



EUROPEAN ASSESSMENT DOCUMENT

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**THERMAL AND/OR SOUND
INSULATION BASED ON BOUND
EXPANDED POLYSTYRENE BULK
MATERIAL**

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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) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD is established for the assessment of thermal and/or sound insulation based on in situ formed bound expanded polystyrene bulk material.

The thermal and/or sound insulation is made of expanded polystyrene (EPS) granules and cement-based binders and do not contain any other natural or artificial aggregate. The granules of expanded polystyrene (EPS) are made from new and/or recycled polystyrene granules.

The EAD covers products, which are premixed in a factory, and products, which are manufactured on site by a mobile production unit.

The ETA will be issued for the product on the basis of tests and calculations performed in compliance with this EAD.

The issued ETAs based on this EAD are only valid for products, which correspond to the above mentioned data/information.

The product is not covered by a harmonised European standard (hEN).

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 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.

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

1.2.1 Intended use(s)

The insulation product is used for thermal and/or sound insulation of building constructions as follows:

- Thermal insulation for ceilings, roofs and floors
- Impact sound insulation product under floating floors inside buildings

The insulation product is used in structures only where it is protected from wetting, weathering and moisture.

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 thermal insulation and/or sound insulation materials based on bound expanded polystyrene and binders for the intended use of 50 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 works¹.

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.

¹ 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 1 shows how the performance of the thermal and/or sound insulation based on in situ formed bound expanded polystyrene bulk material is assessed in relation to the essential characteristics.

Table 1 Essential characteristics of the product and assessment methods and criteria for the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method see clause	Type of expression of product performance <i>(level, class, description)</i>
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
Basic Works Requirement 3: Hygiene, health and the environment			
2	Content, emission and/or release of dangerous substances	2.2.2	Level
3	Water vapour permeability	2.2.3	Level
Basic Works Requirement 4: Safety and accessibility in use			
4	Compressive stress at 10 % strain / Compressive strength	2.2.4	Level
5	Compressive creep	2.2.5	Level
6	Thickness and compressibility	2.2.6	Level
7	Dimensional stability	2.2.7	Level
8	Point load	2.2.8	Level
9	Alkaline Resistance	2.2.18	Level
Basic Works Requirement 5: Protection against noise			
10	Impact sound reduction (for impact sound insulation only)	2.2.9	Level
11	Dynamic stiffness (for impact sound insulation only)	2.2.10	Level

No	Essential characteristic	Assessment method see clause	Type of expression of product performance <i>(level, class, description)</i>
Basic Works Requirement 6: Energy economy and heat retention			
12	Particle size distribution of EPS	2.2.11	Level
13	Water absorption	2.2.12	Level
14	Thermal conductivity (for thermal insulation only)	2.2.13	Level
15	Density of fresh mortar	2.2.14	Level
16	Bound EPS density	2.2.15	Level
17	Bulk Density of the dry mixture of granulated polystyrene and compound or of the granulated polystyrene	2.2.16	Level
18	Moisture sorption	2.2.17	Level

2.2 Assessment methods and criteria for the performance of the product in relation to essential characteristics of the product

2.2.1 Reaction to fire

The insulation material shall be tested using the test method(s) according to EN 13501-1 and relevant for the corresponding reaction to fire class. The product shall be classified according to Commission Delegated Regulation (EU) No 2016/364.

For reaction to fire testing the mounting and fixing instructions according to EN 16025-1, Annex C shall be used.

Deviating from Annex C of EN 16025-1 it is necessary to test the highest as well as lowest thickness of the insulation in case of using a combustible substrate in the SBI test. The test results cover all thicknesses between those evaluated.

The reaction to fire class of the product is stated in the ETA.

2.2.2 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer² after identifying the release scenarios taking into account EOTA TR 34 and the intended use of the product.

2.2.2.1 Content of chromium VI

The content of chromium VI of the binder shall be tested in accordance with EN 196-10

The content of chromium VI is stated in the ETA

2.2.2.2 Content of Hexabromocyclododecane (HBCDD)

The content of Hexabromocyclododecane (HBCDD) of the EPS granules shall be tested in accordance with ANNEX B of the EAD

The content of HBCDD is stated in the ETA

2.2.3 Water vapour permeability

Water vapour permeability shall be tested in accordance with EN 12086 and water vapour diffusion factor μ according to EN 12086 (Table 1, climatic condition A and/or C) shall be determined. The minimum sample size is 100x100xthickness mm.

