EAD 030218-01-0402

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European Assessment Document for

Membranes for use as roof or wall underlays or both

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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

The EAD covers membranes for use as roof and/or wall underlays; in the following referred to as

- membrane(s), if both membranes for use as roof underlay and membranes for use as wall underlay are addressed,
- roof underlay(s), if only the membranes for use as roof underlay are addressed,
- wall underlay(s), if only the membranes for use as wall underlay are addressed.

The membranes consist of multilayer flexible sheets. They are diffusion open membranes with additional characteristics, see below.

The membranes consist of plastics, bitumen or rubber.

The roof underlays covered by this EAD do not contain any substances that are intended to inhibit or prevent root penetration (root protection agents).

The precise description of the product (e.g., build-up, type of materials, total weight per unit area of the product [g/m²], overlapping and accessories) shall be given in the ETA.

The roof underlays are not fully covered by the harmonised European standard EN 13859-1[1] as at least one[2] of the following justifications is applicable:

- The standard provides for three classes of resistance to water penetration, none of which is applicable to the performance of those types of the roof underlays which have increased resistance to water pressure (water column resistance).
- Since the standard foresees that the roof underlays will be covered by a roofing, it does not cover the aspects related to the roof underlays being exposed to weathering for an extended period of time, as:
    - External fire performance of roofs,
    - Hail resistance,
    - UV testing for 5000 h,
    - Tightness of perforations from nails and screws.
- The following essential characteristics of the product are also not covered by the standard:
    - Emissivity,
    - High heat resistance.
- This EAD includes an assessment of the resistance to artificial weathering in excess of what is covered by the above standard, i.e., prolonged exposure to heat with accelerated air-speed to a higher level of 5±2 m/s (this part of the assessment is applicable to a higher working life category).

The wall underlays are not fully covered by the harmonised European standard EN 13859-2 as at least one[2] of the following justifications is applicable:

- The standard provides for three classes of resistance to water penetration, none of which is applicable to the performance of those types of the wall underlays which have increased resistance to water pressure (water column resistance).
- The following essential characteristics of the product are also not covered by the standard:
    - Emissivity,
    - Water tightness of seams,
    - High heat resistance.

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

2 If applicable depending on the specific product to be assessed and/or the applicable use scenario.

- This EAD includes also an assessment of the resistance to artificial weathering in excess of what is covered by the above standard, i.e., prolonged exposure to heat with accelerated air-speed to a higher level of 5±2 m/s (this part of the assessment is applicable to a higher working life category).

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.

The main technical changes in comparison to EAD 030218-00-0402 are given in Table 1.1.1:

Table 1.1.1 Main technical changes in comparison to EAD 030218-00-0402

Clause/Table		Main technical changes
EAD 030218-01-0402	EAD 030218-00-0402	
Clause 1.1	Clause 1.1	The description of the construction product has been amended. The EAD now covers "membranes for use as roof and/or wall underlays" (not only as roof underlay) made of plastics, bitumen or rubber in general, except for those roof underlays which contain root protection agents.
Clause 1.2.1	Clause 1.2.1	Use scenarios II (use as wall underlay), IV (use for different working life conditions) and V (in warm climates) have been added.
Clause 1.2.2	Clause 1.2.2	Working life 25 years has been added.
Table 2.1.2	-	A distinction between the intended uses (existing use as roof underlay and newly added use as wall underlay) has been made by allocation of two different sets of essential characteristics. Thus, Table 2.1.2 has been added.
Clause 2.2.2	-	External fire performance of roofs has been added.
Clause 2.2.3.1	-	The possibility of classification of membranes (membranes without increased resistance to water penetration) in accordance with EN 13859-1, clause 4.3.2, has been added.
Clause 2.2.7	Clause 2.2.6.1 and Annex A	Hail resistance has been reworked by adapting the test in accordance with EN 13583 and Annex A "Hail Resistance" of the previous version has been deleted (the same numbering "Annex A" is used now for another essential characteristic, see below)
Clause 2.2.10.1.1	-	Artificial ageing behaviour by exposure to combination of UV radiation (336 h) and elevated temperature and to heat in accordance with EN 13859-1, clause 4.3.8, has been added.
Clause 2.2.10.1.2	Clause 2.2.6.2	Resistance to perforation (resistance to persons stepping through the membrane) has been reworked as well as partially included in the new clause 2.2.10.1.2 "high heat resistance" (only the part concerns the assessment of possibly relevant parameters before/after a special aging)
Clause 2.2.10.3 and Annex C	-	Artificial ageing behaviour by prolonged exposure to heat with accelerated air-speed of 5±2 m/s has been added.
Clause 2.2.14 and Annex B	Clause 2.2.13 and Annex B	Tightness of perforations from nails or screws has been reworked.
Clause 2.2.15 and Annex A	-	Content, emission and/or release of dangerous substances has been added.

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

1.2.1 Intended use(s)

The intended use covers the following use scenarios:

- Use scenario I (use as roof underlay): The product is intended for use as underlay which is to be used under roof covering of discontinuous roofs.
- Use scenario II (use as wall underlay): The product is intended for use as underlay which is to be used behind wall covering.
- Use scenario III (in connection with use scenario I, only relevant for roof underlays): Some types of the roof underlays are intended to be used in high altitude and to be exposed to weathering (UV, rain and/or hail) for a defined extended period of time up to 24 months depending on the type. The type and correlated exposure time will be given in the ETA.
- Use Scenario IV (in connection with use scenario(s) I and/or II, relevant for both roof and wall underlays): Some types of the membrane are intended to be used for different working life conditions (25 years) depending on their resistance to artificial weathering by prolonged exposure to heat with accelerated air-speed 5±2 m/s in addition to the other artificial weathering tests of the harmonised European standards EN 13859-1 and/or EN 13859-2. The type and correlated working life category will be given in the ETA.
- Use Scenario V (in connection with use scenario(s) I and/or II, relevant for both roof and wall underlays): The products can optionally also intended to be used especially in warm climates. Therefore, this EAD provides for relevant assessment methods.

The use scenarios III, IV and V are only applicable in connection (together) with the relevant main use scenario(s) (I and/or II) as given above.

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 membranes for the intended use of 10 or 25 (see 2.2.10) 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[3].

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.

[3] 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 the assumed working life.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performances of the roof underlays are 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	External fire performance of roofs	2.2.2	Class
Basic Works Requirement 3: Hygiene, health and the environment			
3	Resistance to water penetration	2.2.3.1	Class
4	Water column resistance	2.2.3.2	Level
5	Water vapour transmission properties	2.2.4	Level
6	Tensile properties	2.2.5	Level
7	Resistance to tearing	2.2.6	Level
8	Hail resistance	2.2.7	Level
9	Dimensional stability	2.2.8	Level
10	Flexibility at low temperature	2.2.9	Level
11	Resistance to penetration of air	2.2.11	Level
12	Water tightness of seams	2.2.12	Level
13	Emissivity	2.2.13	Level
14	Tightness of perforations from nails and screws	2.2.14	Level, Description
15	Content, emission and/or release of dangerous substances	2.2.15	Level, description
Aspects of durability			
16	Artificial ageing behaviour by exposure to combination of UV radiation (336 h) and elevated temperature and to heat	2.2.10.1.1	Level, description
17	High heat resistance	2.2.10.1.2	Level, description
18	Artificial ageing behaviour by exposure to combination of UV radiation (5000 h) and elevated temperature and to heat	2.2.10.2	Level, description
19	Artificial ageing behaviour by prolonged exposure to heat with accelerated air-speed 5±2 m/s	2.2.10.3	Level, description

Table 2.1.2 shows how the performances of the wall underlays are assessed in relation to the essential characteristics.

