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European Assessment Document for

Pressure-equalizing insulating glass units

This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

The pressure-equalizing insulating glass units are insulating glass units filled with air and produced in accordance with EN 1279-5[1]. In the edge seal of the insulating glass unit a pressure-equalizing element made of a stainless steel cylindric element and a plastic membrane is integrated to realize a pressure equalization between the insulating glass unit cavity and the outside. The pressure-equalizing element consists of a cylindrical body with an inner membrane. Examples are shown in Annex A.

The product is not fully covered by the harmonised European standard EN 1279-5. EN 1279-5 refers to EN 1279-1. In EN 1279-1, clause 3.1, multiple-glazed insulating glass units are described as hermetically sealed systems. As by using the pressure-equalizing element, the multi-pane insulating glass unit becomes a permanently open system. Therefore, an additional essential characteristic (Pressure equalization between the insulating glass unit cavity and outside) which is not covered by EN 1279-5 is to be addressed.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations, e.g., with regard to the intended end use conditions, having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA as long as the details of the assessment methods as laid down in this EAD are respected.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The intended uses of the product are installations in windows, doors, and curtain walls.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the pressure-equalizing insulating glass unit for the intended use of 10 years when installed in the works. These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

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1 All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

2 The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the pressure-equalizing insulating glass units is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	class
2	Resistance to fire	EN 1279-5, 4.2.2.2	class
3	External fire performance (for the use in roof coverings only)	EN 1279-5, 4.2.2, 4.2.2.4 and 4.2.2.15	class
Basic Works Requirement 4: Safety and accessibility in use			
4	Bullet resistance: Shatter properties and resistance to attack	EN 1279-5, 4.2.2, 4.2.2.5 and 4.2.2.15	class
5	Explosion resistance: Impact behaviour and resistance to attack	EN 1279-5, 4.2.2, 4.2.2.6 and 4.2.2.15	class
6	Burglar resistance: Shatter properties and resistance to attack	EN 1279-5, 4.2.2, 4.2.2.7 and 4.2.2.15	class
7	Pendulum body impact resistance: Shatter properties (safe breakability) and resistance to impact	EN 1279-5, 4.2.2, 4.2.2.8 and 4.2.2.15	class
8	Mechanical resistance: Resistance against sudden temperature changes and temperature differentials	EN 1279-5, 4.2.2, 4.2.2.9 and 4.2.2.15	level
9	Mechanical resistance: Resistance against wind, snow, permanent load and/or imposed loads of the glass unit	EN 1279-5, 4.2.2, 4.2.2.10 and 4.2.2.15	level
10	Pressure equalization between the insulating glass unit cavity and outside	2.2.2	level

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 5: Protection against noise			
11	Direct airborne sound reduction	EN 1279-5, 4.2.2, 4.2.2.11 and 4.2.2.15	level
Basic Works Requirement 6: Energy economy and heat retention			
12	Thermal properties: Emissivity Thermal transmittance value (U-value)	EN 1279-5, 4.2.2, 4.2.2.12 and 4.2.2.15	level
13	Radiation properties: Light transmittance and reflectance	EN 1279-5, 4.2.2, 4.2.2.13 and 4.2.2.15	level
14	Solar energy characteristics: Solar direct transmittance, solar direct reflectance and total solar energy transmittance	EN 1279-5, 4.2.2, 4.2.2.14 and 4.2.2.15	level
Aspects of durability			
15	Durability	EN 1279-5, 4.2.2.15, 5.2.1 and 5.2.2	level, description

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

2.2.1 Reaction to fire

One of the following options shall apply:

a) The pressure-equalizing insulating glass unit (including the pressure-equalizing element) is considered to satisfy the requirements for performance class A1 of the essential characteristic reaction to fire in accordance with the Decision 96/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/EC, without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

   Therefore, when the conditions referred to above are fulfilled, the performance of the product is A1, which shall be given in the ETA.

b) In case of fulfilling the requirements for small components by the pressure-equalizing element (see below), the reaction to fire classification of the pressure-equalizing insulating glass unit can be taken from the Declaration of Performance of the multi-pane insulating glass in accordance with EN 1279-5, if available and the relevant performance is declared, because the fire contribution of the pressure-equalizing element is negligible and doesn't affect the performance of the multi-pane insulating glass unit.

   The relevant reaction fire class shall be stated in the ETA together with those conditions for which the classification is valid.

c) If neither option "a)" nor option "b)" applies, the pressure-equalizing insulating glass unit shall be assessed according to the method(s) referred to in EN 13501-1 and relevant for the corresponding reaction to fire class. The product shall be classified according to the Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1.

   For conducting the relevant tests and the application of test results, the provisions of EN 1279-5, clause 4.2.2.3, and additionally of Annex B apply.

The obtained reaction fire class shall be stated in the ETA together with those conditions for which the classification is valid.

