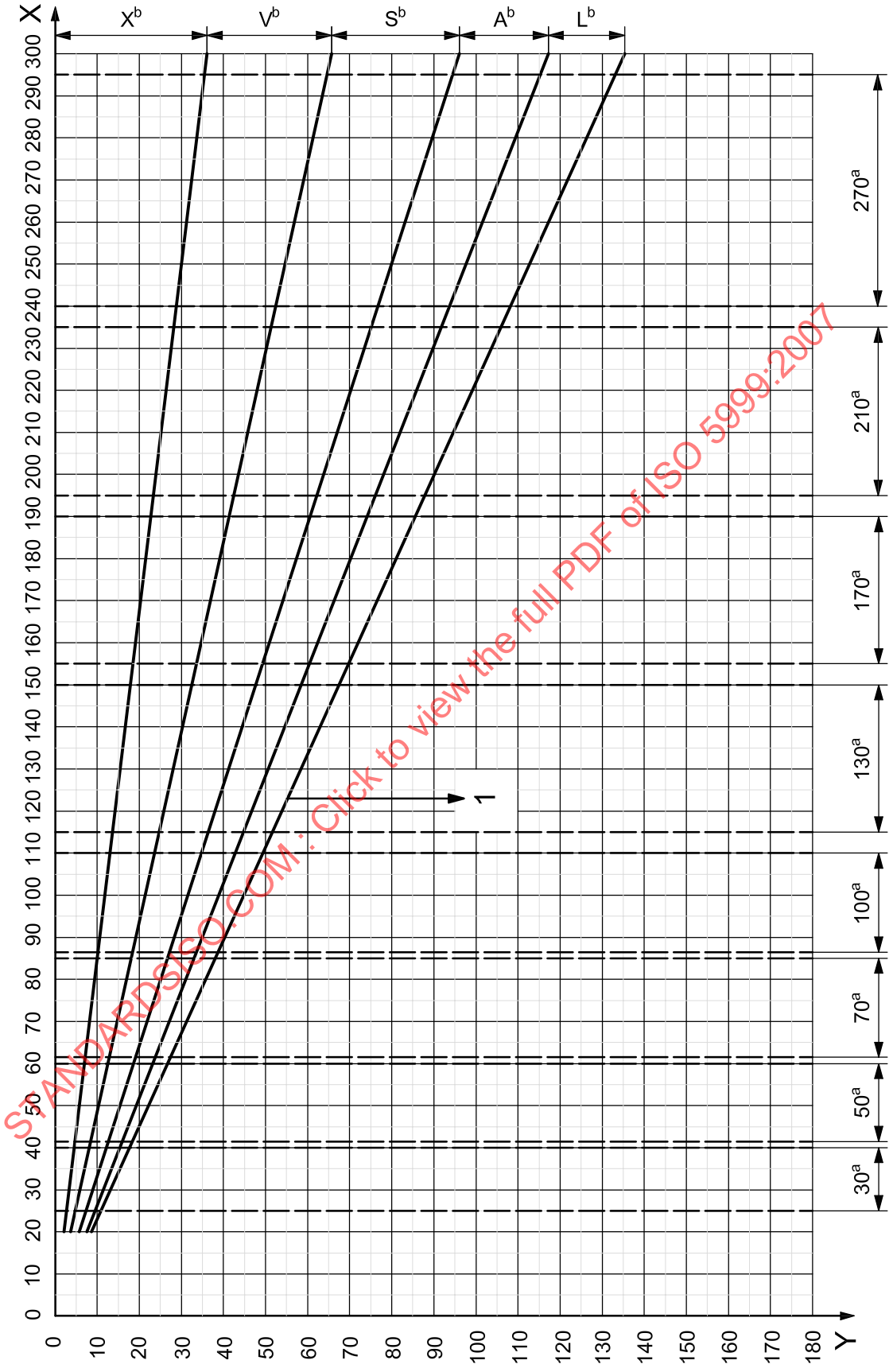

Figure 1 (*continued*)

Key

X initial indentation hardness index (N)
Y indentation hardness loss (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

