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Thermal insulation for building applications — Guidelines for selecting properties

Produits isolants thermiques pour le bâtiment — Lignes directrices pour le choix des charactéristiques

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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.

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 9774 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

It cancels and replaces ISO/TR 9774:1990, which has been technically revised.

Thermal insulation for building applications — Guidelines for selecting properties

1 Scope

This International Standard gives guidelines to the standards writer in selecting thermal-insulation material properties for standards used in building applications.

These guidelines are not intended to prove the suitability of any particular product for any given application.

When standards are established or existing specifications are revised on the basis of these guidelines, the performance characteristics in these guidelines should be translated into product requirements (specified values) in the International Standard for a product or application, together with appropriate test methods, which must be fulfilled at the time of delivery, in order to ensure that the product provides the performance requirements in service. This relationship between specified values for the product and the service performance characteristic of the product in use can be different for different insulating products, depending on the characteristic of the material (e.g. ageing or time-dependent behaviour).

This International Standard applies only to prefabricated thermal-insulation products, i.e. manufactured mats and boards including any facings or coverings which may be present, although the basic characteristics may also be applied to other insulation products, e.g. *in situ* in systems or components, where appropriate.

The International Standard covers only thermal-insulation products for use in buildings within normal climatic conditions. It does not cover insulation products for building services, e.g. plumbing and heating, nor insulation products for industrial use.

Acoustic properties are not included in the properties given in this International Standard, although these may be additionally required for some fields of application.

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/TR 9165, *Practical thermal properties of building materials and products*

3 Applications of thermal-insulation products in buildings

A review of the most common applications of thermal-insulation products in different roof, wall, ceiling and foundation structures is given in Table 1. The applications are illustrated in more detail in Figure 1.

The purpose of Figure 1 is only to illustrate the applications for the various insulation products and to assist in relating the performance characteristics of the products to their application. The figure will also assist in determining requirements for other applications not listed.

The sketches are for illustration only and are not intended as construction drawings: for example, water vapour barriers and air infiltration barriers which may be necessary are not shown. Waterproofings in the roof

or foundation area are only shown to clarify the position of the insulation layer — in the area affected by precipitation or ground water or in the area protected against the penetration of water.

4 Performance characteristics of products according to their application

Table 2 lists those properties — for different applications — which need to be considered when preparing standards and specifications for different products. The performance characteristics necessary for these properties to ensure serviceable and durable thermal insulation are explained and some values are suggested in Table 4.

Derived from Table 2, Table 3 gives specific properties which may be necessary only for certain applications.

For additional applications in building, not shown in Figure 1, the properties of the insulation products may be determined using the information in Tables 2, 3 and 4.