If the pressure-equalizing element as a whole fulfils the following conditions

- not made completely of class A1/A2 material,
- total weight ≤ 50 g,
- size of the visible surface ≤ 50 mm x ≤ 50 mm or diameter ≤ 57 mm, and
- distance between the same type of component ≥ 200 mm in one air cavity,

it can be considered as small component. Its contribution to fire is very low and doesn't need to be considered for the application of "a)" and "b)". In case of option "c)" consideration of the pressure-equalizing element is only necessary within testing according to EN 13823 (Single Burning Item test) of the complete pressure-equalizing insulating glass unit.

2.2.2 Pressure equalization between the insulating glass unit cavity and outside

2.2.2.1 Purpose of assessment

The performance property "pressure equalization between the insulating glass unit (IGU) cavity and outside" is described with the time constant τ_{peq} which is determined as follows.

2.2.2.2 Assessment method

2.2.2.2.1 Double IGU

The numerical value of the time constant $\tau_{peq,calc}$ shall be calculated as follows:

$$\tau_{peq,calc} = \frac{V_{peq}}{\phi \cdot n_{PEE} \cdot C_{PEE,C} \cdot p_0} \qquad (2.2.2.2.1.1)$$

With:

$\tau_{peq,calc}$	Time constant of the pressure-equalized IGU	$[\tau_{peq,calc}]$ = [h]
V_{peq}	Volume of the pressure-equalized cavity	$[V_{peq}]$ = [(dm)^3] = [l]
ϕ	Insulating unit factor in accordance with EN 16612/(C.3)	$[\phi]$ = [-]
n_{PEE}	Number of the pressure-equalizing elements (PEE)	$[n_{PEE}]$ = [-]
$C_{PEE,C}$	Characteristic value of the air flow coefficient of the PEE	$[C_{PEE,C}]$ = [l/(h hPa)]
p_0	p_0 = 1013 hPa Normal atmospheric pressure	$[p_0]$ = [hPa]

The volume of the pressure-equalized cavity V_{peq} is given by:

$$V_{peq} = b \cdot h \cdot s \qquad (2.2.2.2.1.2)$$

With:

b	Width of the pressure-equalized IGU	$[b]$ = [m]
h	Height of the pressure-equalized IGU	$[h]$ = [m]
s	Width of cavity	$[s]$ = [mm]

For simplification, the external dimensions of the IGU can be used for b and h.

The insulating unit factor ϕ shall be determined in accordance with EN 16612/(C.3).

The characteristic value of the air flow coefficient of the PEE $C_{PEE,C}$ shall be determined in accordance with Annex C.

2.2.2.2.2 Triple IGU

2.2.2.2.2.1 Symmetrically constructed triple IGU

Symmetrically constructed triple insulating glass is defined as follows:

1. Both pressure-equalized cavities between the glass panes have the same size,
2. the same number of PEEs with the same $C_{PEE,C}$ is located in both cavities, and
3. the thickness of the outer and inner glass pane is the same.

The triple IGU with the symmetrical structure $d_1/s_1/d_2/s_1/d_1$ is represented by a double IGU with the structure $d_1/2 \times s_1/d_1$.

With:

d_1	Thickness of the outer glass pane = thickness of the inner glass pane of the triple IGU in mm
d_2	Thickness of the middle glass pane of the triple IGU in mm
s_1	Thickness of the cavities of the triple IGU in mm

For this set-up, the time constant $\tau_{peq,calc}$ shall be determined according to equation (2.2.2.2.1.1) with n_{PEE} = total number of all installed PEEs.

Example: The symmetrical triple IGU 4/12/4/12/4 with one PEE with the same $C_{PEE,C}$ in each cavity is converted into a double IGU 4/24/4 with two PEEs with the same $C_{PEE,C}$ in the cavity. $\tau_{peq,calc}$ shall be determined according to equation (2.2.2.2.1.1).

2.2.2.2.2.2 Asymmetrically constructed triple IGU

Asymmetrically constructed triple insulating glass is defined as follows:

1. The pressure-equalized cavities between the glass panes have not the same size, and/or
2. different numbers of PEEs are installed in both cavities, and/or
3. the same number of PEEs but with different $C_{PEE,C}$ are installed in both cavities, and/or
4. the thickness of the outer and inner pane is not the same.

To determine the time constant $\tau_{peq,calc}$, the triple IGU with the set-up $d_1/s_1/d_2/s_2/d_3$ is represented by two double IGUs and equation (2.2.2.2.1.1) shall be used to determine the associated time constants:

Double IGU 1: $d_1/s_1/d_2$ $\Longrightarrow$ $\tau_{peq,calc,1}$

Double IGU 2: $d_2/s_2/d_3$ $\Longrightarrow$ $\tau_{peq,calc,2}$

With:

d_1 Thickness of the outer glass pane of the triple IGU in mm
d_2 Thickness of the middle glass pane of the triple IGU in mm
d_3 Thickness of the inner glass pane of the triple IGU in mm
s_1, s_2 Thickness of cavity 1/cavity 2 of the triple IGU in mm

The time constant $\tau_{peq,calc}$ for the triple IGU shall be obtained from the larger of the two-time constants for the corresponding double IGUs:

$$\tau_{peq,calc} = Max(\tau_{peq,calc,1}; \tau_{peq,calc,2})$$

Example: The asymmetric triple IGU 8/12/4/12/6 with one PEE with the same $C_{PEE,C}$ in each cavity is converted to two double IGUs:

IGU 1: 8/12/4

IGU 2: 4/12/6

$\tau_{peq,calc}$ shall be determined according to equation (2.2.2.2.1.1) separately for IGU 1 and IGU 2. The time constant $\tau_{peq,calc}$ for the triple IGU 8/12/4/12/6 is the larger of the two-time constants of the double IGUs.