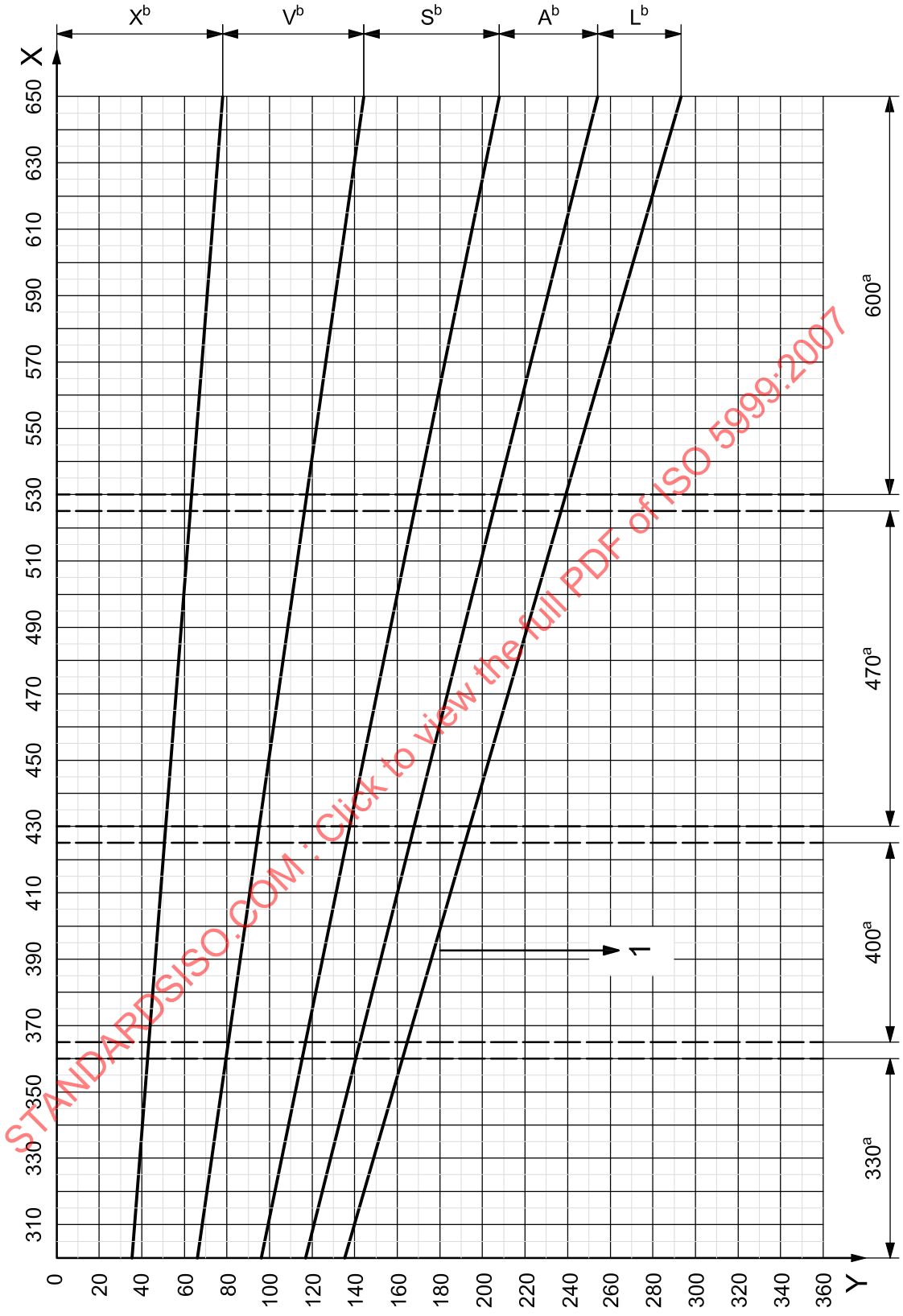

Figure 2 (*continued*)

Key

X initial indentation hardness index (N)

Y indentation hardness loss (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 may 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, a material of initial hardness indentation index 140 N, with an indentation hardness loss between 0 N and 17 N, is a class X material, with a hardness loss between 17 N and 31 N is a class V material, with a hardness loss between 31 N and 45 N is a class S material, with a hardness loss between 45 N and 55 N is a class A material, and with a hardness loss between 55 N and 63 N is a class L material, provided, in all cases, that the other property levels are achieved.