Table 2.1.2 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
Basic Works Requirement 3: Hygiene, health and the environment			
2	Resistance to water penetration	2.2.3.1	Class
3	Water column resistance	2.2.3.2	Level
4	Water vapour transmission properties	2.2.4	Level
5	Tensile properties	2.2.5	Level
6	Resistance to tearing	2.2.6	Level
7	Dimensional stability	2.2.8	Level
8	Flexibility at low temperature	2.2.9	Level
9	Resistance to penetration of air	2.2.11	Level
10	Water tightness of seams	2.2.12	Level
11	Emissivity	2.2.13	Level
Aspects of durability			
12	Artificial ageing behaviour by exposure to combination of UV radiation (336 h) and elevated temperature and to heat	2.2.10.1.1	Level, description
13	High heat resistance	2.2.10.1.2	Level, description
14	Artificial ageing behaviour by exposure to combination of UV radiation (5000 h) and elevated temperature and to heat	2.2.10.2	Level, description
15	Artificial ageing behaviour by prolonged exposure to heat with accelerated air-speed 5±2 m/s	2.2.10.3	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

The membranes shall be tested, using the test method(s) relevant for the corresponding reaction to fire class according to EN 13501-1. The membranes shall be classified according to Commission Delegated Regulation 2016/364 in connection with EN 13501-1.

The provisions of Annex D shall be considered for mounting and fixing purposes of the test specimens.

The obtained reaction to fire classification shall be stated in the ETA together with those conditions (see relevant parameters in Annex D) for which the classification is valid.

2.2.2 External fire performance of roofs

The roof (including the complete roof covering, where relevant) in which the roof underlay is intended to be incorporated, installed or applied shall be tested using one or several test method(s) according to CEN/TS 1187 and relevant for the corresponding external fire performance roof class(es) according to in EN 13501-5.

The roof (including the complete roof covering, where relevant) in which the roof underlay is intended to be incorporated, installed or applied shall be classified according to Commission Decision 2001/671/EC, as amended by Commission Decision 2005/823/EC, in connection with EN 13501-5 and considering the provisions of CEN/TS 16459 for the extended application of test results.

The obtained class(es) shall be stated in the ETA together with a clear description of the assembly of the roof(s) which is/are covered by the classification(s).

2.2.3 Resistance to water penetration

2.2.3.1 Resistance to water penetration

The resistance to water penetration shall be assessed in accordance with EN 13859-1, clause 4.3.2, or EN 13859-2, clause 4.3.2[4], and the resistance to water penetration (relevant class of the harmonised European standards EN 13859-1/EN 13859-2) shall be given in the ETA.

2.2.3.2 Water column resistance

– e.g., for types of membrane which have increased resistance to water pressure, see clause 1.1 –

The resistance to water penetration of the membranes shall be assessed in accordance with EN 13859-1/EN 13859-2, clause 5.2.3[4], with the deviation that the water column shall be increased above the levels given in EN 13859-1 to assess the maximum water resistance which can be achieved by the product. The assessed value for the water column [mm] at which the membrane passes the test shall be stated in the ETA.

4 The given assessment methods of EN 13859-1 and EN 13859-2 are technically identical, therefore, both of them are equivalent.

2.2.4 Water vapour transmission properties

The water vapour transmission properties shall be assessed in accordance with EN 13859-1/EN 13859-2, clause 4.3.3[4], which leads to the assessment methods in accordance with EN 13859-1/EN 13859-2, clause 5.2.5.1 (using EN 1931 as test method) or with clause 5.2.5.2 (using EN ISO 12572 as test method), and defines in which case they shall be used. The water vapour diffusion-equivalent air layer thickness s_d [m] shall be stated in the ETA as expression of performance[5].

2.2.5 Tensile properties

The tensile properties shall be assessed in accordance with EN 13859-1, clause 4.3.4, or EN 13859-2, clause 4.3.5[4], and the mean value of tensile strength [N/50 mm] and the mean value of elongation at maximum force [%] for both longitudinal and transverse directions shall be stated in the ETA.

2.2.6 Resistance to tearing

The resistance to tearing shall be assessed in accordance with EN 13859-1, clause 4.3.5, or EN 13859-2, clause 4.3.6[4], and the level [N] for both longitudinal and transverse directions shall be stated in the ETA.

2.2.7 Hail resistance

The hail resistance of the roof underlays shall be assessed in accordance with EN 13583.

Testing shall be done with an underlying surface that are relevant for the end use application depending on manufacturer's specifications, if any, otherwise the test is performed with both types of underlying surface of EN 13583, namely, with the hard underlying surface and the soft underlying surface in accordance with clauses 5.6 and 5.7 of EN 13583.

The damage velocity v_d [m/s] - according to clause 9.1 of EN 13583 - with a reference to the type as well as a description (type of material, thickness, density and, if applicable, related European product standard) of the underlying surface shall be stated in the ETA.

2.2.8 Dimensional stability

The dimensional stability shall be assessed in accordance with EN 13859-1, clause 4.3.6 or EN 13859-2, clause 4.3.7[4], using the relevant test methods, i.e.:

- EN 1107-1 for bitumen sheets: Both method A and B can be used und lead to equivalent results.
- EN 1107-2 for all other materials.

The level [%] for both longitudinal and transverse directions shall be stated in the ETA.

2.2.9 Flexibility at low temperature

The flexibility at low temperature shall be assessed in accordance with EN 13859-1, clause 4.3.7 or EN 13859-2, clause 4.3.8[4], in combination with EN 1109, clauses 8.4 and 9.2, and the level [°C] shall be stated in the ETA.

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5 As it is clear, based on the value of s_d, which test method (EN 1931 or EN ISO 12572) is used, see EN 13859-1/EN 13859-2, clause 4.3.3, there is no need to give an indication to the test method used in the test.

2.2.10 Artificial ageing behaviour

2.2.10.1 Exposure to combination of UV radiation (336 h) and elevated temperature and to heat

2.2.10.1.1 Exposure to combination of UV radiation (336 h) and elevated temperature and to heat

– in case of working life 10 years –

The artificial ageing behaviour by exposure to combination of UV radiation (336 h) and elevated temperature and to heat shall be assessed concerning the resistance to water penetration and tensile properties in accordance with EN 13859-1, clause 4.3.8, for the roof underlays or EN 13859-2, clause 4.3.9 (applying 336 h UV radiation), for the wall underlays. The level (resistance to water penetration after exposure + mean values of tensile strength and elongation at maximum force before and after exposure for both longitudinal and transverse directions) and description of any occurred effects shall be stated in the ETA.

2.2.10.1.2 High heat resistance:

– e.g., for the use in warm climates, see clause 1.2.1 –

The assessment shall be made in accordance with clause 2.2.10.1.1 with the deviation that a higher temperature than the one given in EN 13859-1/EN 13859-2[4], clause C.5.2, (namely: higher than (70 ± 2) °C) which corresponds to the expected use temperature according to the intended use (e.g., (90 ± 2) °C) is used. The level (resistance to water penetration after exposure + mean values of tensile strength and elongation at maximum force before and after exposure for both longitudinal and transverse directions) and description of any occurred effects shall be stated in the ETA together with an indication to the applied aging heat temperature.

Informative note: The results of this assessment method can also serve to users when setting rules for personal safety (persons stepping through the membrane).

2.2.10.2 Exposure to combination of UV radiation (5000 h) and elevated temperature and to heat

– in case of working life 10 years with expected prolonged exposure to UV –

The artificial ageing behaviour by exposure to combination of UV radiation (5000 h) and elevated temperature and to heat shall be assessed concerning the resistance to water penetration and tensile properties in accordance with EN 13859-2, clause 4.3.9 (applying 5000 h UV radiation), and the level (resistance to water penetration after exposure + mean values of tensile strength and elongation at maximum force before and after exposure for both longitudinal and transverse directions) and description of any occurred effects shall be stated in the ETA.

2.2.10.3 Prolonged exposure to heat with accelerated air-speed of 5±2 m/s

– additional test to 2.2.10.1.1 and/or to 2.2.10.2 (in combination with at least one of them) in case of working life 25 years –

The artificial ageing behaviour by prolonged exposure to heat with accelerated air-speed of 5±2 m/s of both roof and wall underlays shall be assessed concerning resistance to water penetration in accordance with Annex C of this EAD. The levels (resistance to water penetration before and after exposure) and description of any occurred effects shall be stated in the ETA.