2.2.2.3 Expression of results

$\tau_{peq,calc}$ shall be stated in the ETA as τ_{peq} in accordance with Table 2.2.2.3.1.

Table 2.2.2.3.1 τ_{peq} stated in the ETA

$\tau_{peq,calc}$ **in h**	τ_{peq} **in h**
$\tau_{peq,calc} \leq 0,01$	0,01
$0,01 < \tau_{peq,calc} \leq 0,1$	0,1
$0,1 < \tau_{peq,calc} \leq 1$	1
$1 < \tau_{peq,calc} \leq 10$	10
$10 < \tau_{peq,calc} \leq 100$	100
$100 < \tau_{peq,calc} \leq 500$	500
$\tau_{peq,calc} > 500$	> 500

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 2000/245/EC, as amended by 2001/596/EC.

The systems are

- **1** for use as anti-bullet, or anti-explosion glazing, or for uses in a glazed assembly intended specifically to provide fire resistance,
- **3** or **4** for uses subject to reaction to fire regulations or for uses subject to external fire performance regulations, depending on the conditions defined in the said Decision,
- **3** for uses subject to regulations regarding safety in use risks, excluding uses as anti-bullet or anti-explosion glazing,
- **3** for uses relating to energy conservation and/or noise reduction,
- **4** for other intended uses.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) **[including testing of samples taken at the factory in accordance with a prescribed test plan]**					
1	Insulating glass unit	EN 1279-6; EN 1279-5, 5.4 and 5.5	EN 1279-6; EN 1279-5, 5.4 and 5.5	EN 1279-6; EN 1279-5, 5.4 and 5.5	EN 1279-6; EN 1279-5, 5.4 and 5.5
2	Pressure-equalizing element: - Packaging and labelling - Documentation of the relevant production parameters used in the manufacturing process of the pressure-equalizing element	Visual inspection	According to purchase specification	According to control plan	Every batch
3	Air flow coefficient $C_{PEE,C}$ of the pressure-equalizing element	3.4	According to control plan	5% per batch	Every batch
4	Dimensions of the pressure-equalizing element	Measurement	According to control plan	5% per batch	Every batch
5	Installation of the pressure-equalizing element in the spacer bar of the insulating glass unit	Visual inspection and measurement	According to control plan	According to control plan	Every batch

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for the pressure insulating glass units are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control *(for systems 1+, 1 and 2+ only)*					
1	Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the product.	EN 1279-5, 5.4	EN 1279-5, 5.4	EN 1279-5, 5.4	EN 1279-5, 5.4
Continuous surveillance, assessment and evaluation of factory production control *(for systems 1+, 1 and 2+ only)*					
3	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	EN 1279-5, 5.5	EN 1279-5, 5.5	EN 1279-5, 5.5	EN 1279-5, 5.5

3.4 Monitoring of the air flow coefficient $C_{PEE,C}$ within Factory Production Control (FPC)

Within FPC the volumetric flow $\dot{q}_{v,m}$ of the PEE shall be measured in accordance with Annex C and controlled at one fixed pressure difference $\Delta p_{FPC} = (30 \pm 5) hPa$.

Using equation (3.4.1) $\dot{q}_{v,m}$ shall be corrected to normal conditions.

$$\dot{q}_{v,FPC,0} = \dot{q}_{v,m} \cdot \frac{293K}{T_x} \cdot \frac{p_x}{1013} \qquad (3.4.1)$$

With:

T_x	Ambient air temperature, temperature of the "test air" during FPC measurement	$[T_x]$ = [K]
p_x	Atmospheric pressure during FPC measurement	$[p_x]$ = [hPa]

$\dot{q}_{v,FPC,0}$ shall then be compared with the expected normalised volumetric flow $\dot{q}_{v,0,exp}$ considering the specified tolerance $\Delta\dot{q}_{v,0}$.

$$\dot{q}_{v,0,exp} - \Delta\dot{q}_{v,0} \leq \dot{q}_{v,FPC,0} \leq \dot{q}_{v,0} + \Delta\dot{q}_{v,0} \qquad (3.4.2)$$

$\dot{q}_{v,0,exp}$ shall be calculated in accordance with equation (3.4.3); $\Delta\dot{q}_{v,0}$ shall be calculated in accordance with equation (3.4.4).