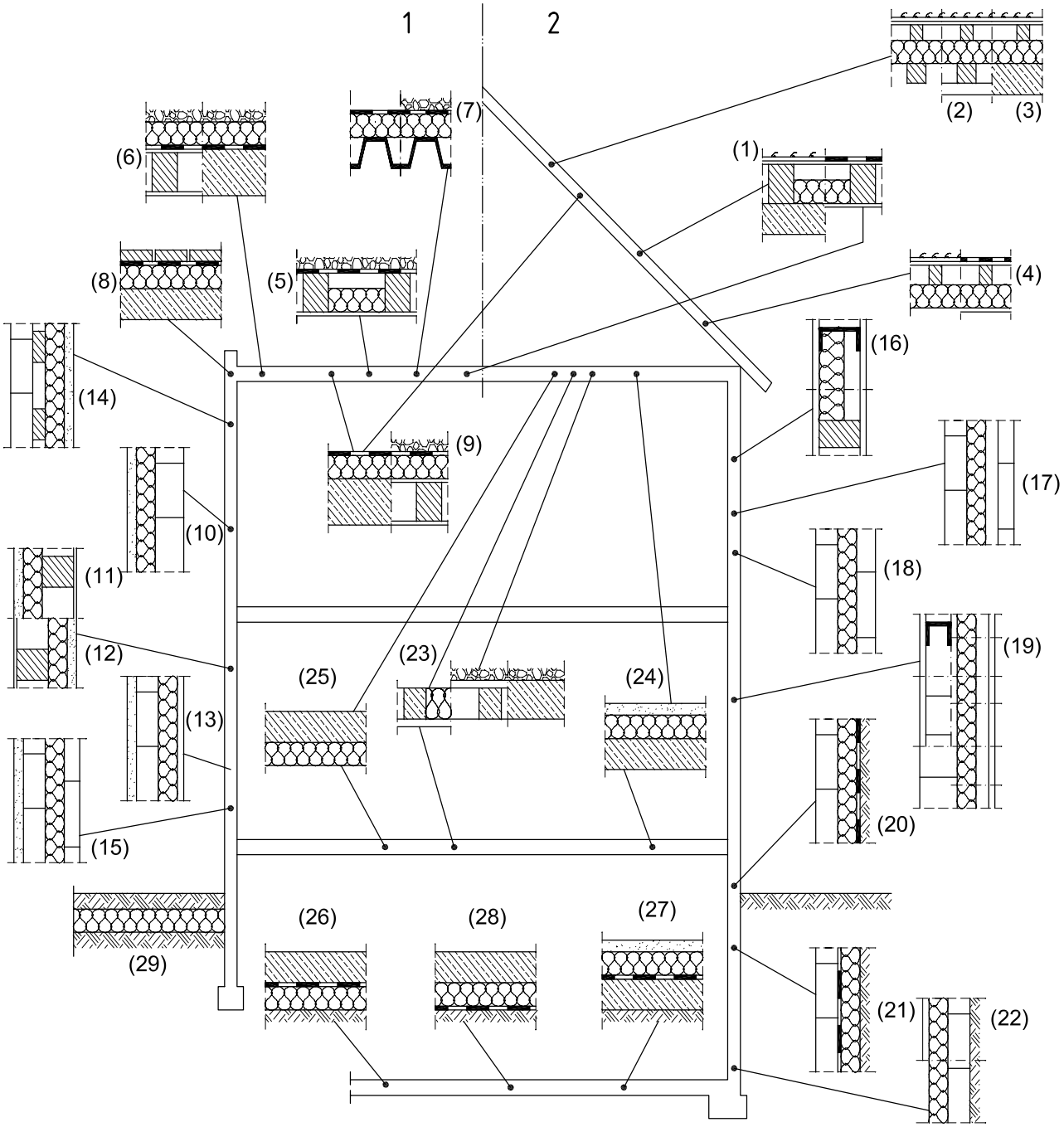
Insulation products used in two or more applications as indicated in Figure 1 shall have all relevant properties for all the intended applications.

For certain constructions, the knowledge of the water vapour transmission rate and the permeability to air is necessary. In such cases, the values for these shall be included in the product specification.

For some applications, additional performance criteria may be relevant, e.g. dimensional stability when in contact with solvents. In such cases, the product specification shall include these additional properties.

5 Application categories

For simplicity, the various applications for insulating products shown in Figure 1 may be grouped into categories having common performance requirements. It is then the task of the insulation material standards or specifications to define these categories and the applications which are covered by the categories.



For key, see next page.

NOTE The numbers in parentheses are for use with Tables 1, 2 and 3.

Key

1 flat roof
2 pitched roof

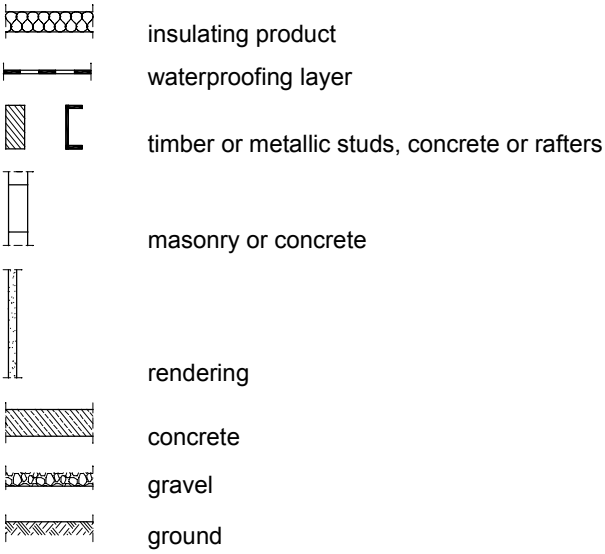


Figure 1 — Examples of the most common applications of thermal-insulation products in buildings

Table 1 — Examples of the most common applications of thermal-insulation products in buildings
(for additional information, see sketches in Figure 1)