2.2.11 Resistance to penetration of air

The resistance to penetration of air shall be assessed in accordance with EN 13859-1, clause 4.3.9, which leads to EN 13859-2, clauses 4.3.4/5.2.6, and the relevant testing standard EN 12114, clause 7.2. The test is performed with seven pressure steps between 10 and 100 Pa (EN 12114, Figure A.1). One seamless sample is tested and the level [$m^3/(m^2 \times h \times 50\ Pa)$] shall be stated in the ETA.

2.2.12 Water tightness of seams

The water tightness of seams shall be assessed in accordance with EN 13859-1, clause 4.3.10, and the level shall be stated in the ETA.

2.2.13 Emissivity

The emissivity shall be assessed in accordance with EN 15976, and the level [-] shall be stated in the ETA.

2.2.14 Tightness of perforations from nails and screws

The tightness of perforations from nails and screws of the roof underlays shall be assessed in accordance with Annex B of this EAD and the results shall be stated in the ETA in accordance with:

- B.1.5 "Assessment/expression of the test results (part 1)".

In case of a hygrothermal simulation is additionally performed (see explanations in B.1.5), the results shall be stated in the ETA in accordance with:

- B.2.5 "Assessment/expression of the results of test and hygrothermal simulation results (parts 1 and 2)".

2.2.15 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 shall be assessed on the basis of the information provided by the manufacturer[6] after identifying the release scenarios taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The identified intended release scenario for this product and intended use with respect to dangerous substances is:

IA 2[7]: Product with indirect contact to indoor air (e.g., covered products) but possible impact on indoor air.

The use of recycled material shall always be indicated to the Technical Assessment Body. If recycled rubber is used and for the addition of polycyclic aromatic hydrocarbons (PAH) containing extender oils or PAH containing carbon black the additional assessment methods following clause 2.2.15.1 are to be performed. The assessment following clause 2.2.15.2 are to be performed for the case recycled rubber and/or nitrosamine forming agents are used.

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6 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 Regulation (EU) No 305/2011).

The manufacturer may **not** be obliged:

- to provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- to 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 SGDS, 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.

7 Scenario IA2 is applicable for products which are covered with other products but nevertheless could release dangerous substances to indoor air (e.g., products covered with porous/unsealed coverings incapable of avoiding migration, such as gypsum panels).

2.2.15.1 Specific organic compounds PAH and B[a]P

If recycled rubber is used and for the addition of polycyclic aromatic hydrocarbons (PAH) containing extender oils or PAH containing carbon black the additional assessment method for the content of specific organic compounds (PAH and B[a]P) has to be assessed based on the raw materials according to the testing method described in Annex A (based on the method for the determination of polycyclic aromatic hydrocarbons (PAHs) in polymers, AfPS GS 2019:01 PAK).

The sample to be tested is a composite sample of at least four incremental samples collected from different areas of a batch to represent the raw material as good as possible.

The product performance to be stated in the ETA takes into account the concentration of single PAH and/or the sum of PAH in mg/kg, as applied by the client.

2.2.15.2 Nitrosamines

If recycled rubber is used or nitrosamine forming agents are added to the product an additional assessment for the content of nitrosamines has to be performed based on the raw materials following the method published by DIK (Deutsches Institut für Kautschuktechnologie e.V. in Hannover, Germany) as described below:

The sample to be tested is a composite sample taking at least four incremental samples collected from different areas of a batch to represent the raw material as good as possible.

Immediately before analysis, the raw material rubber sample is cut into pieces of about 1 mm^3 particle size. About 2 g of sample are transferred to a 30 mL extraction thimble used for Soxhlet-extraction. Subsequent, extraction is performed for 24 hours at 65°C using 75 mL N-nitrosamine-free methanol with 0.1 %wt ascorbic acid in a 100 mL round bottom flask containing two boiling stones made of glass.
After cooling down, 2 mL of N-nitrosodiisopropylamine (NDiPA, approximately 0.2 µg/mL) are added as internal standard. Following, the extract is evaporated with approximately 3.5 mL/min to about 5 mL using a rotary evaporator with a 40°C water bath and 220±10 mbar.
The resulting pre-concentrate is transferred to a test tube using a Pasteur pipette. The round bottom flask is rinsed twice with 1 mL N-nitrosamine-free methanol and the rinse solution is pooled with the pre-concentrate.
By treatment with a nitrogen stream (0.05 mL/min) the solution is adjusted to 2 mL. Extracts with high oil content need chromatographic purification. The sample is analysed within 48 hours using packed columns. The analysis of extracted N-nitrosamines is achieved by gas chromatography using a thermal energy analyzer (TEA) as detector. The conditions for gas chromatographic analysis are shown in table 2.2.15.2.1.

Table 2.2.15.2.1: Conditions for gas chromatographic analysis of N-nitrosamines

Nitrosamine	NDMA, NDEA, NDPA, NDBA, NPIP, NPYR, NMOR, NDiPA	NMPA, NEPA
column	silanzed glas column (l = 2 m, ID = 1 mm)	
Stat. phase	10% Carbowax 20 M, 2% KOH on Chromosorb HAW 80/100 mesh	10% OV 101 on Chromosorb HAW 80/100 mesh
Carrier gas	helium	
Carrier gas flow	30 L/min	
Sample injection	on column	
Injector temperature	200°C	
Temperature program	125°C 2 min isothermal 125°C - 175°C (10°C/min) 175°C 5 min isothermal	100°C - 200°C (10°C/min)
Sample volume	5 µL	5 µL

As published in Kautschuk Gummi Kunststoffe; 44, 1991, pp. 514-21, R. Liekefeld, R. H. Schuster, G. Wünsch

The N-nitrosamines to be determined are:

- N-nitrosodibutylamine (NDBA)
- N-nitrosodiethylamine (NDEA)
- N-nitrosodimethylamine (NDMA)
- N-nitrosodipropylamine (NDPA)
- N-nitrosomethylphenylamine (NMPA)
- N-nitrosoethylphenylamine (NEPA)
- N-nitrosomorpholine (NMOR)
- N-nitrosopiperidine (NPIP)
- N-nitrosopyrrolidine (NPYR)

The stated product performance in the ETA takes into account the concentration of the relevant N-nitrosamines [µg/kg], certain limits of determination and detection limits, as applied by the client.

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 1999/90/EC, as amended by 2001/596/EC.

The system is 3 except for uses subject to regulations on reaction to fire and for uses subject to regulations on external fire performance.

For uses subject to regulations on reaction to fire the applicable AVCP systems regarding reaction to fire are 1, or 3, or 4 depending on the conditions defined in the said Decision.

For uses subject to regulations on external fire performance the applicable AVCP systems regarding external fire performance are 3 or 4 depending on the conditions defined in the said Decision.

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	The specifications of all incoming raw materials and components	As defined in control plan	As defined in control plan	As defined in control plan	Each delivery/ batch
2	Length, width, straightness	EN 13859-1, clause 4.2	As defined in control plan	EN 13859-1, clause 4.2	EN 13859-1, Annex D
3	Mass per unit area	EN 13859-1, clause 4.2	As defined in control plan	EN 13859-1, clause 4.2	EN 13859-1, Annex D
4	Reaction to fire	2.2.1	As defined in control plan	2.2.1	EN 13859-1, Annex D
5	External fire performance	2.2.2	As defined in control plan	1	Once per 5 years
6	Resistance to water penetration	2.2.3	As defined in control plan	2.2.3	EN 13859-1, Annex D
7	Water vapour transmission properties	2.2.4	As defined in control plan	2.2.4	EN 13859-1, Annex D
8	Tensile properties	2.2.5	As defined in control plan	2.2.5	EN 13859-1, Annex D
9	Resistance to tearing	2.2.6	As defined in control plan	2.2.6	EN 13859-1, Annex D
10	Artificial ageing behaviour	2.2.10.1	As defined in control plan	2.2.10.1	EN 13859-1, Annex D
		2.2.10.2	As defined in control plan	2.2.10.2	EN 13859-2, Annex D
		2.2.10.3	As defined in control plan	2.2.10.3	Once per 5 years
11	Resistance to penetration of air	2.2.11	As defined in control plan	2.2.11	EN 13859-1, Annex D

3.3 Tasks of the notified body

The intervention of the notified body under AVCP system 1 is only necessary for reaction to fire for products/materials 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).