$$\dot{q}_{v,0,exp} = C_{PEE,C} \cdot \Delta p_{FPC} \qquad (3.4.3)$$

$$\Delta\dot{q}_{v,0} = \Delta C_{PEE,C} \cdot \Delta p_{FPC} \qquad (3.4.4)$$

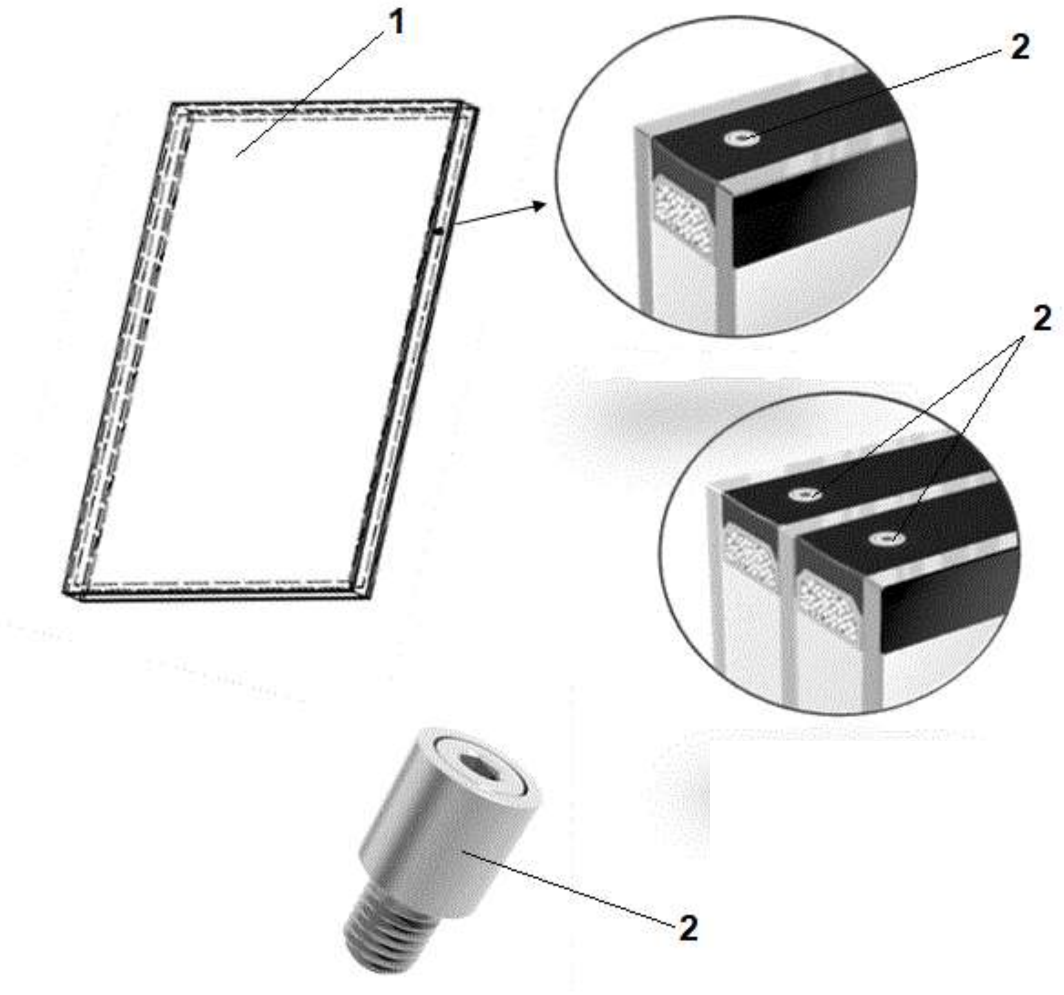
With:

$C_{PEE,C}$	Characteristic value of the air flow coefficient of the PEE	$[C_{PEE,C}]$ = [l/(h hPa)]
Δp_{FPC}	Pressure difference used at FPC level	$[\Delta p_{FPC}]$ = [hPa]
$\Delta C_{PEE,C}$	Tolerance of the characteristic value of the air flow coefficient of the PEE	$[\Delta C_{PEE,C}]$ = [l/(h hPa)]

4 REFERENCE DOCUMENTS

EN 1279-1:2018	Glass in Building – Insulating glass units – Part 1: Generalities, system description, rules for substitution, tolerances and visual quality
EN 1279-5:2018	Glass in building – Insulating glass units – Part 5: Product standard
EN 13501-1:2018	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests;
EN 13823:2020+A1:2022	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
EN 1279-6:2018	Glass in building – Insulating glass units – Part 6: Factory production control and periodic tests
EN 16612:2019	Glass in building – Determination of the lateral load resistance of glass panes by calculation
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 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)
EN 1026:2016	Windows and doors – Air permeability – Test method;
EN 13141-1:2019	Ventilation for buildings --Performance testing of components/products for residential ventilation - Part 1: Externally and internally mounted air transfer devices

ANNEX A: EXAMPLES OF PRESSURE-EQUALIZING INSULATING GLASS UNITS



1 Insulating glass units
2 pressure-equalizing element

Figure A.1: Examples of pressure-equalizing insulating glass units

ANNEX B: FURTHER PROVISIONS FOR REACTION TO FIRE TESTS AND THE APPLICATION OF TESTS RESULTS OF THESE TESTS

B.1 Tests according to EN ISO 1182

This test method is relevant for determination of classes A1 and A2 according to EN 13501-1.

All substantial components of the pressure-equalizing insulating glass unit shall be tested except in cases as prescribed below.