The water vapour diffusion factor μ and the used climatic condition/s are stated in the ETA.

2.2.4 Compressive stress at 10 % strain / Compressive strength

Compressive stress at 10 % strain and/or compressive strength shall be determined according to EN 826.

The sample size is 200x200 mm of the highest as well as the lowest thickness. The test shall be performed at least on 5 samples with the lowest density.

Compressive stress at 10% strain σ_{10} [kPa] and/or compressive strength σ_m [kPa] both as an average value are stated in the ETA.

2.2.5 Compressive creep

The determination of compressive creep ε_{ct} and the total thickness reduction, ε_t shall be carried out according to EN 1606 over a period of at least 122 days of testing with the imposed load plus the self-weight of the screed.

² The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (cf. Article 6(5) of the CPR (EU) No 305/2011).

The manufacturer is **not** obliged to:

- provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the EGDS – taking into account the installation conditions of the construction product and the release scenarios resulting from there.

Any information provided by the manufacturer regarding the chemical composition of the products may not be distributed to EOTA or to TABs.

Length and width of the sample is 200x200 mm. The thickness shall be between 50 mm and 100 mm. The test shall be performed at least on 2 samples with the lowest density.

The compressive creep ε_{ct} [%] and the total thickness reduction, ε_t [%] shall be determined after 122 days of testing and the measured values shall be extrapolated thirty times, which corresponds to ten years.

Compressive creep ε_{ct} [%] and the total thickness reduction, ε_t [%] are stated in the ETA.

2.2.6 Thickness and Compressibility

The determination of thickness d_L and d_B shall be carried out according to EN 12431 at least with the maximum insulation product thickness and a pause of 300 s before measuring d_B .

The test shall be performed at least on 3 samples with the lowest density and the highest as well as the lowest thickness.

The compressibility c is defined as follows:

$$c = d_L - d_B$$

The value c [mm] is stated in the ETA.

2.2.7 Dimensional stability

2.2.7.1 Dimensional stability at 60 °C / 90 % RH – 48 hours

The test shall be performed in accordance with EN 1604 for 48 h at (60 ± 2) °C and (90 ± 5) % relative humidity and/or at (70 ± 2) °C and (90 ± 5) % relative humidity.

The sample thickness shall be between 50 mm and 100 mm. The test shall be performed at least on 3 samples with the lowest density.

The relative changes in length $\Delta\varepsilon_l$ [%], width $\Delta\varepsilon_b$ [%] and thickness $\Delta\varepsilon_d$ [%] for dimensional stability at 60 °C / 90 % RH and/or 70 °C / 90 % RH are stated in the ETA.

2.2.7.2 Deformation under specified compressive load and temperature conditions

Deformation under specified compressive load and temperature conditions shall be determined according to EN 1605 for test conditions No. 1 (20 kPa / 80 °C).

Length and width of the sample is 100x100 mm. The thickness shall be between 50 mm and 100 mm. The test shall be performed at least on 3 samples with the lowest density.

The relative change in thickness, ε_2 , [%] is stated in the ETA.

2.2.8 Point load

The behaviour under point load at 5 mm deformation shall be determined according to EN 12430. At least 3 test specimens of 300 mm x 300 mm shall be used for the testing.

The sample thickness shall be between 50 mm and 100 mm. The test shall be performed at least on 3 samples with the lowest density.

The mean value of point load F_p [N] at 5 mm deformation is stated in the ETA.

2.2.9 Impact sound reduction (for impact sound insulation only)

The impact sound reduction ΔL by floating screeds on a heavyweight standard floor using the insulation product shall be determined according to the relevant parts of EN ISO 10140-1 and 3 (category II according to Annex H of EN ISO 10140-1).

Using this data the weighted impact sound reduction ΔL_w is calculated according to EN ISO 717-2.