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for membranes for use as roof underlays are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

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)*				
Initial inspection of the manufacturing plant and of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire and taking into account, e.g., a limiting of organic material and/or the addition of fire retardants.	Verification of the complete FPC, to be implemented by the manufacturer	As defined in control plan	-	When starting the production or a new production line
Continuous surveillance, assessment and evaluation of factory production control *(for systems 1+, 1 and 2+ only)*				
Continuous surveillance, assessment and evaluation of the factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire and taking into account, e.g., a limiting of organic material and/or the addition of fire retardants.	Verification of the controls carried out by the manufacturer on the raw materials, on the process and on the product as indicated in Table 3.2.1	As defined in control plan	-	Once a year

4 REFERENCE DOCUMENTS

EN 1107-1:1999	Flexible sheets for waterproofing - Determination of dimensional stability - Part 1: Bitumen sheets for roof waterproofing
EN 1107-2:2001	Flexible sheets for waterproofing - Determination of dimensional stability - Part 2: Plastic and rubber sheets for roof waterproofing
EN 1296:2000	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Method for artificial ageing by long term exposure to elevated temperature
EN 1928:2000	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of watertightness
EN 1931:2000	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of water vapour transmission properties
EN 12114:2000	Thermal performances of buildings – Air permeability of building components and building elements – Laboratory test method
EN 12154:1999	Curtain walling - Watertightness - Performance requirements and classification
EN 12155:2000	Curtain walling - Watertightness - Laboratory test under static pressure
EN 13162:2012+A1:2015	Thermal insulation products for buildings — Factory made mineral wool (MW) products — Specification
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 13501-5:2016	Fire classification of construction products and building elements - Part 5: Classification using data from external fire exposure to roofs tests
EN 13583:2012	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of hail resistance
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 13859-1:2010	Flexible sheets for waterproofing – Definitions and characteristics of underlays – Part 1: Underlays for discontinuous roofing
EN 13859-2:2010	Flexible sheets for waterproofing – Definitions and characteristics of underlays – Part 2: Underlays for walls
EN 15026:2007	Hygrothermal performance of building components and building elements - Assessment of moisture transfer by numerical simulation
EN 15976:2011	Flexible sheets for waterproofing - Determination of emissivity
EN ISO 811:2018	Textiles - Determination of resistance to water penetration – Hydrostatic pressure test (ISO 811:2018)
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 ISO 12572:2016	Hygrothermal performance of building materials and products - Determination of water vapour transmission properties - Cup method (ISO 12572:2016)
CEN/TS 1187:2012	Test methods for external fire exposure to roofs
CEN/TS 16459:2020	External fire exposure of roofs and roof coverings - Extended application of test results from CEN/TS 1187
EAD 030218-00-0402:2016-12	Membrane for use as roof underlay
GS 2019:01	PAK – Testing and assessment of polycyclic aromatic hydrocarbons (PAH) in the course of awarding the GS mark.
KGK, 1991	Kautschuk Gummi Kunststoffe; 44, 1991, pp. 514-21, R. Liekefeld, R. H. Schuster, G. Wünsch

ANNEX A TESTING INSTRUCTIONS FOR THE DETERMINATION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN POLYMERS

A.1 Method

A.1.1 Brief description

A.1.1.1 Standard method

A representative partial sample (see 2.2.15.1) is taken of the material and cut up into pieces with a maximum size of 2–3 mm using scissors, wire cutters, etc. Then, 500 mg of the sample is weighed into a container and extracted with 20 ml of toluene (to which an internal standard has been added) for 1 h at 60°C in an ultrasonic bath. An aliquot is taken from the extract once it has cooled down to room temperature. In the case of polymers (e.g., plastics or rubber products) for which matrix problems arise throughout the analysis, an additional purification step is carried out using column chromatography. Quantification is performed on a gas chromatograph with a mass-selective detector (GC/MSD) using the SIM method.

A.1.1.2 Method for insufficient quantities

If the total mass of material to be analysed is less than 500 mg, the procedure is as follows: Identical materials from the product can be combined and considered as one sample. Additional product specimens shall not be used.
If less than 50 mg of material is available for individual samples, these are not tested.
If the available mass of chopped-up material is between 50 mg and 500 mg, the sample shall be tested according to A.1.1.1 and the quantity of toluene converted or adapted in proportion. The actual mass of the sample is to be recorded accordingly.

A.1.2 Utensils

• Ultrasonic bath with a minimum power of 200 W and a bath area of 706 cm^2, corresponding to 0.28 W/cm^2, without a basket and with an internal or external thermostat,
• Gas chromatograph with a mass-selective detector.

A.1.3 Chemicals and solutions

A.1.3.1 Chemicals

• Toluene
• Internal standards
  - Standard 1: Naphthalene-d8
  - Standard 2: Pyrene-d10 or anthracene-d10 or phenanthrene-d10
  - Standard 3: Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene

At least three internal standards must be used; these are added to the extraction solvent (toluene).
• External standard: 18 PAH substances according to the list under no. A.2.3, as a mix or individually
• Petroleum ether
• Silica gel
• Sodium sulfate

A.1.3.2 Calibration solutions

The concentrations of the calibration solutions must be chosen as follows: A three-point calibration covers a working range of 0.1 to 10 mg/kg in the samples. This corresponds to a concentration range of 2.5 to 250 ng/ml in the calibration solutions.

A.2 Sample preparation and execution

A.2.1 Extraction

500 mg of the sample is placed in a vial. 20 ml of toluene, previously amended with internal standards, are added. The sample extraction should take place for 1 h in the ultrasonic bath at a temperature of 60 °C. For this purpose, the vials are placed or suspended in the ultrasonic bath without using a basket. The vials are then removed, the extract is left to cool to room temperature and shaken briefly, and an aliquot is taken from the extract and measured either directly or following dilution with toluene.

A.2.2 Column chromatography extraction step

For some polymers (e.g., plastic or rubber products), especially those that dissolve well in toluene under the described extraction conditions, it is necessary to clean the extract using adsorption chromatography on silica gel.
For this purpose, a clean-up column with “Hahnschliff” (“stopcock”) (approximately 220 mm x 15 mm) is filled with glass wool, 4 g of silica gel and 1 cm of sodium sulfate.
The silica gel is deactivated previously by adding 10% water (the corresponding volume of water is added to the silica gel in a glass flask, and the mixture is homogenised on the rotary evaporator for 1 h at standard pressure and room temperature. The silica gel shall then be stored in the sealed glass flask at room temperature).
The packed column is conditioned with 10 ml of petroleum ether.
The aliquot of toluene extract is then evaporated to a volume of approximately 1 ml on the rotary evaporator and poured into the column. The pointed flask is rinsed out with approximately 20 ml of eluent, which is then also transferred to the clean-up column. Elution is performed with 50 ml of petroleum ether. The collected petroleum ether eluate is amended with 1 ml of toluene and evaporated to a volume of approximately 1 ml under a nitrogen stream (e.g., on the TurboVap). This is then made up to a defined volume with toluene, and the extract is analysed by GC-MS.

A.2.3 Measuring procedure

The method of determination to be applied is gas chromatography with a mass-selective detector in the SIM mode.