Application			Sketch No.
Roof	Pitched roof	Unloaded insulation between rafters, fully supported	1
		Insulation separating rafters and outer covering	2
		Insulation separating supporting construction and outer covering	3
		Insulation beneath rafters	4
	Flat roof	Insulation between rafters or beams	5
		Inverted, insulation above roofing membrane including roof gardens and parking decks	6
		On steel deck, insulation beneath roofing membrane	7
		Accessible to light or heavy traffic or loads from roof garden (soil layer, plants, etc.) and parking decks (concrete pavers or slabs), insulation beneath roofing membrane	8
		Accessible only to maintenance personal, insulation beneath roofing membrane	9
Wall		Masonry or concrete wall, external insulation covered by rendering	10
		Timber stud construction, outside insulation and rendering directly supported by the studs	11
		Timber stud construction, insulation at the internal side with rendering	12
		Masonry or concrete wall, fully supported internal insulation supporting light protective internal facing (e.g. gypsum board)	13
		Masonry or concrete wall, internal insulation supporting light protecting facing, partly supported by studs	14
		Masonry or concrete wall, internal insulation with heavy self-supported protective internal facing (e.g. tiles at roomside)	15
		Timber or metal stud construction with boards covering, insulation between the studs	16
		Cavity wall construction, insulation between the leaves, cavity ventilated	17
		Cavity wall construction, cavity fully filled with insulation, outer leave not watertight	18
		Timber or metal stud construction with boards covering, insulation supported by boards; or masonry or concrete wall, supporting the insulation with ventilated exterior covering	19
		Wall under ground, external insulation behind waterproof membrane with mechanical protection	20
		Wall under ground, external insulation with direct contact to the ground	21
		Cellar or crawlspace hall, internal insulation with or without covering	22
Ceiling/floor		Insulation over the supporting construction or between the beams	23
		Insulation under load distributing flooring, fully supported	24
		Insulation under the construction	25
Foundation		Concrete, insulation under the slab with direct contact to the ground	26
		Concrete, insulation supported by the slab, above waterproof membrane, beneath load distributing flooring	27
		Concrete, insulation under the slab above waterproof membrane	28
		Frost insulation in or against the ground	29

Table 2 — List of relevant properties to be considered according to the application of insulating material in buildings (0 indicates specification writer should consider this property)

Application of insulation with reference to Figure 1 sketch No.						Roof									Wall							
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
a	Thermal resistance R or thermal conductivity λ					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b	Service temperature	Normal –40 °C/+60 °C (depending on covering)				0	0	0	0	0	0		0		0	0	0	0	0	0	0	0
c		Elevated –40 °C/+90 °C										0		0								
d	Shape and dimensional stability	Under temperature action				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
e		Under humidity action				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
f		Under humidity and temperature action									0											
g	Behaviour under compression	Application	No loading or compressive action			0			0	0					0			0		0	0	0
h			Compression under uniform load other than service load				0	0								0	0		0			
i			Service load	Only by maintenance personnel							0	0		0								
k				Light traffic (persons)							0		0									
l				Heavy traffic	Cars						0		0									
m					Trucks						0		0									
n1	Lateral tensile strength under wind load							0				0		0	0							
n2	Flexural strength under wind load						0		0							0						
o	Shear strength														0	0	0	0	0			
p	Handling properties					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
q	Bending strength under man load											0										
r	Behaviour under influence of water	Not planned, short-term wetted					0	0				0	0	0	0	0						0
s		Planned, long-term wetted									0											
t	Freeze/thaw resistance										0											
u	Influence on health and safety					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v	Fire behaviour					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
w	Behaviour under biological attack					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
x	Compatibility with other materials					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
y	Water vapour transmission					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
z	Permeability to air					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 (*continued*)

Application of insulation with reference to Figure 1 sketch No.						Wall					Ceiling			Foundations			
						18	19	20	21	22	23	24	25	26	27	28	29
a	Thermal resistance R or thermal conductivity λ					0	0	0	0	0	0	0	0	0	0	0	0
b	Service temperature	Normal −40 °C/+60 °C				0	0	0	0	0	0	0	0	0	0	0	0
c		Elevated −40 °C/+90 °C															
d	Shape and dimensional stability	Under temperature action				0	0	0	0	0	0	0	0	0	0	0	0
e		Under humidity action				0	0	0	0	0	0	0	0	0	0	0	0
f		Under humidity and temperature action															
g	Behaviour under compression	Application	No loading or compressive action			0	0			0	0		0				
h			Compression under uniform load other than service load					0	0					0		0	0
i			Service load	Only by maintenance personnel													
k				light traffic (persons)								0		0	0	0	0
l				Heavy Traffic	Cars									0		0	
m					Trucks									0		0	
n1	Lateral tensile strength under wind load						0										
n2	Flexural strength under wind load																
o	Shear strength																
p	Handling properties					0	0	0	0	0	0	0	0	0	0	0	0
q	Bending strength under man load																
r	Behaviour under influence of water	Not planned, short-term wetted						0								0	
s		Planned, long-term wetted				0	0		0					0			0
t	Freeze/thaw resistance								0					0			0
u	Influence on health and safety					0	0	0	0	0	0	0	0	0	0	0	0
v	Fire behaviour					0	0	0	0	0	0	0	0	0	0	0	0
w	Behaviour under biological attack					0	0	0	0	0	0	0	0	0	0	0	0
x	Compatibility with other materials					0	0	0	0	0	0	0	0	0	0	0	0
y	Water vapour transmission					0	0	0	0	0	0	0	0	0	0	0	0

