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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Thermal insulation products for buildings - Factory-made vacuum insulation panels (VIP) - Specification

Produits isolants thermiques pour le bâtiment -
Panneaux isolants sous vide (VIP) manufacturés -
Spécification

Wärmedämmstoffe für Gebäude - Werksmäßig
hergestellte Vakuumisulationspaneele (VIP) -
Spezifikation

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 88.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European foreword

This document (prEN 17140:2021) has been prepared by Technical Committee CEN/TC 88 “Thermal insulating materials and products”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 17140:2020.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association.

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

Introduction

This document specifies factory-made vacuum insulation panels (VIP). In the building environment, these products are used for the thermal insulation of buildings and are used in components or within systems that are applied to the building envelope. Therefore, the products in end use conditions are not directly exposed to the environment and always covered by additional layers.

1 Scope

This document specifies characteristics of factory-made vacuum insulation panels (VIP) intended to be used for the thermal insulation of buildings (roofs, walls, ceilings and floors).

This document is applicable for factory-made vacuum insulation panels (VIP), independent of the type of envelope (see 3.1.11), using the following core materials (see 3.1.10):

- organic fibres;
- inorganic fibres and particles (e.g. glass fibre, silica, etc.).

This document is applicable for factory-made vacuum insulation panels (VIP) with or without desiccants (see 3.1.12) and with and without evacuation valve (3.1.14).

The products covered by this document can be used in roofs, walls, ceilings and floors.

This document specifies procedures for assessment and verification of constancy of performance (AVCP) of characteristics of factory-made vacuum insulation panels (VIP).

This document does not cover products:

- intended to be used for the thermal insulation of building equipment and industrial installations;
- intended to be used for civil engineering works;
- intended to be used as perimeter or foundation;
- intended to be used for acoustic applications;
- with a thermal resistance R_D lower than $0,5 \text{ m}^2\cdot\text{K}/\text{W}$;
- that contain getters (3.1.13);
- that have protective layers (3.1.9).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 822:2013, *Thermal insulating products for building applications - Determination of length and width*

EN 823:2013, *Thermal insulating products for building applications - Determination of thickness*

EN 824:2013, *Thermal insulating products for building applications - Determination of squareness*

EN 825:2013, *Thermal insulating products for building applications - Determination of flatness*

EN 826:2013, *Thermal insulating products for building applications - Determination of compression behaviour*

EN 1602:2013, *Thermal insulating products for building applications - Determination of the apparent density*

EN 1604:2013, *Thermal insulating products for building applications - Determination of dimensional stability under specified temperature and humidity conditions*

EN 1605:2013, *Thermal insulating products for building applications - Determination of deformation under specified compressive load and temperature conditions*

EN 1606:2013, *Thermal insulating products for building applications - Determination of compressive creep*

EN 1607:2013, *Thermal insulating products for building applications - Determination of tensile strength perpendicular to faces*

EN 12664:2001, *Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Dry and moist products of medium and low thermal resistance*

EN 12667:2001, *Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Products of high and medium thermal resistance*

EN 13238:2010, *Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates*

EN 13501-1:2018, *Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests*

EN 13820:2003, *Thermal insulating materials for building applications - Determination of organic content*

EN 13823:2020, *Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item*

EN 16516:2017+A1:2020, *Construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air*

EN 16733:2016, *Reaction to fire tests for building products - Determination of a building product's propensity to undergo continuous smouldering*

EN ISO 1182:2020, *Reaction to fire tests for products - Non-combustibility test (ISO 1182:2020)*

EN ISO 1716:2018, *Reaction to fire tests for products - Determination of the gross heat of combustion (calorific value) (ISO 1716:2018)*

EN ISO 10211:2017, *Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations (ISO 10211:2017)*

EN ISO 10456:2007¹, *Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values (ISO 10456:2007)*

EN ISO 11925-2:2020, *Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2:2020)*

ISO 16269-6:2014, *Statistical interpretation of data - Part 6: Determination of statistical tolerance intervals*

¹ As impacted by EN ISO 10456:2007/AC:2009.