The following 18 PAHs are to be determined:
• Naphthalene
• Acenaphthylene
• Acenaphthene
• Fluorene
• Phenanthrene
• Anthracene
• Fluoranthene
• Pyrene
• Chrysene
• Benzo[a]anthracene
• Benzo[b]fluoranthene
• Benzo[k]fluoranthene
• Benzo[j]fluoranthene
• Benzo[a]pyrene
• Benzo[e]pyrene
• Indeno[1,2,3-cd]pyrene
• Dibenzo[a,h]anthracene
• Benzo[g,h,i]perylene

A.2.3.1 Measuring conditions for gas chromatography

The equipment parameters (temperatures, columns, mass traces) may be chosen by the individual laboratory or are determined by the analytes.

A.2.3.2 Analysis

At least three internal standards must be used. For these three standards, the internal standards and the correction ranges are defined as followed:

Parameter	Internal standards with recommended reference
• Naphthalene	Naphthalene-d8
• Acenaphthylene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Acenaphthene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Fluorene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Phenanthrene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Anthracene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Fluoranthene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Pyrene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Benzo[a]anthracene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Chrysene	Pyrene-d10 or anthracene-d10 or phenanthrene-d10
• Benzo[b]fluoranthene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Benzo[k]fluoranthene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Benzo[j]fluoranthene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Benzo[a]pyrene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Benzo[e]pyrene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Indeno[1,2,3-cd]pyrene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Dibenzo[a,h]anthracene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene
• Benzo[g,h,i]perylene	Benzo[a]pyrene-d12 or perylene-d12 or triphenylbenzene

• External calibration: for each individual PAH, at least a three-point calibration must be carried out with reference to the internal standardisation set out above. A working range of 0.1 to 10 mg/kg is recommended.
• Concentrations above the calibration range can be determined by diluting the extract.

A.2.3.3 Limit of quantification

The limit of quantification for material samples is 0.2 mg/kg per parameter.

A.2.4 Special characteristics

Naphthalene is a parameter hard to be assessed in products that come into contact with the skin. Experiences indicates that it is possible to identify instances of both naphthalene depletion in materials and secondary contamination. The result obtained for naphthalene, therefore, only ever reflects the test specimen's current situation at the time of measurement.

A.2.5 Measuring conditions for gas chromatography

Injected volume: 1 µl pulsed splitless
Column: HT8 25m, ID 0.22mm, film thickness: 0.25µm
Injector temperature: 280°C
Transfer-line temperature: 260°C
Initial temperature: 50°C
Initial time: 2 min
Heating rate: 11°C/min
Final temperature: 320°C
Final time: 8 min

Retention time [min.]	PAH
3,418	D-naphthalene
8,186	D-phenanthrene
23,182	D-benzo[a]pyrene
3,459	Naphthalene
5,586	Acenaphthylene
5,845	Acenaphthene
6,634	Fluorene
8,235	Phenanthrene
8,337	Anthracene
11,217	Fluoranthene
11,914	Pyrene
16,830	Benzo(a)anthracene
16,982	Chrysene
21,860	Benzo(b+j)fluoranthene
21,964	Benzo(k)fluoranthene
23,055	Benzo(e)pyrene
23,302	Benzo(a)pyrene
27,974	Indeno(ghi)perylene
28,121	Dibenzo(ah)anthracene
28,549	Benzo(ghi)perylene

As published in AfPS GS 2014:01 Testing and assessment of polycyclic aromatic hydrocarbons (PAHs) in the course of awarding the GS mark

ANNEX B TIGHTNESS OF PERFORATIONS FROM NAILS AND SCREWS

B1 Part 1 – Reference assessment method - Laboratory test

B.1.1 General

The purpose of this part is to test the water ingress around penetrations in the membrane coming from the fasteners, e.g., staples, screws or nails.

The principle of the test is to establish a test frame which is then sprayed with water, applying at the same time an air pressure.

B.1.2 Test method

The determination of the water ingress is carried out on the basis of EN 12154 in combination with EN 12155 with a step-by-step increase in the differential pressure up to 600 Pa with an increased total sprinkling period of 3 hours. The sprinkling is applied with approximately 2 l/ (m^2 × min). For this, an adjustable sprinkling device consisting of nozzles arranged on a grid as described in clause B.1.3 and in Figure B.1.3.1 of this Annex shall be used.

The water nozzles are interpreted as follows:

- Full cone-shaped beam
- Spray angle 120°
- Working pressure in the range from 2 bar to 3 bar

The following devices are used:

- A device for measuring the constant or fluctuating positive test pressure, calibrated to an accuracy of ± 5%,
- A device for measuring the total water consumption with an accuracy of 10%.

The complete test frames are conditioned in a climate of 23 °C ± 3°C and 50 % ±15 % relative humidity for at least 24 hours.

The irrigation is carried out in accordance with the table below, showing the sprinkling duration and pressure stages of the test.

Pressure stage	**Sprinkling duration at approximately 2l/m²min**
[Pa]	[min]
0	60
50	15
100	15
150	15
200	15
250	15
300	15
450	15
600	15
Time:	180

The specimen is inspected for any water penetration on the underside and the water ingress points are documented.

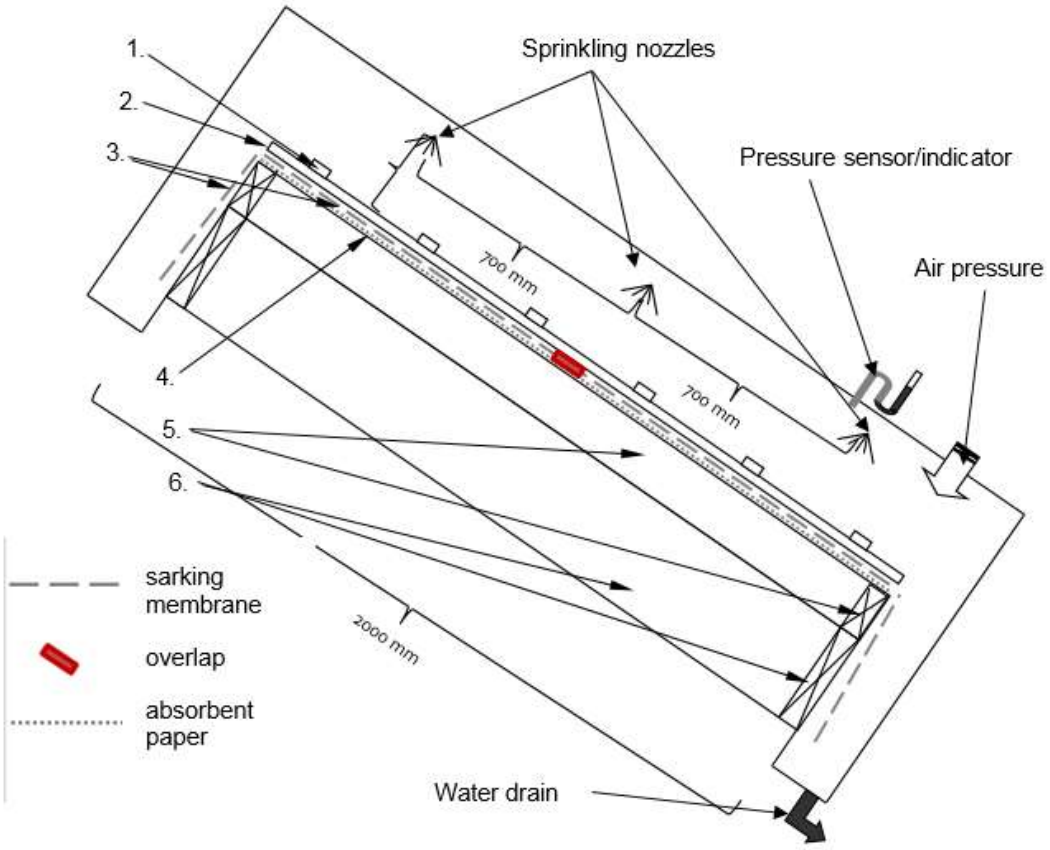
After sprinkling, the test specimen is removed from the rig. One hour (± 10 min.) after removal, subsequently, the battens and the roof underlay membrane are removed and the test frame is weighed again together with the paper (Quality of the paper 100 g/m², dry installed). The points at which water ingress is visible on the absorbent paper are documented.