Components of the pressure-equalizing insulating glass unit covered by Decision 96/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/EC, for materials classified as class A1 without the need for testing, do not need to be tested according to EN ISO 1182.

For linear components (e.g., edge sealings, spacers) or discrete components (except small components as defined in clause 2.2.2) their total weight (depending on the size of the glass unit and/or their number per glass unit) shall be used to calculate the weight per unit area and thickness of a “virtual” flat layer as basis for the assessment whether they shall be considered as substantial or non-substantial (as defined in EN 13501-1) and whether they need to be tested or not.

Relevant parameters for sampling and preparing the specimens of the components and the application of test results:

- Variations of a product-family (as defined by a certain combination or raw materials and a certain type of production process) => the variation with the highest amount of organic content shall be tested covering all variations of the same product family with lower organic content, and
- Density => where relevant, the highest and lowest density shall be tested covering the whole range between those values evaluated.

All tests shall be performed in accordance with the provisions of the test standard.

B.2 Tests according to EN ISO 1716

This test method is relevant for determination of classes A1 and A2 according to EN 13501-1.

All components of the pressure-equalizing insulating glass unit shall be tested except in cases as prescribed below.

Components of the pressure-equalizing insulating glass unit covered by Decision 96/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/EC, for materials classified as class A1 without the need for testing, do not need to be tested according to EN ISO 1716. Their Q_{PCS} value (gross heat of combustion) shall be set as zero for further calculations.

For linear components (e.g., edge sealings, spacers) or discrete components (except small components as defined in clause 2.2.1) their total weight (depending on the size of the glass unit and/or their number per glass unit) shall be used to calculate the weight per unit area and thickness of a “virtual” flat layer as basis for the assessment whether they shall be considered as substantial or non-substantial (as defined in EN 13501-1) and for the assessment of their relevant PCS value.

Relevant parameters for sampling and preparing the specimens of the components and the application of test results:

- Variations of a product-family (as defined by a certain combination or raw materials and a certain type of production process) => the variation with the highest amount of organic content shall be tested covering all variations of the same product family with lower organic content.

In addition, for calculation of the total Q_{PCS} value of a non-homogenous product (consisting of several layers / components) the variations of thickness and density of the various component shall be considered to determine the worst case. The result covers all variations between those values of thickness and density of components of the insulating glass unit as investigated within the calculations.

B.3 Tests according to EN 13823 (SBI)

This test method is relevant for determination of classes A2 to D according to EN 13501-1 and in certain cases (as defined in EN 13501-1) for determination of class A1, too.

General**:**

The specimens of the pressure-equalizing insulating glass unit consist of a long wing and a wide wing and their size shall be as prescribed in the test standard.

Deviating from the standard specimen configuration as prescribed in the test standard, neither a vertical joint at a distance of 200 mm from the internal corner of the test specimen nor a horizontal joint at a height of 500 mm above the bottom edge of the test specimen shall be considered on the long wing.

The two wings of the test specimen are arranged on the trolley according to EN 13823, Figure 2. On the backside there shall be arranged a sub-construction made out of vertically directed, linear metal profiles or discrete metal spacing holders. The function of this sub-construction is just to hold the glass against the lower U-profile and the upper stop for preventing the glass panes to fall over. The distance of the backside of the pressure-equalizing insulating glass unit to the backing board of the SBI test rig shall be at least 80 mm. The measures for having free ventilation (see EN 13823, clause 5.2.2 a)), shall be taken into account.

When conducting tests in the SBI-test, all components of the insulating glass unit shall be included in the test specimens.

Relevant parameters for sampling and preparing the specimens of the components and the application of test result:

- structure of the insulating glass unit,
- symmetrical or asymmetrical assembly of the layers of the insulating glass unit,
- type and thickness of the glass used for the external panes,
- type and thickness of intermediate layers, and
- type and thickness of external facings or coatings of the glass panes.

Cornerstones for the necessary SBI tests:

a) Symmetrical assembly

a.1) One single test (one specimen) shall be carried out with a glass which has the thinnest thickness of the external glass panes (per type of glass to be used) and – if relevant – the intermediate layer which shows the maximum thickness and which verified the maximum gross heat of combustion (Q_{PCS} value) according to EN ISO 1716 in combination with the provisions of clause B.2.

a.2) One single test (one specimen) shall be carried out with a glass which has the thinnest thickness of the external glass panes (per type of glass to be used) and – if relevant – the intermediate layer which shows the maximum thickness and which verified the maximum gross heat of combustion (Q_{PCS} value) according to EN ISO 1716 and a possible external coating (e.g., foils, markings or enamels etc.) with the most critical coating to be verified first by determination of the gross heat of combustion (Q_{PCS} value) according to EN ISO 1716 in combination with the provisions of clause B.2.

Inorganic coatings don't need to be considered for testing.

a.3) Other two tests shall be carried out with the most critical specimen variant found from tests "a.1)" and "a.2)", so that three test results on hand for this variant will be the basis for the classification of the insulating glass unit.

The result with the thinnest thickness of the external glass also covers the use of higher glass thicknesses.