3 Terms and definitions, symbols, units and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

vacuum insulation panel

VIP

insulation product made of a sealed barrier envelope containing a core material with an open porosity structure, where the gas pressure inside the sealed barrier envelope is lowered below atmospheric pressure

3.1.2

centre of panel

COP

area of the VIP whose thermal performance is not affected by the edge effect

3.1.3

edge effect

form of thermal bridging along the edge due to the higher thermal conductivity of the outer envelope, both through the material of the envelope itself and the sealed folded envelope, compared to the core

3.1.4

inner pressure

total gas pressure within the VIP, measured in mbar

3.1.5

pressure compensation method

method of testing inner pressure of a VIP using a laminate-lift-off technique with a vacuum chamber or suction bell

Note 1 to entry: In some literature also called foil-lift-off technique.

3.1.6

vacuum chamber

device to remove air or other gases from a volume around a VIP to determine the inner pressure of a VIP by the pressure compensation method

3.1.7

suction bell

device to remove air or other gases from a volume connected to a part of a VIP to determine the inner pressure of a VIP by the pressure compensation method

3.1.8

pressure sensor

device to measure the inner pressure of a VIP

3.1.9

protective layer

functional surface material, e.g. paper, glass fibre textile or rubber, which is not considered as separate thermal insulation layer to be added to the thermal resistance of the product, intended to improve the handling of the product and protect it from damage

3.1.10

core material

insulation material with an open porosity structure constituting the main component inside the VIP envelope

3.1.11

envelope

airtight and water-tight outer layer of the VIP securing the vacuum inside the VIP

3.1.12

desiccant

additive material different from the core material which intends to absorb or adsorb water vapour in the sealed panel

3.1.13

getter

additive material different from the core material which intends to absorb or adsorb other gases than water vapour in the sealed panel

3.1.14

evacuation valve

device to connect the VIP to a vacuum pump

3.2 Symbols and abbreviated terms

For the purposes of this document, the following symbols, units and abbreviated terms apply.

A	surface area of the VIP	m^2
A_m	metering area of the GHP or HFM apparatus used for the measurement	m^2
b_c	core width	m
b_w	working width	m
$CS(Y)$	compressive stress/strength(Y =yield)	kPa
d	thickness	m
$d_{ambient}$	thickness of the ventilated VIP	m
d_N	nominal thickness of the product	m
f_{air}	acceleration factor for dry air of the VIP envelope	–
f_v	acceleration factor for water vapour of the VIP envelope	–
k	factor related to the number of test results available	–
l_c	core length	m

l_w	working length	m
l_ψ	length of the joints within the metering area	m
N	number of test results	–
P_{air}	air permeability of the VIP envelope	$\text{m}^3 \text{ Pa} / (\text{m}^2 \cdot \text{s})$
P_v	water intake rate of the VIP envelope	$\text{kg} / (\text{m}^2 \cdot \text{s})$
p_{air}	pressure inside the VIP	Pa
p_{lim}	maximum value of the inner pressure measured at least 24 h after production	Pa
p_v	water vapour pressure inside the VIP	Pa
p_0	initial value of the inner pressure	Pa
$p_{1/2}$	inner pressure of a VIP, where λ increases by 1/2 of the thermal conductivity of still air.	Pa
$R_{\text{COP},90/90\text{aged}}$	$R_{90/90}$ at centre of panel plus ageing	$\text{m}^2 \cdot \text{K} / \text{W}$
R_D	expressed thermal resistance including ageing, edge-effect and rounding rules	$\text{m}^2 \cdot \text{K} / \text{W}$
R_{mean}	mean thermal resistance	$\text{m}^2 \cdot \text{K} / \text{W}$
R_i	one test result of thermal resistance	$\text{m}^2 \cdot \text{K} / \text{W}$
$R_{90/90}$	90 % fractile with a confidence level of 90 % for the thermal resistance	$\text{m}^2 \cdot \text{K} / \text{W}$
S	top surface area (length x width) of the VIP	m^2
S_b	deviation from squareness on width or length	mm/m
S_{max}	deviation from flatness	mm
S_N	nominal perimeter of the product	m
S_R	estimate of the standard deviation of the thermal resistance	$\text{m}^2 \cdot \text{K} / \text{W}$
S_λ	estimate of the standard deviation of the thermal conductivity	$\text{W} / (\text{m} \cdot \text{K})$
$S_{\lambda i}$	estimate of the standard deviation of the initial thermal conductivity within 90 days of production	$\text{W} / (\text{m} \cdot \text{K})$
T	temperature	K
t	time	s
t_{Des}	service life time of the desiccant	a
X	water content inside the VIP	mass-%
$X'_{t,50/70}$	change of water content with time at 50°C 70 % RH	mass-%/s