The test shall be performed with the floor build-up representing the worst case for impact sound reduction (e.g. minimum mass per unit area of the floating screed and thinnest insulation layer covered by the ETA). If need be, the tests shall be carried out with several build-ups.

The weighted impact sound reduction ΔL_w [dB] (if need be, for different build-ups) shall be given in the ETA. The assessed floor build-up shall be described in detail in the ETA. It shall be stated clearly to which floor build-up the measured impact sound reduction applies. In particular the minimum mass per unit area of the screed shall be given in the ETA.

2.2.10 Dynamic stiffness (for impact sound insulation only)

The determination of the dynamic stiffness shall be determined according to EN 29052-1.

The highest as well as the lowest thickness of the insulation material shall be tested. The test shall be performed at least on 3 samples with the highest density.

The mean value of dynamic stiffness s' [MN/m³] shall be given in the ETA..

2.2.11 Particle size distribution of EPS

The determination of the maximum particle size and/or the particle size distribution of the EPS granulate shall be carried out according EN 933-1.

At least 3 samples shall be tested.

The volume fraction of particles, whose diameter is greater than specified in EN 16025-1 Table 1 shall not exceed 5%.

The level of the maximum particle size is to be determined according EN 16025-1 Table 1.

The volume fraction of dust particles with a diameter of 0 mm to 0.5 mm must be determined in accordance with EN 933-1.

The level is to be determined according to EN 16025-1 Table 2.

The maximum particle size and/or the particle size distribution of the EPS granulate is given in the ETA

2.2.12 Water absorption

Short-term water absorption by partial immersion shall be determined according to EN 1609, Method A.

The sample thickness shall be 100 mm. At least 4 samples shall be tested.

The result is stated as the maximum value of water absorption W_p [kg/m²] of tested specimens.

The short-term water absorption W_p [kg/m²] is stated in the ETA.

2.2.13 Thermal conductivity (for thermal insulation only)

The determination of the thermal conductivity and the mass-related moisture conversion coefficient to high moisture content based on lambda $\lambda_{(23,50)}$ shall be performed according to Annex A.

The sample thickness shall be between 50 mm and 100 mm. The test shall be performed at least on samples with the highest density.

2.2.13.1 Lambda fractile value at 10 °C, at dry conditions

The determination of the lambda fractile value at 10 °C, at dry conditions ($\lambda_{10,dry,90/90}$), representing at least 90 % of the production with a confidence limit of 90 % shall be carried out in accordance with Annex A, clause 1.

At least 4 specimen shall be tested at a notified testing laboratory.

The $\lambda_{10,dry,90/90}$ [$W/(mK)$] value is stated in the ETA.

2.2.13.2 Mass-related moisture conversion coefficient ($f_{u,1}$)

The mass-related moisture conversion coefficient ($f_{u,1}$) [kg/kg] for the conversion of $\lambda_{10,dry}$ to $\lambda_{23,50}$ shall be determined according to Annex A, clause 2 and stated in the ETA.

2.2.13.3 Lambda at 23 °C and 50 % relative humidity $\lambda_{(23,50)}$

The calculation of the lambda at 23 °C and 50 % relative humidity shall be carried out in accordance with Annex A, clause 3.

The calculated lambda at 23 °C and 50 % relative humidity $\lambda_{(23,50)}$ [$W/(mK)$], representing at least 90 % of the production with a confidence level of 90 %, shall be stated in the ETA.

2.2.13.4 Mass-related moisture conversion coefficient to high moisture content ($f_{u,2}$)

The determination of the mass-related moisture conversion coefficient to high moisture content ($f_{u,2}$) shall be carried out in accordance with Annex A, clause 4.

The mass-related moisture conversion coefficient to high moisture content ($f_{u,2}$) [kg/kg], and the moisture content mass by mass [kg/kg] at 23 °C and 50 % relative humidity and 23 °C and 80 % relative humidity shall be given in the ETA.

2.2.13.5 Moisture conversion factor (dry-23/50 and 23/50-23/80)

The moisture conversion factor F_{m1} for the conversion of $\lambda_{10,dry}$ to $\lambda_{23,50}$ and F_{m2} for the conversion of $\lambda_{23/50}$ to $\lambda_{23,80}$ shall be determined in accordance with EN ISO 10456:2010, equation (4) and given in the ETA.