The use of an intermediate layer with the highest thickness and the most critical Q_{PCS} value includes the use of intermediate layers with the same or lower thickness and/or a lower Q_{PCS} value.

b) Symmetrical assembly with multi-layer intermediate layers

Tests in accordance with "a)" shall be carried out with the maximum number of intermediate layers, testing both the highest and lowest thickness of the layers.

c) Asymmetrical assembly

c.1) asymmetric assembly with single-layer intermediate layer

For each side of the insulating glass unit one single test (one specimen) shall be performed according to "a.1)"

For the variant, which shows the more critical test result, tests following the provisions of ""a.2)" and "a.3)" shall be carried out.

c.2) asymmetric assembly with multi-layer intermediate layer

Tests shall be done following the provisions of "c.1) with the maximum number of intermediate layers.

Using the above-mentioned rules, it is possible to make a grouping for getting different classifications of the product families depending on

- Thickness, type, PCS value and number of intermediate layers,
- Type and thickness of the glass panes, and
- Type of the external coating.

B.4 Tests according to EN ISO 11925-2

This test method is relevant for determination of classes B to F according to EN 13501-1.

The following parameters shall be considered within testing:

- Structure of the insulating glass unit,
- thickness of the glass used for the external panes,
- type and thickness of intermediate layers,
- type and thickness of external facings or coatings of the glass panes, and
- type of spacers and edge sealings.

The specimens shall be prepared with the thinnest thickness of the external glass pane as well as – if relevant – with maximum thickness of the intermediate layer having the highest Q_{PCS} value and include all components of the insulating glass unit, except those identified as small components according to the definition in clause 2.2.1.

For insulating glass units with edge sealing built-in in a compressed manner, the specimens shall be prepared and tested with the lowest level of compression and the maximum width and depth of the sealing. The results are also valid for higher levels of compression as well as lower widths and depths of the sealing.

<u>Cornerstones for the necessary tests:</u>

a) At least three tests shall be done with edge exposure of specimens with non-coated or inorganic coated glass panes.
b) At least three tests shall be done with both surface exposure as well as edge exposure of specimens with organic coated glass panes.
c) At least three tests shall be done with edge exposure of specimens turned 90 degrees on their vertical axis and flame impingement of each different layer.
d) At least three further tests of the most critical specimen configuration and exposure type identified in the tests according "a)" to "c)" shall be done to obtain the required number of test results for the classification.

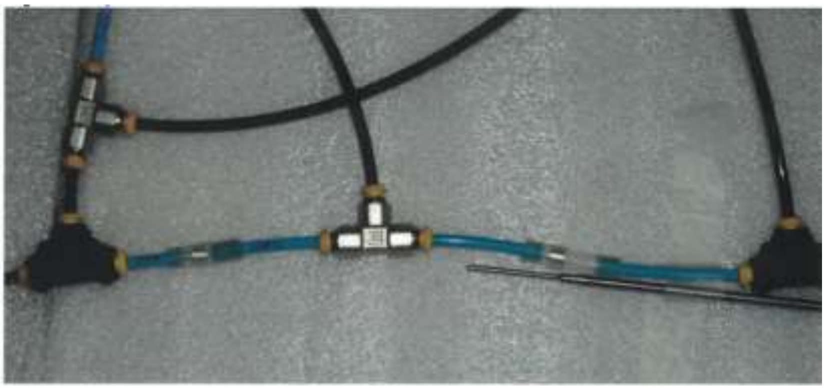
If several numbers of the same type of intermediate layers exist in the specimen assembly, only one layer of this intermediate layer type needs to be tested according the above-mentioned point "c)".

ANNEX C: EXPERIMENTAL DETERMINATION OF THE CHARACTERISTIC VALUE OF THE AIR FLOW COEFFICIENT $C_{PEE,C}$

C.1 General

The air flow coefficient of a pressure-equalizing element (PEE) C_{PEE} shall be determined by measuring the pressure-volume flow characteristic curve of the PEE using ambient air as the gas.

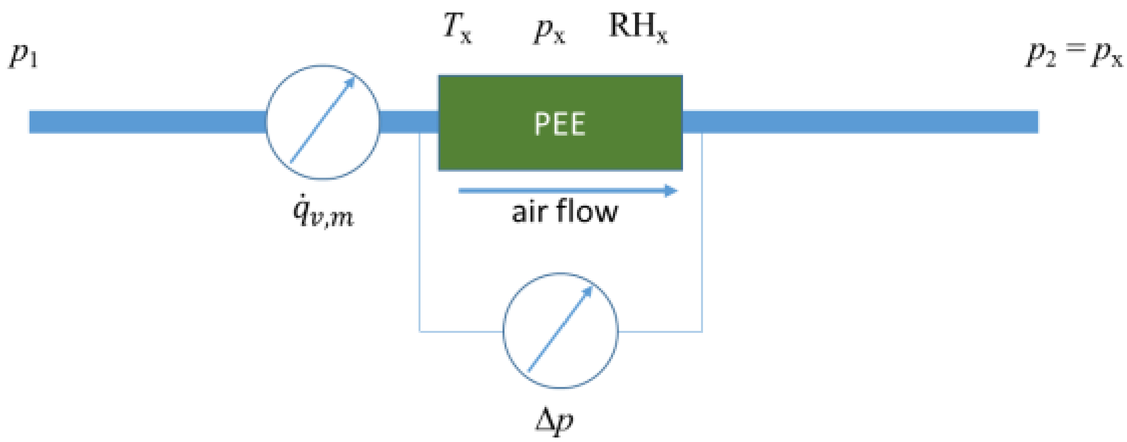
In principle, the pressure-volume flow characteristic curve is determined according to the physical principles used in EN 1026 and EN 13141-1. However, the volume flows to be measured for the products controlled in the EAD are significantly lower than for products according to EN 1026 (windows and doors) and EN 13141-1 (ventilation units). Therefore, the test benches used for windows and doors as well as ventilation units cannot generally be used to determine the pressure-volume flow characteristic of pressure equalisation elements for IGUs. The following picture C.2.1 shows an example of a measurement setup.