X_{ct}	compressive creep	mm
X_t	total thickness reduction	mm
λ	thermal conductivity	W/(m·K)
$\lambda_{ambient}$	thermal conductivity of a ventilated VIP at centre of the panel	W/(m·K)
λ_{COP}	thermal conductivity for centre of panel	W/(m·K)
$\lambda_{COP,mean}(25years)$	average value of thermal conductivity over the first 25 years in use at centre of panel	W/(m·K)
$\lambda_{COP,90/90,aged}$	$\lambda_{90/90}$ at centre of panel plus ageing	W/(m·K)
λ_D	expressed thermal conductivity including ageing, edge-effect and rounding rules	W/(m·K)
$\lambda_{eq\ ja}$	equivalent thermal conductivity including edge effects for the specific joint assembly	W/(m·K)
λ_{mean}	mean value of thermal conductivity	W/(m·K)
λ_i	one test result of thermal conductivity	W/(m·K)
λ'_p	change of thermal conductivity with pressure	W/(m·K·Pa)
λ'_t	change of thermal conductivity with time	W/(m·K·s)
λ'_x	change of thermal conductivity with humidity	W/(m·K)/mass-%
$\lambda_{90/90}$	90 % fractile with a confidence level of 90 % for the thermal conductivity	W/(m·K)
$\lambda'_{t, 23, 50}$	change of thermal conductivity with time at 23°C 50 % RH	W/(m·K·a)
$\lambda'_{t, 50, 70}$	change of thermal conductivity with time at 50°C 70 % RH	W/(m·K·a)
$\lambda(t)$	time-dependent thermal conductivity value	W/(m·K)
$\lambda(t)_{23, 50}$	time dependent value of thermal conductivity at 23°C 50 % RH	W/(m·K)
$\lambda^*(t = 0)$	interpolated initial value of thermal conductivity	W/(m·K)
σ_c	compressive stress	kPa
σ_m	compressive strength	kPa
σ_{mt}	tensile strength perpendicular to faces	kPa
σ_{10}	compressive stress at 10 % deformation	kPa
ϕ	relative humidity inside the VIP	%
ϕ'_x	change of relative humidity inside the VIP as function of water content	(rel. humidity-%)/(mass-%)

ψ	linear thermal transmittance	W/(m·K)
ψ_m	linear thermal transmittance for the joints in the metering area	W/(m·K)

Abbreviated terms used in this document:

VIP	vacuum insulation panel
COP	centre of panel
AVCP	assessment and verification of constancy of performance (previously named attestation of conformity)
DoP	declaration of performance
FPC	factory production control
STP	standard condition for temperature and pressure
RtF	reaction to fire
ThIB	thermal insulation for buildings
VOC	volatile organic compounds

4 Characteristics

4.1 Reaction to fire

4.1.1 Determination

Reaction to fire classification shall be determined according to 5.2.1.

4.1.2 Expression

The reaction to fire shall be classified and expressed according to EN 13501-1:2018, Clause 11.

EXAMPLE Class E.

4.2 Propensity to undergo continuous smouldering

4.2.1 Determination

Propensity to undergo continuous smouldering of the core material shall be determined according to 5.2.2.

4.2.2 Evaluation and expression

Propensity to undergo continuous smouldering shall be expressed according to EN 16733:2016, Clause 11. If the test according to EN 16733:2016, Clause 11 has been passed, the result shall be expressed as follows: “the product does not show propensity for continuous smouldering combustion”. If the test according to EN 16733:2016, Clause 11 has been failed, the result shall be expressed as follows: “the product shows propensity for continuous smouldering combustion”. If the assessment was not possible according to EN 16733:2016, Clause 11, the result shall be expressed as follows: “assessment of the propensity for continuous smouldering combustion is not possible”.