The paper is removed and weighed. After drying to ambient climate, the dry weight of the paper is determined.

B.1.3 Sample

The configuration of the test fixture and test specimen is illustrated in Figures B.1.3.1 and B.1.4.1. On the side to be sprinkled, the test fixture is sealed tight with a cover and the test specimen can be subjected to overpressure and sprinkling at the same time in accordance with EN 12155 (water sprinkling adjusted to approximately 2 l/(m² × min)). The sprinkling is performed by 3 rows of nozzles, each containing 3 nozzles with an output of up to 1 l/min positioned within a 700-mm grid and at a distance of 400 mm from the specimen surface.

The roof element to be tested has the following configuration, as shown in Figure B.1.3.1:
Dimensions of the roof surface: 1600 mm x 2000 mm (± 5 mm)
Gradient: 14°



Construction from outside to inside:

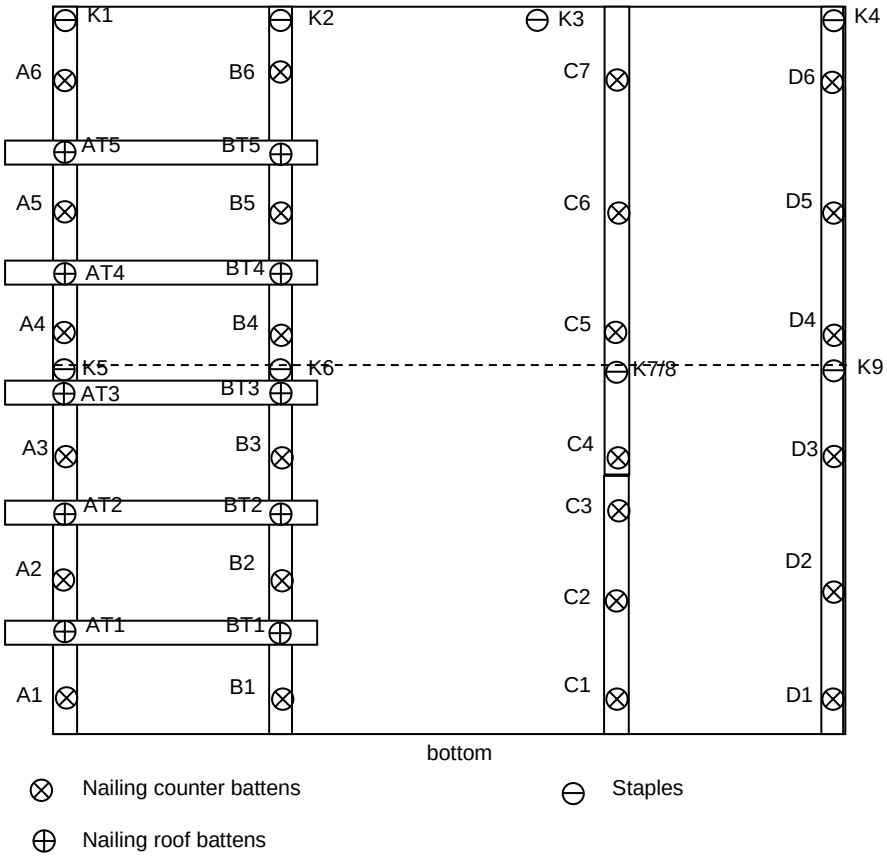
1. Battens (30 mm x 50 mm, coniferous sawn timber, normal strength) only on the left side
2. Counter battens (30 mm x 50 mm, coniferous sawn timber, normal strength)
3. Roof underly membrane with an overlap in the middle, this overlap is glued to the membrane own adhesive zones without additional products
4. Absorbent paper for detecting possible water ingress areas
5. Test frame (80/60)
6. Beam (80/120 mm)

Figure B.1.3.1: Test rig configuration (side view)

B.1.4 Assembly

First, absorbent paper is laid on the test frame to make any water ingress areas apparent (Figure B.1.3.1). The test frame is then weighed with the paper. The roof underlay membrane (sarking membrane) is subsequently laid. The roof underlay membrane is stapled at the top and in the centre line and the top stapling points are sealed with the relevant adhesive tape. The overlap in the middle is glued according to manufacturer's instructions. The counter battens and additionally the roof battens on the left side are subsequently nailed to the structure.

The fully fitted test specimen is installed in the test fixture. The test fixture is tilted through 14°(± 0,2°).



Nailing dimension chain (from bottom to top)											
Counter battens left		Roof battens left		Roof battens right		Counter battens centre left		Counter battens centre right		Counter battens right	
Level A		Level AL		Level BL		Level B		Level C		Level D	
–	cm	–	cm	–	cm	–	cm	–	cm	–	cm
A1	20	AT1	37	BT1	37	B1	20	C1	20	D1	20
A2	34	AT2	34	BT2	34	B2	34	C2	34	D2	34
A3	34	AT3	34	BT3	34	B3	34	C3	10	D3	34
A4	34	AT4	34	BT4	34	B4	34	C4	24	D4	34
A5	34	AT5	34	BT5	34	B5	34	C5	34	D5	34
A6	34						34	C6	34	D6	34
–	–	–		–		–	–	C7	34	–	–

Figure B.1.4.1: View from top, with specification of the nailing positioning.

B.1.5 Assessment/expression of the test results (part 1)

1. If no water entry is assessed in the test, a description shall be given in the ETA that the roof underlay sheet is watertight at perforations from nails and screws without using nail sealing tape. The level of wetting in [l/ (m2 x min)] and the maximum wind pressure in [Pa] which applied in the test shall be given in the ETA. In this case, the optional Part 2 of this Annex (hygrothermal simulation) is not applicable and the assessment is completed.

2. If water entry is assessed, one of the following shall be performed:
   a. Reference assessment: A description like no. (1), above, together with the level of wetting and wind pressure at which the perforations were still watertight, shall be given in the ETA (e.g., at 600 Pa, water entry was assessed but at pressure 300 Pa there was no water entry; the level 300 Pa is given in the ETA). In this case, the optional Part 2 of this Annex (hygrothermal simulation) is not needed and the assessment is completed.

   or

   b. Optional extension of assessment for manufacturers who may wish to expand results obtained according to the Clause B.1 also for hygrothermal simulation made for specific geographic region: An assessment is done of whether there can be a damage to the wood by the determined water entry (water entry determined in part 1) in accordance with the following part 2 of this Annex. Then B.2.5 "Assessment/expression of the results of test and hygrothermal simulation results (parts 1 and 2)" applies.

B.2 Part 2 – Optional extension of reference assessment method - Additional hygrothermal simulation depending on the results of the laboratory test

– based on manufacturers request, see B.1.5, 2, b –

B.2.1 Description of the calculation and assessment method for tightness of perforations from nails and screws related to part 2

Procedure:

1. Laboratory tests to determine the water inlet (Part 1 of this annex)
2. Hygrothermal simulation of exposure phase for maximum outdoor exposure time (up to 24 months temporary roofing without covering) according to manufacturer's specifications.
3. Subsequent hygrothermal simulation with the humidity and temperature conditions after outdoor exposure time, for a period of 5 years (with roof covering).
4. Evaluation/expression of the simulation results.

B.2.2 Structure of the simulated roof construction

The assessment of whether water penetration at the nail or screw points (determined in the laboratory test in accordance with part 1 of this Annex) leads to damage to the underlying rafter or not is carried out by means of two-dimensional hygrothermal simulation using a simulation programme (computer aided) that follows the numerical simulations of EN 15026, example WUFI® 2D[8]. For this purpose, a two-dimensional section of a standard roof construction (Figure B.2.2.1) is defined in the simulation programme as following:

- Moderate vapour barrier film with a water vapour diffusion-equivalent air layer thickness (S_d) - established according to EN 1931 - of about 6 m (bottom),
- 200 mm × 80 mm softwood / spruce rafter,
- Mineral wool thermal insulation in accordance with the harmonised standard EN 13162, with a thermal conductivity λ_D in accordance with EN 13162, clause 4.2.1, of 0,040 W/(m·K),
- The roof underlay membrane with the s_d value determined by laboratory tests (top).