3.2.5 Any material having an indentation hardness index of 140 N and a hardness loss greater than 63 N does not comply with the requirements of this International Standard.

3.3 Grade

Polyurethane foams are further graded by indentation hardness index, as determined by the method 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 may not be possible to manufacture foam falling into all these grades in each of the material classes. To control the hardness of foam to within the above grades, selection of material may be necessary, since the typical variation of the hardness of foam within and between production runs can be of the order of ± 16 %.

4 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.

5 Construction

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

5.2 Depending on the manufacturing conditions, the material may have to be corrected or repaired. Repaired or corrected material 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 that such corrections do not adversely affect performance or alter the size and shape beyond the tolerances agreed upon between the purchaser and the supplier.

5.3 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.

5.4 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.

6 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.

7 Odour

The odour of the foam shall not be objectionable.[1)]

8 Colour

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

9 Component mass and density

9.1 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.

9.2 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 13.2.

1) Tests for odour have been investigated, but none has yet been found to be of practical use in this context.

10 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 responsibility solely of the designer. The actual dimensions of a flexible polyurethane foam article used in upholstering is 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

All values 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

All values in millimetres

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

11 Physical and chemical requirements

11.1 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 Figure 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.

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

11.3 The standard test pieces required for the tests listed in Table 6 shall not normally 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 normally be removed.

It is permissible, however, to use test pieces of moulded materials with skin 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 all such cases, the surface condition of the test pieces shall be stated in the test report.

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

Table 6 — Requirements for all types

Property	Test method	Requirement
Change in tensile strength, % of original value, max., after humidity ageing in accordance with ISO 2440 [a]	ISO 1798	30
Change in tensile strength, % of original value, max., after heat ageing in accordance with ISO 2440 [b]	ISO 1798	30

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

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

Table 7 — Requirements for types MB, HB, HM, LB and LM

Property	Test method	Class and type														
		X			V			S			A			L		
		MB	HB HM	LB LM	MB	HB HM	LB LM	MB	HB HM	LB LM	MB	HB HM	LB LM	MB	HB HM	LB LM
Compression set [a] % max.	ISO 1856	—[d]	8	8	6	8	8	10	12	12	10	15	15	10	15	15
Elongation at break % min.	ISO 1798	—[d]	100	100	150	90	90	150	90	90	150	90	90	150	90	90
Tensile strength kPa min.	ISO 1798	—[d]	50	50	70	50	50	70	50	50	70	50	40	60	50	40
Tensile strength after heat ageing [b] kPa min.	ISO 1798 ISO 2440	—[d]	35	35	55	35	35	55	35	35	55	35	35	50	35	35
Tensile strength after humidity ageing [c] kPa min.	ISO 1798 ISO 2440	—[d]	35	35	55	35	25	55	35	25	55	35	15	50	35	15
Resilience %	ISO 8307	—[d]	—[e]	15 max.	—[d]	—[e]	15 max.	—[d]	—[e]	15 max.	—[d]	—[e]	15 max.	—[d]	—[e]	15 max.

NOTE Requirements for type MM are decided between the purchaser and the supplier.

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

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

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

[d] Not applicable.

[e] Normally, the resilience of types HB and HM is over 50 %.

Table 8 — Requirements for type RE (reconstituted or bonded foam)

Property	Test method	Requirement
Indentation hardness loss max.	ISO 3385	As specified in Figures 1 and 2 for class V material
Compression set [a] % max.	ISO 1856	25
Elongation at break % min.	ISO 1798	40
Tensile strength kPa min.	ISO 1798	50

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

12 Burning characteristics

12.1 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.

12.2 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).

13 Test methods

13.1 Test conditions

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

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.

13.2 Density

Density shall be measured in accordance with ISO 845.

13.3 Hardness

Hardness shall be measured in accordance with 7.2 (method A) of ISO 2439:1997.

13.4 Resilience

Resilience shall be measured in accordance with ISO 8307.

13.5 Compression set

Compression set shall be measured in accordance with ISO 1856.

13.6 Dynamic fatigue by constant-load pounding

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

13.7 Tensile strength and elongation at break

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

13.8 Burning behaviour

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

13.9 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.

13.10 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.

14 Marking

When so 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 characteristics, where applicable;

f) the number of 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 also 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 will 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.