Table 3 — Specific properties for thermal insulation products, necessary only for certain applications
(0 indicates specification writer should consider this property)

Application of insulation with reference to Figure 1 sketch No.						Roof									Wall							
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
c	Service temperature		Elevated −40 °C/+90 °C									0		0								
f	Shape and dimensional stability		Under humidity and temperature action								0											
g	Behaviour under compression	Application	No loading or compressive action			0			0	0					0			0		0	0	0
h			Compression under uniform load other than service load				0	0								0	0		0			
i			Service load	Only by maintenance personnel							0	0		0								
k				Light traffic (persons)							0		0									
l				Heavy traffic	Cars						0		0									
m					Trucks						0		0									
n1	Lateral tensile strength under wind load							0				0		0	0							
n2	Flexural strength under wind load						0		0							0						
o	Shear strength														0	0	0	0	0			
q	Bending strength under man load											0										
r	Behaviour under influence of water		Not planned, short-term wetted				0	0				0	0	0	0	0						0
s			Planned, long-term wetted								0											
t	Freeze/thaw resistance										0											

Table 3 (*continued*)

Application of insulation with reference to Figure 1 sketch No.						Wall					Ceiling			Foundations			
						18	19	20	21	22	23	24	25	26	27	28	29
c	Service temperature		Elevated –40 °C/+90 °C														
f	Shape and dimensional stability		Under humidity and temperature action														
g	Behaviour under compression	Application	No loading or compressive action			0	0			0	0		0				
h			Compression under uniform load other than service load					0	0					0		0	0
i			Service load	Only by maintenance personnel													
k				Light traffic (persons)								0		0	0	0	
l				Heavy Traffic	Cars									0		0	
m					Trucks												
n1	Lateral tensile strength under wind load						0										
n2	Flexural strength under wind load																
o	Shear strength																
q	Bending strength under man load																
r	Behaviour under influence of water		Not planned, short-term wetted					0								0	
s			Planned, long-term wetted			0	0		0					0			0
t	Freeze/thaw resistance								0					0			0

Table 4 — Suggested performance characteristics for the properties listed in Tables 2 and 3