2.2.14 Density of fresh mortar

The density of fresh mortar shall be determined on the basis of EN 1015-6. Deviating from EN 1015-6, a measuring vessel with a volume of at least 5 litres shall be used.

The characteristic density ρ_m [kg/m^3] as the maximum value is stated in the ETA.

2.2.15 Bound EPS Density

The apparent density shall be determined according to EN 1602.

The sample size is 500x500xthickness mm. At least 5 samples shall be tested.

The characteristic density ρ_a [kg/m^3] as the maximum value is stated in the ETA.

2.2.16 Bulk Density of the dry mixture of granulated polystyrene and compound or of the granulated polystyrene

The determination of the loose bulk density shall be carried out according to EN 1097-3. A measuring vessel with a volume of at least 5 litres shall be used.

The range of bulk density [kg/m^3] shall be stated in the ETA. The density shall not deviate by more than ± 15 % for a dry mixture and ± 25 % for a granulate.

2.2.17 Moisture sorption

The moisture sorption shall be determined according to EN ISO 12571.

The sample size is at least 200x200x50 mm. The test shall be performed at least on samples with the highest density.

The moisture sorption u [kg/kg] is stated in the ETA by sorption at 23 °C and 50 % RH and at 23 °C and 80 % RH.

2.2.18 Alkaline resistance

The alkaline resistance of the final product shall be determined in accordance with EN ISO 175.

The assessment is carried out on the basis of the level of change of dimensions and mass.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance

For the products covered by this EAD the applicable European legal act is: 1999/91/EC(EU)

The system(s) to be applied is (are): 3

In addition, with regard to reaction to fire for products covered by this EAD the applicable European legal act is: 1999/91/EC amended by 2001/596/EC

The system(s) to be applied is (are): 1, 3, 4

System 1: in case of reaction to fire class A1, A2, B, C of the product for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).

System 3: in case of reaction to fire class A1, A2, B, C, D, E that are not covered in system 1

System 4: in case of reaction to fire class A1 to E - products that do not require to be tested for reaction to fire (e.g. Products/materials of Classes A1 according to Commission Decision 96/603/EC), reaction to fire class F.

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 2.

Table 2 Control plan for the manufacturer; cornerstones

No	Subject/type of control (product, raw/constituent material, component - indicating characteristic concerned)	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 test plan]					
1	Characteristics in accordance with the provisions of EN 16025-1 (Annex B)	EN 16025-1	EN 16025-1	EN 16025-1	See EN 16025-1
2	Dimensional stability	See clause 2.2.7	Control plan	See clause 2.2.7	Twice a year
3	Point load	See clause 2.2.8	Control plan	See clause 2.2.8	Twice a year
4	Impact sound reduction	See clause 2.2.9	Control plan	See clause 2.2.9	Once a year
5	Moisture sorption	See clause 2.2.17	Control plan	See clause 2.2.17	Twice a year
6	HBCDD content	See clause 2.2.2.2	Control plan	See clause 2.2.2.2	Each incoming EPS 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 insulation product are laid down in Table 3.

The involvement of the notified body is required only under the conditions defined in 1999/91/EC amended by 2001/596/EC - in case of reaction to fire class A1, A2, B, C of the product for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).

Table 3 Control plan for the notified body; cornerstones

No	Subject/type of control <i>(product, raw/constituent material, component - indicating characteristic concerned)</i>	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 <i>(for systems 1 only – only for reaction to fire)</i>					
1	<p>The notified body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product. In particular the following items shall be appropriately considered in connection with the reaction to fire:</p> <ul style="list-style-type: none"> – personnel and equipment – the suitability of the factory production control established by the manufacturer – full implementation of the control plan 				1/year
Continuous surveillance, assessment and evaluation of factory production control <i>(for systems 1 only – only for reaction to fire)</i>					
2	<p>The notified body shall verify in connection with the reaction to fire</p> <ul style="list-style-type: none"> – the manufacturing process, – the system of factory production control and – the implementation of the control plan <p>are maintained.</p>				1/year

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment, is of relevance.