If a designation code is given, the following abbreviations shall be used:

- the product does not show propensity for continuous smouldering combustion: NoS

- the product shows propensity for continuous smouldering combustion: *S*
- the assessment of the propensity for continuous smouldering combustion is not possible: *ANP*.

EXAMPLE *NoS*.

4.3 Release of VOCs

4.3.1 Determination

The release of VOCs into indoor air shall be determined according to 5.2.3.

4.3.2 Expression

The release of VOCs into indoor air shall be expressed as values in accordance with EN 16516:2017+A1:2020.

4.4 Compressive strength

4.4.1 Determination

The compressive strength shall be determined according to 5.2.4.

4.4.2 Evaluation and expression

The compressive strength shall be expressed as a designation code *CS(Y)i* or *CS(10)i*, depending on the result of the testing of 5.2.4. The test result *i* shall be rounded downwards in steps of 10 kPa.

EXAMPLE 1 *CS(Y)120*.

EXAMPLE 2 *CS(10)120*.

4.5 Tensile strength perpendicular to faces

4.5.1 Determination

The tensile strength perpendicular to faces, σ_{mt} , shall be determined according to 5.2.5.

4.5.2 Expression

The tensile strength perpendicular to faces, σ_{mt} , shall be expressed as a designation code *TRi*. The value *i* of the tensile strength shall be rounded downwards in steps of 10 kPa.

EXAMPLE *TR80*.

4.6 Thermal resistance

4.6.1 Thermal resistance of the VIP

4.6.1.1 Determination

The thermal resistance shall be determined according to 5.2.6.1.

4.6.1.2 Expression

The thermal resistance shall be rounded downwards to the nearest 0,05 m²·K/W and be expressed as a value in m²·K/W. It shall be expressed together with thermal conductivity rounded upwards in steps of 0,000 5 W/(m·K) and expressed as a value in W/(m·K). It shall be expressed together with the thickness given as a value in mm.

EXAMPLE $R_D = 4,60 \text{ m}^2 \cdot \text{K/W}$ ($\lambda_D = 0,0065 \text{ W/(m} \cdot \text{K)}$, $d = 30 \text{ mm}$).

4.6.2 Thermal resistance of the ventilated VIP under ambient pressure due to damage

4.6.2.1 Determination

The thermal resistance of the ventilated VIP under ambient pressure due to damage shall be determined according to 5.2.6.2.

4.6.2.2 Expression

The thermal resistance of the ventilated VIP under ambient pressure due to damage shall be rounded downwards to the nearest $0,05 \text{ m}^2\cdot\text{K}/\text{W}$ and be expressed as a value in $\text{m}^2\cdot\text{K}/\text{W}$. It shall be expressed together with the thickness given as a value in mm.

EXAMPLE $R_{\text{ambient, eff}} = 1,00 \text{ m}^2\cdot\text{K}/\text{W}$ ($d_{\text{ambient}} = 20 \text{ mm}$).

4.7 Durability aspects

4.7.1 Dimensional stability under specified temperature and humidity conditions

4.7.1.1 Determination

Dimensional stability under specified temperature or under specified temperature and humidity conditions shall be determined according to 5.2.7.1.

4.7.1.2 Expression

Dimensional stability under specified temperature or under specified temperature and humidity conditions shall be expressed as a code in the following way: If the relative changes in core length and core width do not exceed 1 % and the relative reduction in thickness does not exceed 3 %, the code shall be *DS*. Otherwise, the code shall be *NoDS*.

EXAMPLE *DS*.

4.7.2 Dimensional stability under specified compressive load and temperature conditions

4.7.2.1 Determination

Dimensional stability under specified compressive load and temperature conditions shall be determined according to 5.2.7.2.

4.7.2.2 Expression

Dimensional stability under specified compressive load and temperature conditions shall be expressed as a code in the following way: If the relative changes in thickness do not exceed 3 %, the code shall be *DSC*. Otherwise, the code shall be *NoDSC*.

EXAMPLE *DSC*.

4.7.3 Compressive creep

4.7.3.1 Determination

The compressive creep shall be determined according to 5.2.7.3.