	Property					Performance characteristics[a]	
a	Thermal resistance R or thermal conductivity λ					Design values for R or λ (i.e. those which will be met throughout the intended service life of the product in the given application) should be stated at 10 °C or 23 °C (or 40 °C in tropical areas). Values required in specifications should be such that due allowance is made for any predictable changes caused by ageing, moisture uptake, etc. (see ISO/TR 9165).	
b	Service temperature (surface temperature)		Normal −40 °C/+60 °C			The insulation material should be such that, in the given range of temperatures, it performs properly in the intended way.	
c			Elevated −40 °C/+90 °C				
d	Shape and dimensional stability		Under temperature action			There should be e.g. no restriction or irreversible shape or dimensional change which detracts from satisfactory performance of the product in use.	Between −40 °C and upper limit of service temperature.
e			Under humidity action				At 20 °C and R.H. between 30 % and 90 %.
f			Under humidity and temperature action				Between 20 °C and 60 °C and 30 % and 90 % R.H.
g	Behaviour under compression	Application	No loading or compressive action			Not relevant.	
h			Compression under uniform load other than service load			Restricted deformation under long-term uniform load of 30 kN/m^2.	
i			Service load	Only by maintenance personnel		Restricted deformation under long-term uniform load, e.g. 2 kN/m^2; less than 2 mm under short-time point load of e.g. 1 kN on area of 10 × 10 cm^2 of the product with roof covering in the temperature range.	
k				Light traffic (persons)		Restricted deformation under long-term uniform and repeated load, e.g. 4 kN/m^2, in the temperature range.	
l				Heavy traffic	Cars	Restricted deformation under long-term uniform and repeated load, e.g. 8 kN/m^2, in the temperature range.	
m					Trucks	Restricted deformation under long-term uniform and repeated load, e.g. 20 kN/m^2, in the temperature range.	
n1	Lateral tensile strength under wind load					Sufficient lateral tensile strength (cohesive strength) and bending strength between supports to cover wind load appropriate for height and location of buildings (e.g. 2,5 kN/m^2 for buildings up to 20 m height).	
n2	Flexural strength under wind load						
o	Shear strength					To withstand long-term load of covering, etc., of 30 mm thickness (shear load approx. 0,6/m^2).	
p	Handling properties					— Strength sufficient to withstand all stresses during transport and application, e.g. tensile strength > 2 × weight of product or bending strength to bear 2 × weight of board. — Product should be such that it can be shaped and fitted to usual constructions with normal tools.	
q	Bending strength under man load					Sufficient bending strength to perform properly under man load of 1 kN during construction and maintenance.	
r	Behaviour under influence of water		Not planned, short-term wetted			Limited water absorption and dimensional changes caused by a 24 h period of rain during construction such that the product is still suitable for its purpose.	
s			Planned, long-term wetted			Water absorption and dimensional changes of the product after long-term water immersion in the range of service temperatures should be limited so that the product is still suitable for its purpose.	
t	Freeze/thaw resistance					When wetted by direct water contact or penetration of water by diffusion, the product should withstand a sufficient number of freeze/thaw cycles.	
u	Influence on health and safety					Until international regulations are available, the product should be such that — upon application with normal methods and precaution procedures — and during use of the buildings national regulations, if any, are satisfied.	
v	Fire behaviour					Until international regulations are available, the material shall fulfill the national requirements.	
w	Behaviour under biological attack					The product should not substain the growth of fungus and not support life of insects/vermin.	
x	Compatibility with other materials					The insulation product should be compatible with other building materials with which it is designed to come into contact.	
y	Water vapour transmission					No upper and lower limit; range of values to be supplied.	
z	Permeability to air					No upper and lower limit, range of values to be supplied.	

[a] For translation of performance characteristics into product specifications, see Clause 1.

Table 5 — Applicable reference specifications

Property						Specification
a	Thermal resistance R or thermal conductivity λ					ISO 8301 or ISO 8302
b	Service temperature		Normal −40 °C/+60 °C			
c			Elevated −40 °C/+90 °C			
d	Shape and dimensional stability		Under temperature action			
e			Under humidity action			
f			Under humidity and temperature action			ISO 2796
g	Behaviour under compression	Application	No loading or compressive action			
h			Compressive deformation under uniform load other than service load			ISO 7616
i			Service load	Only by maintenance personnel		
k				Light traffic (persons)		
l				Heavy traffic	Cars	
m					Trucks	
n1	Lateral tensile strength under wind load					
n2	Flexural strength under wind load					
o	Shear strength					ISO 1922
p	Handling properties					
q	Bending strength under man load					
r	Behaviour under influence of water		Not planned, short-term wetted			
s			Planned, long-term wetted			ISO 2896
t	Freeze/thaw resistance					EN 12091
u	Influence on health and safety					
v	Fire behaviour					ISO 9772, ISO 4589
w	Behaviour under biological attack					
x	Compatibility with other materials					
y	Water vapour transmission					ISO 1663
z	Permeability to air					
aa	Apparent field density					ISO 845

Bibliography

[1] ISO 845, *Cellular plastics and rubbers — Determination of apparent (bulk) density*

[2] ISO 1663, *Rigid cellular plastics — Determination of water vapour transmission properties*

[3] ISO 1922, *Rigid cellular plastics — Determination of shear strength*

[4] ISO 2796, *Cellular plastics, rigid — Test for dimensional stability*

[5] ISO 2896, *Rigid cellular plastics — Determination of water absorption*

[6] ISO 4589, *Plastics — Determination of burning behaviour by oxygen index*

[7] ISO 7616, *Cellular plastics, rigid — Determination of compressive creep under specified load and temperature conditions*

[8] ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

[9] ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

[10] ISO 9772, *Cellular plastics — Determination of horizontal burning characteristics of small specimens subjected to a small flame*

[11] EN 12091, *Thermal insulating products for building applications — Determination of freeze-thaw resistance*

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