EN 196-10	Methods of testing cement – Part 10: Determination of the water-soluble chromium (VI) content of cement
EN 826	Thermal insulating products for building applications - Determination of compression behaviour
EN 933-1	Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method
EN 1097-3	Tests for mechanical and physical properties of aggregates - Part 3: Determination of loose bulk density and voids
EN 1602	Thermal insulating products for building applications — Determination of the apparent density
EN 1604	Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions
EN 1605	Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions
EN 1606	Thermal insulating products for building applications — Determination of compressive creep
EN 1609	Thermal insulating products for building applications - Determination of short term water absorption by partial immersion
EN 12086	Thermal insulating products for building applications — Determination of water vapour transmission properties
EN 1015-6	Methods of test for mortar for masonry — Part 6: Determination of bulk density of fresh mortar
EN 12430	Thermal insulating products for building applications — Determination of behaviour under point load
EN 12431	Thermal insulating products for building applications — Determination of thickness for floating floor insulating products
EN 12667	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 12939	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Thick products of high and medium thermal resistance
EN 13163	Thermal insulation products for buildings — Factory made expanded polystyrene (EPS) products — Specification
EN 13171	Thermal insulation products for buildings — Factory made wood fibre (WF) products — Specification
EN 13501-1	Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests

EN 16025-1	Thermal and/or sound insulating products in building construction — Bound EPS ballastings — Part 1: Requirements for factory premixed EPS dry plaster
EN 29052-1	Acoustics – Determination of dynamic stiffness – Part 1: Materials used under floating floors in dwellings (ISO 9052-1)
EN ISO 175	Plastics - Methods of test for the determination of the effects of immersion in liquid chemicals
EN ISO 717-2	Acoustics - Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation
EN ISO 10140-1	Acoustics — Laboratory measurement of sound insulation of building elements - Part 1: Application rules for specific products — Rainfall sound (ISO 10140-1:2010 + Amd 2:2014) (consolidated version)
EN ISO 10140-3	Acoustics — Laboratory measurement of sound insulation of building elements - Part 3: Measurement of impact sound insulation (ISO 10140-3:2010)
EN ISO 10456	Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values — Technical Corrigendum 1 (ISO 10456:2007 + Cor 1:2009)
EN ISO 12571	Hygrothermal performance of building materials and products — Determination of hygroscopic sorption properties

Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

Commission Regulation (EU) No 143/2011 amending Annex XIV to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals ('REACH')

ANNEX A DETERMINATION OF THERMAL CONDUCTIVITY AND THE MASS-RELATED MOISTURE CONVERSION COEFFICIENT TO HIGH MOISTURE CONTENT

A.1 Determination of the λ fractile value at 10 °C, at dry conditions ($\lambda_{10,dry,90/90}$)

A.1.1 Measurement of the λ_{dry} at 10 °C

A.1.1.1 Test specimens for the determination of the thermal conductivity λ at 10 °C shall be conditioned to dryness after storage for at least 72 hours at $(65 \pm 2)^\circ\text{C}$ in an oven ventilated with air taken at $(23 \pm 2)^\circ\text{C}$ and $(50 \pm 5)\%$ relative humidity.

A.1.1.2 The thermal conductivity of the test specimens conditioned according to A.1.1.1 shall be measured according to EN 12667 or EN 12939 for thick products at a mean temperature of $(10 \pm 0,3)^\circ\text{C}$.

During the measurement, precaution shall be taken to avoid moisture absorption by the specimen. It is acceptable, for instance, to put the test specimen into a thin plastic bag.

A.1.2. Calculation of the λ fractile value at 10°C, at dry conditions ($\lambda_{10,dry,90/90}$)

The λ fractile value at 10 °C, at dry conditions ($\lambda_{10,dry,90/90}$) representing at least 90 % of the production with a confidence limit of 90 % shall be calculated using the principles as detailed in EN 13163, Annex A.

A.2 Determination of the mass-related moisture conversion coefficient ($f_{u,1}$)

For the determination of the mass-related moisture conversion coefficient $f_{u,1}$, two sets of measurements are needed.

Set 1

At least three measurements on dry test specimens, to determine $\lambda_{10,dry}$ and u_{dry} (moisture content mass by mass).