4.7.3.2 Expression

Compressive creep, X_{ct} , shall be expressed as a designation code $CC(i_1/i_2/y)\sigma_c$ together with the total thickness reduction, X_t . The value of the total thickness reduction i_1 and the value of compressive creep i_2 after y years shall be given in steps of 0,1 mm and at the expressed stress σ_c .

EXAMPLE $CC(2,5/2/10)50$.

5 Assessment methods

5.1 General

5.1.1 Sampling

Unlike other insulating materials, VIP cannot be cut to the sizes required by the test standards. They shall be produced in the sizes stated in Table 1.

5.1.2 Conditioning

Conditioning of the test specimens shall be at least 24 h at $(23 \pm 5) ^\circ\text{C}$ unless otherwise specified in the test standard. In case of dispute, the test specimens shall be stored at $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity for at least 24 h prior to testing.

Table 1 — Characteristics and test specimens

Clause		Test specimen length and width
No	Title	
5.2.1	Reaction to fire	See Annex H
5.2.2	Propensity to undergo continuous smouldering	800 x 300
5.2.3	Release of VOCs	Full-size
5.2.4	Compressive strength	≥ 200
5.2.5	Tensile strength perpendicular to faces	≥ 200
5.2.6	Thermal resistance and thermal conductivity of the VIP	≥ 300
5.2.6	Inner pressure at least 24 h after production	≥ 300
5.2.6	Length and width	Full-size
5.2.6	Squareness on length and width	Full-size
5.2.6	Flatness	Full-size
5.2.6	Thickness	Full-size
5.2.7	Dimensional stability according to specified temperature conditions	≥ 200
5.2.7	Deformation under specified compressive load and temperature conditions	≥ 200
5.2.7	Compressive creep	≥ 200

5.2 Test methods

5.2.1 Reaction to fire

Reaction to fire classification shall be determined using the test standards referred to within EN 13501-1:2018, Clause 8 for the claimed class. For specific tests, the mounting and fixing procedure shall be as given in Annex H.

5.2.2 Propensity to undergo continuous smouldering

The propensity to undergo continuous smouldering of the VIP shall be tested on the core material. The material shall be tested according to EN 16733:2016. The following conditions and parameters shall be considered within the tests:

- organic content (in percentage per mass), to be determined by tests according to EN 13820:2003;
- absolute organic content expressed in [kg/m³];
- density according to EN 1602:2013;
- thickness to be determined by test according to EN 823:2013.

The tests shall be done without consideration of the intended end-use conditions. If the paragraph 6.2.5 of EN 16733:2016 applies, a permanent contact between the pieces shall be assured.

The results of tests considering the aforementioned parameters in full are also valid for products

- having tested absolute organic content in [kg/m³] identical or lower, when the organic content in [%] is the same or lower as tested;
- with equal or lower density;
- with lower thickness and also with higher thickness when 100 mm thick specimens were tested;
- with any envelopes;
- for any end-use conditions.

5.2.3 Release of VOCs

The release of VOCs into indoor air shall be tested according to EN 16516:2017+A1:2020, 8.2.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction web site on EUROPA accessed through: <https://ec.europa.eu/growth/tools-databases/cp-ds>.

5.2.4 Compressive strength

In accordance with EN 826:2013 either the compressive stress at 10 % or the compressive strength shall be determined.

In order to even out seams, flaps and uneven surfaces of the VIPs and to enhance comparability of different products on the market, gypsum coating shall be used to enhance the coupling of the specimens to the testing machine – e.g. in a similar way as the procedure given for cellular glass in EN 826:2013, A.3.2.6 but using gypsum instead of bitumen.

5.2.5 Tensile strength perpendicular to faces

Tensile strength perpendicular to faces, σ_{mt} , shall be determined in accordance with EN 1607:2013.

5.2.6 Thermal resistance

5.2.6.1 Thermal resistance of the VIP

5.2.6.1.1 General

For the determination of the thermal resistance the following characteristics are needed:

- thermal conductivity (5.2.6.1.2);
- thickness (5.2.6.1.3);
- length, width, squareness, flatness (5.2.6.1.4).