8 www.wufi.de, Künzel, H. M.: Method for one and two dimensional calculation of the simultaneous heat and moisture transport in components with simple characteristics. Dissertation University of Stuttgart. 1994

The structure for the two-dimensional hygrothermal simulation is exemplified in Figure B.2.2.1: The blue area in Figure B.2.2.1 is the set position of the moisture source for the two-dimensional hygrothermal simulation of outdoor exposure time.

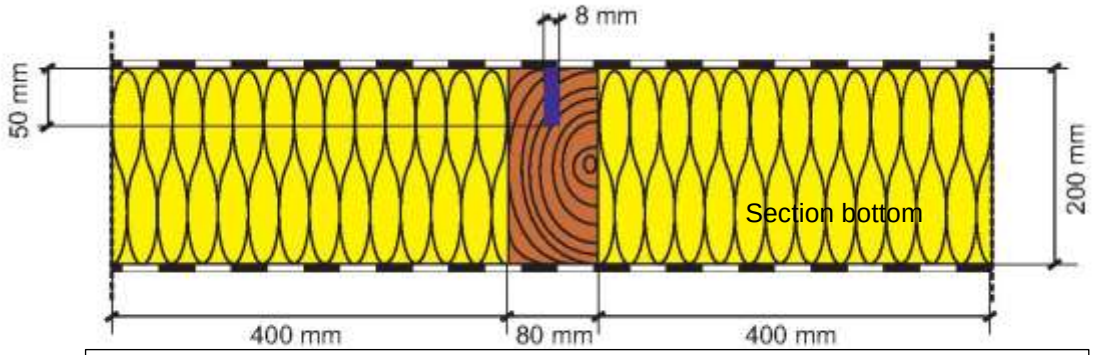


Figure B.2.2.1: Two-dimensional section of a standard roof construction

- The roof surface is inclined to 45° to the north. *This is because of the low solar radiation and the lowest surface temperatures resulting in a more critical drying behaviour.*
- The climate data record used shall have radiation data with sufficient accuracy. *Thus, the simulation shows the explicit radiation balance on the outer surface*.
- The moisture content in the rafter shall be set to 18% by mass or slightly higher. *This simulates a more critical situation*.
- The initial moisture content of other materials shall match the equilibrium moisture content of 80% r.h. *This is also a slightly higher value than it is present generally in the installed on-site installation.*

B.2.3 Simulation of outdoor exposure time

On the outside of the roof structure hygrothermal simulations are set using the hourly climate data of a critical reference location (manufacturer's specifications, if applicable, based on targeted market). If no manufacturer's specifications are available, the hygrothermal reference year (HRY) of Holzkirchen[9], Germany, shall be used[10].

The indoor air is determined according to EN 15026 derived from the outside air conditions in order to comply with normal occupation of the building.

The simulation starts in October. *The outdoor drying conditions are less favourable in the fall and winter months. The average outdoor air temperature is already low at this time of year, the solar radiation is reduced*.

Manufacturer's specifications for outdoor exposure time are taken into account.

The radiation parameters of the roof underlay membrane on the outer surface are to be set using either the values from laboratory tests or, if no test reports are available, the following values:

absorptivity a: 0,65 [-]
emissivity γ: 0,91 [-]

After completion of the hygrothermal simulation the two-dimensional humidity and temperature profile of the entire construction is standard output.

B.2.3.1 Simulation of the moisture ingress into the rafters during the outdoor exposure time:

9 Holzkirchen can be considered because of its location on a plateau in front of the Alps (690 m above sea level with an average total annual rainfall ≤ 1185 mm/a) as critical representative of the central European climate up to comparable altitudes and below.

10 See B.2.5.1.1, the used simulation boundary conditions shall be stated in the ETA together with the performance.

In an actual test the water penetrates directly through the nail holes into the rafters and the water absorption on the rafter surface hardly can be observed[11]. Therefore, in the computer-aided hygrothermal simulation, a moisture source with 8 mm width and 50 mm depth is to be placed in the nail area of the rafter (blue area in Figure B.2.2.1).

The input of the moisture ingress into the rafters shall be calculated and set in the simulation programme as following:

1. For the calculation of the total moisture entry in relation to the annual precipitation, the following equation is used:

$$Total\ moisture\ entry\ outdoor\ exposure\ time\ [kg] = \frac{Annual\ rainfall\ reference\ site\ [mm]}{Rainfall\ laboratory\ tests\colon 360\ [mm]} \cdot Determined\ water\ entry\ \ [kg]$$

Whereas

- "Rainfall laboratory test" is equal to the total water consumption applied during the test according to part 1 of Annex B (2 (l/m² min) x 180 (min) = 360 l/m²).
- The "annual rainfall reference site" is the total annual rainfall of the critical reference location mentioned above. In case of Holzkirchen (if no manufacturer's specifications are available, see first paragraph of B.2.3), the "annual rainfall reference site" = 1185 mm[12].
- "Determined water entry" is the resulting water entries assessed in the test (Part 1 of Annex B).

2. Calculation of the strength of the moisture source which shall be set in the simulation:

Taking into consideration that the calculated "total moisture entry of outdoor exposure time" is related to 2 m long rafters and based on an assumption that this total moisture entry is a result of a one hour per day wetting during the weathering phase, the strength of the moisture source per meter rafter to be given in the simulation is calculated using this equation:

$$Strength\ of\ the\ moisture\ source\left[\frac{kg}{m \cdot s}\right] = \frac{Total\ moisture\ entry\ Outdoor\ exposure\ time\ [kg]}{rafter\ length\ 2\ [m]\ \cdot\ weathering\ phase\ [days] \cdot 1\left[{}^{h}/_{Tag}\right] \cdot 3600\left[{}^{s}/_{h}\right]}$$

The amount of the "strength of the moisture source" is to be introduced during the simulation of a weathering phase over one hour daily, 6:00 to 7:00 p.m., by the moisture source in the rafter (nail hole). *This represents the most critical scenario with the least solar radiation values and thus with the lowest surface temperatures and the lowest drying potential.*

B.2.4 Simulation of the drying phase, over 5 years

In the subsequent drying phase, the simulation of the roof with a tile covering (absorption coefficient a [-] = 0.77 for example) has to be made on battens and counter battens. The effective heat transfer parameters on the eaves for normally ventilated roof constructions are to be used[13].

Wooden structures including pitched roofs are never completely airtight. Ventilation heat loss leads to additional moisture in the structure; This additional moisture shall be considered in the hygrothermal simulation, by appropriate infiltration models. In this case (air-tightness of the component derived from the air-tightness of the building), an air-tightness model in accordance with Figure B.2.4.1 is used. The

11 Kölsch, P., Wagner, R.: Upside the sample. In: The DDH Dachdeckerhandwerk 10.2015 S. 16-21

12 See B.2.5.1.1, the used simulation boundary conditions shall be stated in the ETA together with the performance.

13 Kölsch, P.: Hygrothermal simulation of ventilated pitched roofs with effective transition parameters. Report. Fraunhofer Institute for Building Physics IBP. Holzkirchen. 2015. Available online: https://wufi.de/en/wp-content/uploads/sites/11/2015/11/WUFI-Pro_Ventilated-pitched-roofs.pdf)

calculations must show a flow through the building envelope of a typical building with a q50- value of minimum 3.0 m³ / (m² h) to produce critical possible constraints[14].

The additional moisture source in the two-dimensional simulation is placed in the outer 20 mm of the mineral wool insulation where the dew point is reached under critical temperature conditions (see Figure B.2.4.1).