Set 2

At least three measurements on test specimens conditioned at $(23 \pm 2)^\circ\text{C}$ and $(50 \pm 5)\%$ relative humidity, to determine $\lambda_{10,(23,50)}$ and $u_{23,50}$ (moisture content mass by mass).

A.2.1 Procedure

A.2.1.1 Set 1

A.2.1.1.1 Dry the test specimens following the procedure in A.1.1.1.

A.2.1.1.2 Determine for each test specimen the mass in dry condition. Average the values to determine the m_{dry} . The u_{dry} , being the moisture content in dry condition, is by definition set to 0.

A.2.1.1.3 Determine for each test specimen the λ value at 10 °C following the procedure in A.1.1.2. Average the values to determine the $\lambda_{10,dry}$.

A.2.1.2 Set 2

A.2.1.2.1 Condition the test specimens at $(23 \pm 2)^\circ\text{C}$ and $(50 \pm 5)\%$ relative humidity following the procedures detailed in EN 13171:2015, clause 5.2, step 2.

A.2.1.2.2 Determine for each test specimen the mass at $(23 \pm 2)^\circ\text{C}$ and $(50 \pm 5)\%$ relative humidity. Average the values to determine the mass at 23 °C and 50 % relative humidity as $m_{23,50}$.

A.2.1.2.3 Calculate $u_{23,50}$ by the following formula:

$$u_{23,50} = \frac{m_{23,50} - m_{dry}}{m_{dry}}$$

where,

$m_{23,50}$ is the mass at 23 °C and 50 % relative humidity according to A.2.1.2.2

m_{dry} is the mass according to A.2.1.1.2

A.2.1.2.4 Determine for each test specimen conditioned according to A.2.1.2.1 the λ value in accordance with EN 12667 or EN 12939 for thick products at a mean temperature of $(10 \pm 0,3)$ °C.

Average the values to determine $\lambda_{10,(23,50)}$.

A.2.1.3 Calculation of the mass-related moisture conversion coefficient ($f_{u,1}$)

The mass-related moisture conversion coefficient $f_{u,1}$ shall be calculated by the following formula (derived from ISO 10456:2010, formula 4):

$$f_{u,1} = \frac{\ln \frac{\lambda_{10,(23,50)}}{\lambda_{10,dry}}}{u_{23,50} - u_{dry}}$$

where,

$\lambda_{10,(23,50)}$ is determined according to A.2.1.2.4;

$\lambda_{10,dry}$ is determined according to A.2.1.1.3;

$u_{23,50}$ is determined according to A.2.1.2.3;

u_{dry} is determined according to A.2.1.1.2 and is defined to be 0.

A.3 Calculation of the d thermal conductivity λ

The d thermal conductivity λ shall be calculated using the following formula:

$$\lambda_{(23,50)} = \lambda_{10,dry,90/90} * e^{f_{u,1}(u_{23,50} - u_{dry})}$$

where,

$\lambda_{10,dry,90/90}$ is determined according to A.1.2;

$f_{u,1}$ is determined according to A.2.1.3;

$u_{23,50}$ is determined according to A.2.1.2.3;

u_{dry} is determined according to A.2.1.1.2 and is defined to be 0.

The calculated value $\lambda_{(23/50)}$ shall be rounded upwards to the nearest 0,001W/(m.K) and d as $\lambda_{(23,50)}$.

A.4 Determination of the mass-related moisture conversion coefficient ($f_{u,2}$) to high moisture content

For the determination of the mass-related moisture conversion coefficient to high moisture content $f_{u,2}$, two sets of measurements are needed.

Set 1

At least three measurements on test specimens conditioned at (23 ± 2) °C and (50 ± 5) % relative humidity, to determine $\lambda_{10,(23,50)}$ and $u_{23,50}$ (moisture content mass by mass).

Set 2

At least three measurements on test specimens conditioned at (23 ± 2) °C and (80 ± 5) % relative humidity, to determine $\lambda_{10,(23,80)}$ and $u_{23,80}$ (moisture content mass by mass).