5.2.6.1.2 Thermal conductivity

Thermal conductivity shall be based upon measurements carried out at centre of panel in accordance with EN 12667:2001.

The measurement shall be carried out directly on the VIP, or, for uneven surfaces, to avoid air gaps, the measurement shall be carried out with the VIP positioned between two flexible contact sheets according to EN 12664:2001, 6.3.2.2.

For VIP products the thermal conductivity including ageing shall be determined in accordance with Annex A including ageing and thermal bridge effect according to Annex C and shall be determined according to the following:

- The reference mean temperature for thermal conductivity shall be 10 °C.
- The measured values shall be expressed with two significant figures.
- $\lambda_{90/90}$ is obtained from testing thermal conductivity in the centre of panels shortly after production. It shall be representing at least 90 % of the production, determined with a confidence level of 90 % in accordance with EN ISO 10456:2007^{Error! Bookmark not defined.}.
- The statistical value of thermal conductivity, $\lambda_{90/90}$, shall be rounded upwards to the nearest 0,000 1 W/(m·K).
- The thermal conductivity, λ_D , shall be derived from $\lambda_{90/90}$ by adding ageing and edge effect according to Annex C.
- The thermal conductivity λ_D is achieved including ageing and edge effect according to Annex C and shall be rounded upwards in steps of 0,000 5 W/(m·K).
- Different methods to include the aging apply for VIP with or without desiccants. Both methods are described in Annex C.

5.2.6.1.3 Thickness

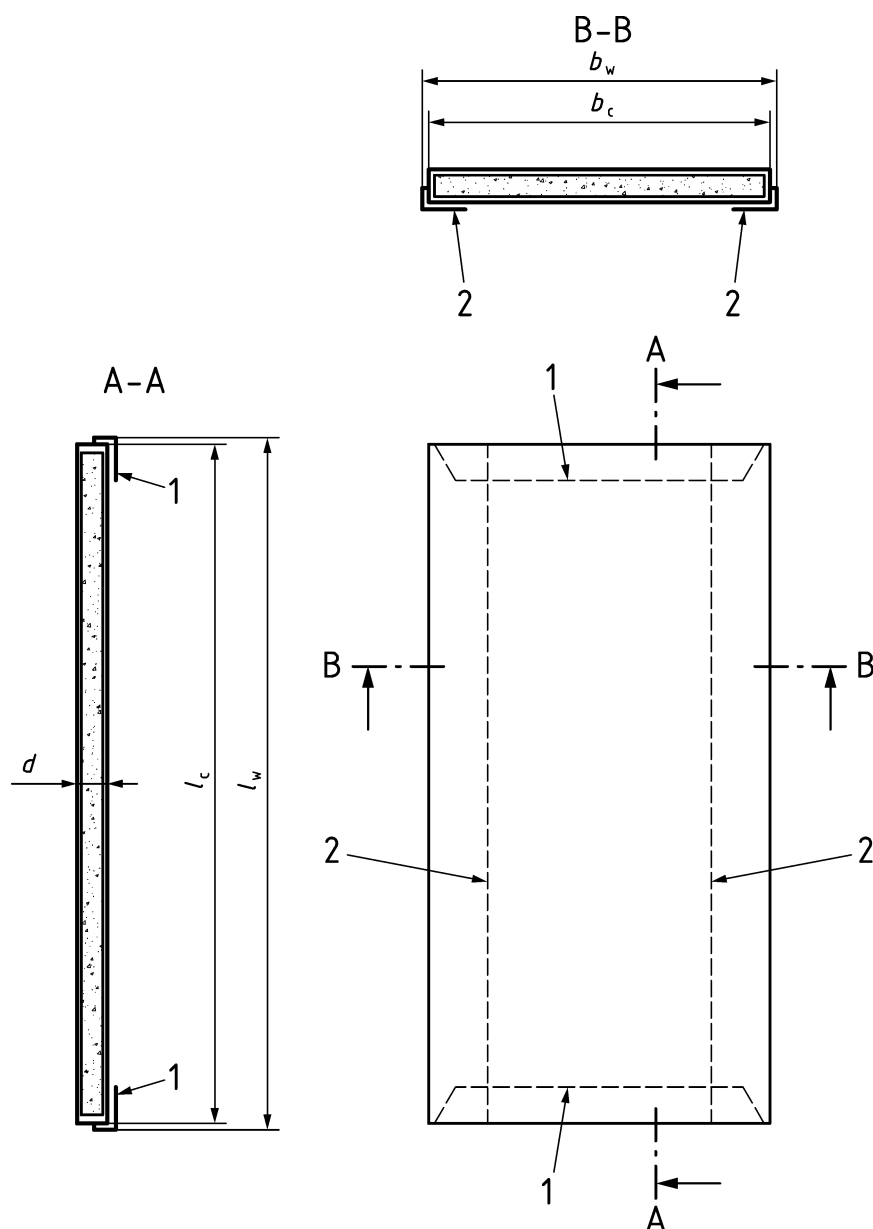
Thickness of the VIP, d , shall be determined in accordance with EN 823:2013. The seams and folded edges or ends shall not be included in the measurement (see Figure 1).