C.2.1 Example of a measurement setup

C.2 Test set-up

Figure C.2.2 shows a schematic representation of the general test set-up.



C.2.2 Schematic representation of the test set-up for determining the pressure-volume flow characteristic curve of the PEE

with

T_x	Ambient air temperature, temperature of the “test air”	$[T_x]$ = [K]
p_x	Atmospheric pressure during measurement	$[p_x]$ = [hPa]
RH_x	Relative humidity of the “test air”	$[RH_x]$ = [%]
p_1	Pressure at the inlet of the PEE	$[p_1]$ = [hPa]
p_2	Pressure at the outlet of the test set-up	$[p_2]$ = [hPa]
Δp	Pressure difference between inlet and outlet of the PEE	$[\Delta p]$ = [hPa]
$\dot{q}_{v,m}$	Measured volumetric flow at pressure difference Δp	$[\dot{q}_{v,m}]$ = [l/(h hPa)]

C.3 Test procedure and specimen

The ambient air temperature close to the test specimen and also the temperature and the humidity of the air flowing through the PEE shall be within the range of 278 K (15°C) ≤ T_x ≤ 298 K (25 °C) and 25 % ≤ RH_x ≤ 75 % RH. The test specimens (namely the PEE) shall be conditioned thus for at least 1 h directly before testing.

The temperature of the test air and the ambient air temperature during measurement T_x shall be measured to within ±1°C and relative humidity RH_x to within ± 10 %. The atmospheric pressure during measurement p_x shall be measured to within ± 5 hPa.

The volumetric flow $\dot{q}_{v,m}$ and the pressure difference ∆p shall be measured to an accuracy of ±10 % related to the measured value.

The volumetric flow $\dot{q}_{v,m}$ shall be determined based on at least 5 different pressure differences ∆p in the interval of 0 hPa ≤ Δp ≤ 50 hPa. The different pressure levels shall be distributed evenly in the interval. The test shall be performed for positive and also negative pressure difference, or to say for both possible flow directions.

C.4 Test results

The result of $\dot{q}_{v,m}$ at each pressure difference shall be adjusted to calculate the normalised volumetric flow $\dot{q}_{v,0}$ at normal conditions (T_0 = 293 K, p_0 = 1013 hPa), considering the actual temperature T_x expressed in K and atmospheric pressure p_x expressed in hPa, during the test.

$$\dot{q}_{v,0} = \dot{q}_{v,m} \cdot \frac{293K}{T_x} \cdot \frac{p_x}{1013} \quad \text{(C.4.1)}$$

The air flow coefficient of the PEE C_{PEE} shall be evaluated for a linear relationship between the normalised volumetric flow and pressure difference with a pressure difference exponent n = 1.

$$\dot{q}_{v,0} = C_{PEE} \cdot \Delta p^n \quad \text{(C.4.2)}$$

For this purpose, the normalised volumetric flow $\dot{q}_{v,0}$ shall be plotted at the pressure differences applied on a log-log diagram.

From the regression line

$$\log(\dot{q}_{v,0}) = \log(C_{PEE}) + n \cdot \log(\Delta p) \quad \text{(C.4.3)}$$

calculated by using the least square method, C_{PEE} and n shall be determined for every flow direction.

For equation (2.2.2.2.1.1) to be valid in conjunction with this EAD, n shall be in the range of 0,95 to 1,05 and the regression coefficient R^2 of the regression line shall be greater than or equal to 0,98.

The characteristic value $C_{PEE,C}$ for the PEE is the arithmetic mean of C_{PEE} of at least 5 specimens.

Instead of measuring at least five PEE individually, it is also possible to measure several PEEs by means of a "parallel circuit".

C.5 Example

This clause gives an example of the determination of characteristic value of the air flow coefficient $C_{PEE,C}$.

The measured volumetric flow $\dot{q}_{v,m}$ of specimen 1 was measured at 5 different pressure differences for both flow directions.

The pressure differences Δp for flow direction 1 were: 7 hPa, 17 hPa, 25 hPa, 33 hPa and 42 hPa.

For flow direction 2 the pressure differences Δp were as follows: 8 hPa, 17 hPa, 23 hPa, 31 hPa and 44 hPa.