A.4.1 Procedure

A.4.1.1 Set 1

Determine the $\lambda_{10,(23,50)}$ and $u_{23,50}$ in accordance with A.2.1.2

A.4.1.2 Set 2

A.4.1.2.1 Condition the test specimens at (23 ± 2) °C and (80 ± 5) % relative humidity following the procedures detailed in EN 13171:2015, clause 5.2, step 2.

A.4.1.2.2 Determine for each test specimen the mass at (23 ± 2) °C and (80 ± 5) % relative humidity. Average the values to determine the mass at 23 °C and 80 % relative humidity as $m_{23,80}$.

A.4.1.2.3 Calculate $u_{23,80}$ by the following formula:

$$u_{23,80} = \frac{m_{23,80} - m_{dry}}{m_{dry}}$$

where,

$m_{23,80}$ is the mass at 23 °C and 80 % relative humidity according to A.4.1.2.2

m_{dry} is the mass according to A.2.1.1.2

A.4.1.2.4 Determine for each test specimen conditioned according A.4.1.2.1 the λ value in accordance with EN 12667 or EN 12939 for thick products at a mean temperature of $(10 \pm 0,3)^\circ\text{C}$.

Average the values to determine $\lambda_{10,(23,80)}$.

A.4.1.3 Calculation of the mass-related moisture conversion coefficient to high moisture content ($f_{u,2}$)

The mass-related moisture conversion coefficient to high moisture content $f_{u,2}$ shall be calculated by the following formula (derived from ISO 10456:2013, formula 4):

$$f_{u,2} = \frac{\ln \frac{\lambda_{10,(23,80)}}{\lambda_{10,(23,50)}}}{u_{23,80} - u_{23,50}}$$

where,

$\lambda_{10,(23,80)}$ is determined according to A.4.1.2.4;

$\lambda_{10,(23,50)}$ is determined according to A.2.1.2;

$u_{23,80}$ is determined according to A.4.1.2.3.

$u_{23,50}$ is determined according to A.2.1.2.

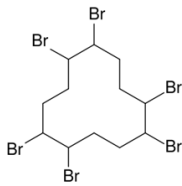
NOTE 1: For the determination of the mass-related moisture conversion coefficient $f_{u,1}$ and the mass-related moisture conversion coefficient to high moisture content $f_{u,2}$, the test specimens shall be taken from the same production run.

NOTE 2: Thermal conductivity may also be measured at mean temperatures other than 10 °C, providing that the accuracy of the relationship between the temperature and thermal properties is well documented.

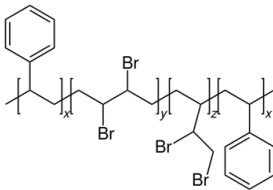
ANNEX B DETERMINATION OF THE HEXABROMOCYCLODODECANE (HBCDD) CONTENT

1. General

In the past, 95% of the flame retardant EPS- insulation products contained HBCDD.



New EPS-insulation products contain other flame retardants based on polymeric bromine (PolyFR) to replace HBCDD in EPS-insulation materials.



HBCDD versus PolyFR

HBCDD and PolyFR differ in molecular weight (642 Da versus > 100000 Da), vapour pressure and solubility.

2. Test principle:

Due to the difference in solubility, a simple method based on quick extraction was established to measure the HBCDD-content of EPS.¹

HBCDD is dissolved in acetone and the related Bromine content of the liquid extract is measured via X-ray fluorescence analysis. Since, PolyFR is insoluble in acetone the measured Bromine content is used to determine the HBCDD content of the original sample.

3. Procedure:

6.0 g of the homogenised sample are weighed in a 500 ml beaker. 15.0 g of acetone are added to this beaker (dilution factor 3.5). The mixture is homogenised for 10 seconds.

Afterwards, 6.0 ml of the liquid extract (without any solid parts) are transferred to an XRF-sample holder and the EDX-measurement (program Brom-HBCDD) is started immediately.