The VIP should be placed even on the measuring table before measurements are taken.

No test result shall deviate from the nominal thickness, d_N , by more than the tolerances given in Table 2.

Table 2 — Tolerances for thickness

Thickness	Tolerance
mm	Mm
< 15	$+2/-0$
$15 \leq d < 40$	$+2/-1$
$40 \leq d < 50$	± 2
≥ 50	$+3/-2$

**Key**

- | | |
|----------------------------------|----------------------|
| 1 folded edges on the short side | l_w working length |
| 2 folded edges on the long side | b_c core width |
| d thickness | b_w working width |
| l_c core length | |

Figure 1 — Dimensions of a Vacuum Insulation Panel

5.2.6.1.4 Length, width, squareness, flatness

The working length, l_w , and the working width, b_w , (see Figure 1) shall be determined in a similar way as the procedure given in EN 822:2013, but taking the measurement at the highest point of the folded edge.

The core length, l_c , and the core width, b_c , (see Figure 1) shall be determined in accordance with EN 822:2013.

The deviation from squareness of the length and width, S_b , shall be determined in a similar way as the procedure given in EN 824:2013, but both sides of the panel shall be measured and the higher value shall be expressed.

The deviation from flatness, S_{max} , shall be measured in a similar way as the procedure given in EN 825:2013, with the measuring points, when possible, excluding the welding or folding areas of the envelopes of the products.

No test result shall deviate from the nominal values by exceeding the tolerances given in Table 3.

Table 3 — Tolerances of length, width, squareness and flatness

Tolerances				
Length or width			Squareness on length and width	Flatness
< 500 mm	$500 \leq (l, b) \leq 1\,000$	> 1 000	S_b	S_{max}
mm			mm/m	mm
8 (e.g. +2 / -6) or (e.g. +0 / -8)	10 (e.g. ± 5) or (e.g. +4 / -6)	12 (e.g. +4 / -8) or (e.g. +10 / -2)	5	6

5.2.6.1.5 Inner pressure

The inner pressure of the panel shall be measured minimum 24 h after production according to Annex G and shall be lower than the limit value p_{lim} . Different methods apply for VIP with or without evacuation valve. Both methods are described in Annex G.

5.2.6.1.6 Report of thermal resistance

The thermal resistance, R_D , is derived by the thermal conductivity, λ_D , and the nominal thickness, d_N , via the equation: $R_D = d_N / \lambda_D$. In addition to the thermal resistance the test report shall contain the thermal conductivity, nominal thickness, length, width, squareness, flatness and inner pressure.

5.2.6.2 Thermal resistance of the ventilated VIP under ambient pressure due to damage

The thermal resistance of a ventilated VIP shall be recorded upon measurements in accordance with EN 12667:2001. The value of ambient pressure should be recorded during the measurement. To this extent the envelope of the VIP shall be opened at the edge. The length or diameter of the opening shall be between 10 mm and 20 mm. For VIP with evacuation valves the valve can be opened until ambient pressure is reached.

The thickness of the ventilated VIP might differ from the thickness of the evacuated VIP. Therefore, the thickness of the ventilated VIP $d_{ambient}$ should be measured according to EN 823:2013.