The temperature of the air $T_x$was $T_x = 296K$ and atmospheric pressure p_x was $p_x = 1002\ hPa$.

Table C.5.1 shows the measured volumetric flow $\dot{q}_{v,m}$ for both flow directions and the calculated normalised volumetric flow $\dot{q}_{v,0}$

Table C.5.1 Pressure differences $\Delta \boldsymbol{p}$, measured volumetric flows $\dot{\boldsymbol{q}}_{\boldsymbol{v,m}}$ and normalised volumetric flows $\dot{\boldsymbol{q}}_{\boldsymbol{v,0}}$ for both flow directions for specimen 1

No.	Flow direction 1			Flow direction 2		
	Δp in hPa	$\dot{q}_{v,m}$ in l/h	$\dot{q}_{v,0}$ in l/h	Δp in hPa	$\dot{q}_{v,m}$ in l/h	$\dot{q}_{v,0}$ in l/h
1	7	0,110	0,108	8	0,138	0,135
2	17	0,269	0,263	17	0,286	0,280
3	25	0,401	0,392	23	0,399	0,391
4	33	0,521	0,510	31	0,520	0,509
5	42	0,680	0,666	44	0,750	0,734

Figure C.5.1 shows the log-log plot of the data given in Table D.5.1.

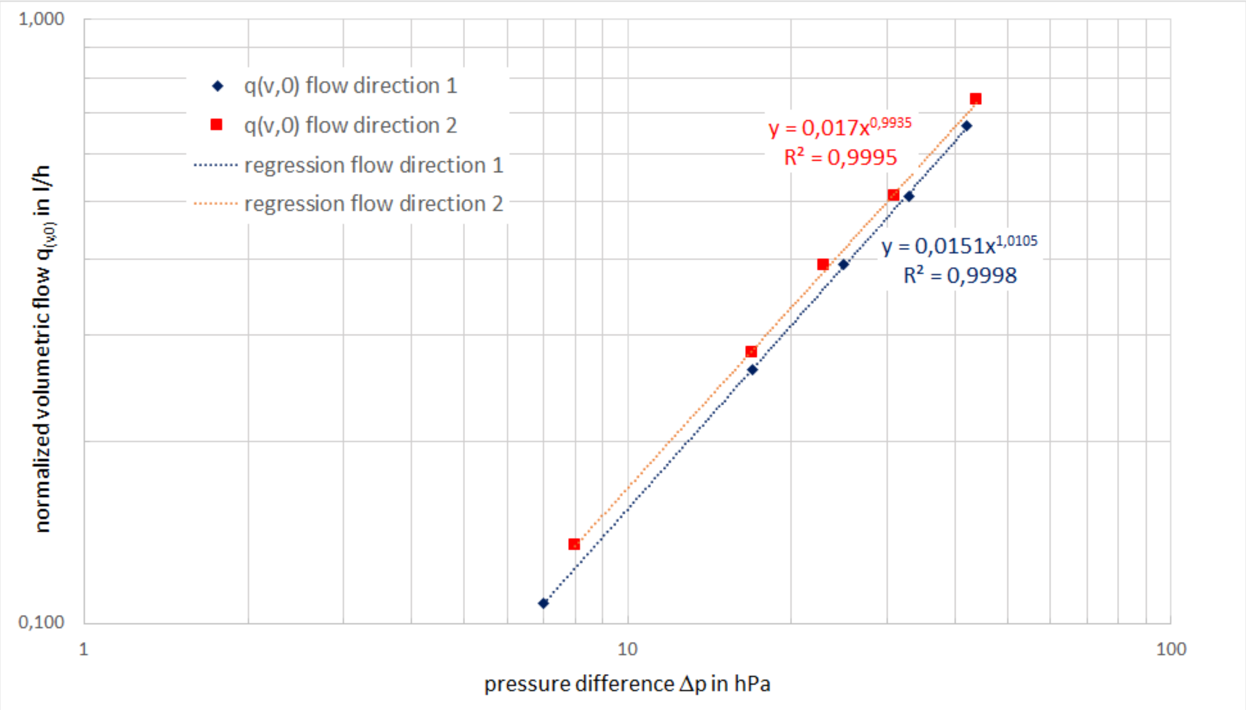


Figure C.5.1 log-log plot of the normalised volumetric flows $\dot{q}_{v,0}$ as a function of pressure difference Δp for both flow directions for the data given in Table D.5.1 with the related regression lines, the calculated coefficients n and C_{PEE} and the regression coefficient R^2

The regression coefficients are R^2 = 0,998 for flow direction 1 and R^2 =0,995 for flow direction 2. Both meet the requirement of $R^2 \geq 0{,}98$.

The exponents are n = 1,011 for flow direction 1 and n = 0,994 for flow direction 2. Both meet the requirement of $0{,}95 \leq n \leq 1{,}05$.

The air flow coefficient of the measured PEE is C_{PEE} = 0,0151 l/h for flow direction 1 and C_{PEE} = 0,0170 l/h for flow direction 2.

The characteristic value $C_{PEE,C}$ for the PEE is the arithmetic mean of C_{PEE} of at least 5 specimens.