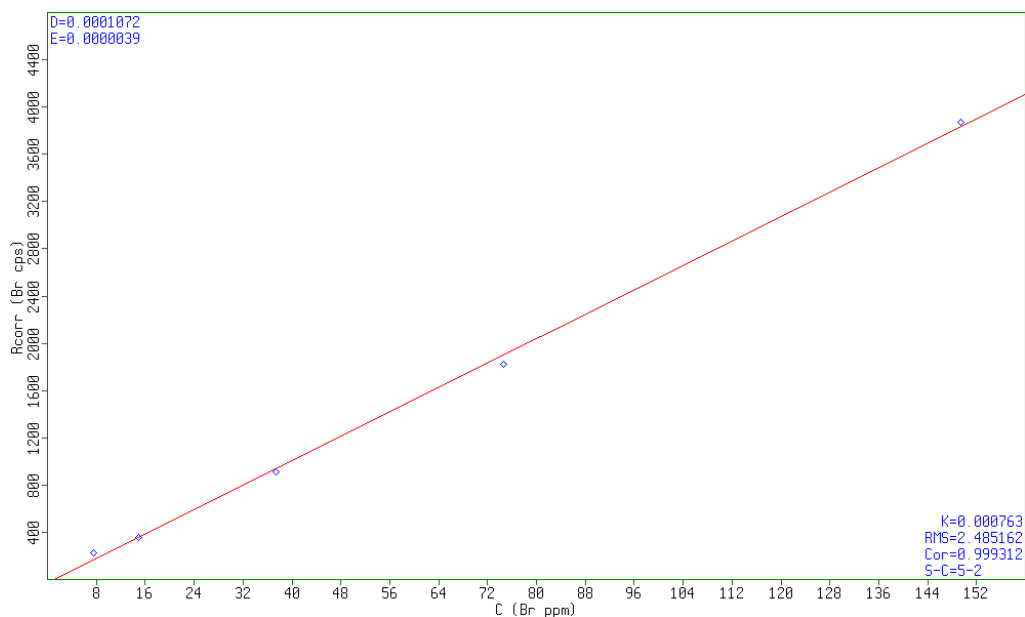
Device parameter and calibration:

The XRF analysis is performed on a e.g. PANalytical Epsilon 3^{XLE} energy dispersive X-ray spectrometer, equipped with a Silver-Anode and a high-resolution Si-drift detector. The liquid samples are placed in sample holders with a bottom out of mylarfoil (Biaxially-oriented polyethylene terephthalate; 6µm thickness). For the measurement of Bromine, the intensity of the Br-K_α line is evaluated. Measurements take place under air-atmosphere for 60 seconds. Adjustments are set to 50 kV and 67 µA, additionally a 100 µm Ag-filter is used.

For the quantification of the measured peak intensities a calibration curve based on five standard samples was constructed.

[HBCDD]/ppm	[Br]/ppm	Measured Intensity/cps*
10	7.47	226.73
20	14.94	355.66
50	37.35	915.50
100	74.71	1822.40
200	149.42	3873.84

* counts per second



Calibration data:

Channel	Br (Brom)
K-factor	0,00076
RMS	2,49 ppm
Correlation	0,99931
No std – coeff	5 – 2
Concentration Range (Br)	7,47 – 149,42 (ppm)
Relative RMS	3,17 %
Matrix correction	No correction
D value	0,000107
E value	0,000004
F value	0,000000
sensitivity	25,8 cps/ppm

Calculation:

The measured intensity of the Br-K α line is quantified according to the calibration curve shown above. The content of HBCDD in the original sample is related to the Bromine concentration according to the following equation:

$$[HBCDD] = [Br] * \frac{M(HBCDD)}{6 * M(Br)} * d = [Br] * \frac{641,7}{6 * 79,9} * 3,5 \approx [Br] * 4,7$$

[HBCDD]...concentration of HBCDD (ppm)

[Br]...concentration of Bromine (ppm)

M ()...molecular mass of () (g/mol)

d...dilution factor

The measurement program includes the calculation above and directly shows the concentration of HBCDD as a result.

4. Test accuracy:

According to Schlummer et al.¹ the LOD (limit of detection) of the method can be calculated as 35 ± 7 ppm Bromine, which corresponds to 47 ± 9 ppm HBCDD in the original sample. The method promises high accuracy and reproducibility.

If PolyFR and HBCDD are present in one sample at the same time, some small amounts of Bromine may be extracted from oligomers of PolyFR (max. 50 ppm). However, the major portion of the brominated additive remains in the PolyFR polymer matrix.