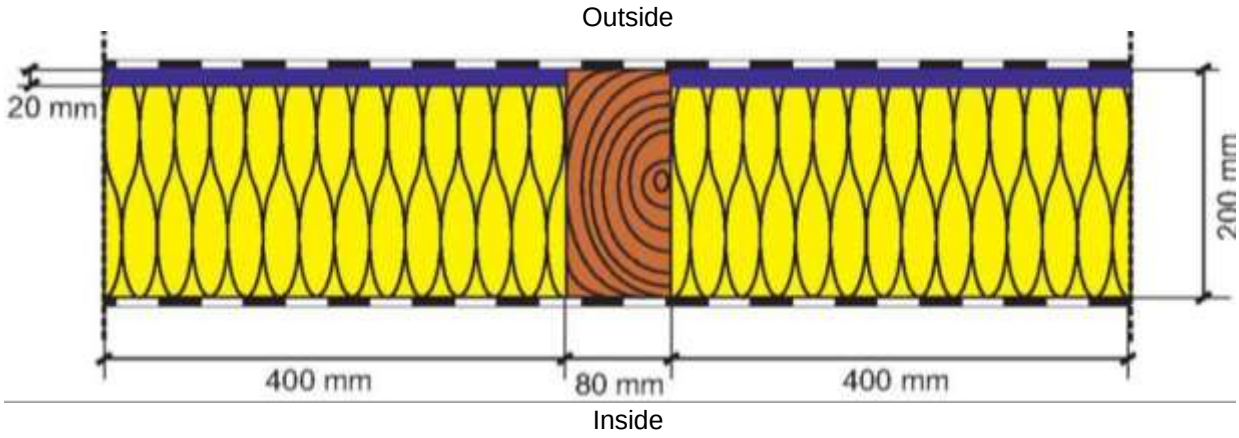


Figure B.2.4.1: Infiltration models with the additional moisture source due to air ventilation in the drying phase

B.2.5 Assessment/expression of the results of test and hygrothermal simulation (parts 1 and 2)

B.2.5.1 Assessment criteria

1. The total water content or the moisture content of the complete rafter cross section over the entire calculation period of 5 years shows a downward trend.

The total moisture content of the rafter dries from the initial 18% by mass during the weathering time. This leads to the conclusion that water entry, set in the nail holes in the present simulation methodology with the extremely critical conditions have little effect on the total moisture content of the entire rafter. The moisture content during the weathering time must show a downward trend at the latest on termination of the simulated weathering time.

2. The water content and the humidity in the critical area of the nail holes show a downward trend after the simulation of the first year.

The highest water contents in the rafters will be around the nail holes; this critical area in the rafters is identical to Figure B.2.2.1. A temporary increase in the moisture content of up to 3 months (above the limit of 20% by mass), during the simulation period, can be considered not critical.

During the test period, it must be checked if the limit of 20 % by mass for more than 3 months is exceeded.

3. The daily averages of temperature and humidity in the nail holes, in the entire simulation period of 5 years, shall not be above the limit value curve for wood-decaying processes of Figure B.2.5.1.1 at any time.

Wood-decaying processes are not only a consequence of the moisture content, but also on the temperature. At low temperatures the moisture content can exceed the 20% without any decaying of the wood takes place.

14 The used air-tightness model follows infiltration models of IBP as published in: D. Zirkelbach1, H.M. Künzel1, B. Schafaczek1, R. Borsch-Laaks, "Dampfkonvektion wird berechenbar – Instationäres Modell zur Berücksichtigung von konvektivem Feuchteeintrag bei der Simulation von Leichtbaukonstruktionen", in 4th Internatioal Symposium on Building and Ductwork Air Tightness, Berlin, 2009

Figure B.2.5.1.1 shows the limit value curve of the relative pore humidity over the corresponding temperature with the limits in solid wood in a range of 95% by mass at 0° C and at 86% by mass at 30° C[15].

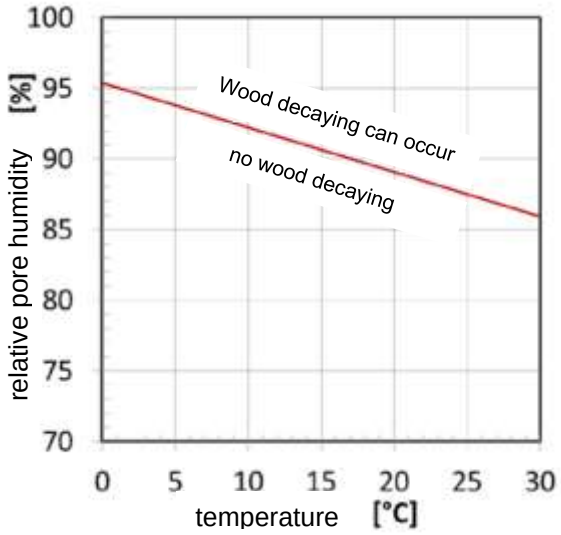


Figure B.2.5.1.1: Limit value curve of the relative pore humidity over the corresponding temperature

B.2.5.2 Expression of results

1. If the above evaluation criteria 1) and 2) or 1) and 3) in clause B.2.5.1 are fulfilled, the perforations from nails and screws are assessed to be watertight without nail sealing tape under the battens (under simulation boundary conditions).

   A description of this assessment together with the following simulation boundary conditions shall be given in the ETA:
   - Level of wetting and the maximum wind pressure have been applied in the laboratory test (part 1).
   - Exposure time without covering considered in the simulation (manufacturer's specifications).
   - The critical country-specific reference location whose hourly climate data have been used in the simulation.
   - The total annual rainfall of the critical reference location considered in the simulation.
2. If not, the results according to clause B.1.5, no 2, option (a), can still be given in the ETA.

15 WTA leaflet E-6-8: "Moisture Technical review of timber structures - Simplified documentation and simulation", 08.2016

ANNEX C RESISTANCE TO PROLONGED EXPOSURE TO HEAT WITH ACCELERATED AIR-SPEED OF 5±2 m/s

Based on the test technology used, this assessment method is only relevant for roof underlays/wall underlays with resistance to water penetration of class W1 according to the harmonised standards EN 13859-1/EN 13859-2.

General

Air movement in the level of the counter battens is part of the concept of ventilated roof coverings which ensures the removal of moisture. This air movement is caused by the air flow between eaves, ridges and hips produced by wind and also the thermal air currents initiated by solar radiation on the roofs. This air movement occurs almost permanently in the counter-battens level and it's usually accompanied by elevated temperatures in large parts of the roof. Similar occurrences of air movement are also expected behind wall covering.

Undesirable consequences of this air movement are the successive migration of the stabilizers and the accelerated oxidation of the surfaces of the underlay membranes due to the permanent flow of fresh air. This air movement in combination with elevated temperatures is the main source of risk for the aging resistance of underlays in the end use state.

Since the rate of aging depends on the air velocity, a much higher air velocity than the real average level was chosen for the artificial simulation of the aging process.

Test

The test method of artificial ageing by prolonged exposure to heat with accelerated air-speed 5±2 m/s is based on EN 1296 with the following modifications:

An oven based on EN 1296 but with capability of producing constant air-speed at the level of 5±2 m/s shall be used. The temperature of the oven shall be set to 70 ±2 °C. The air-exchange shall be set to a minimum air change rate of 10 changes/hour.

The oven shall be equipped with frames (e.g., of steel or aluminium) capable of holding the test specimens in a vertical position. The specimens are fixed between the frames which shall prevent mechanical movement of the specimens as well as curling at corners and edges without stressing them during the conditioning. Figure C.1 shows such exemplary oven and specimen holder (frame).

The size of test specimens shall be at least 15x15cm.

To ensure a stable average air speed during the entire testing time, all specimen places in the frames must be filled with either product specimens or blank specimens.

The specimens shall be covered on the back (e.g., with metal foil or two specimens back-to-back) during the entire exposure period in order to simulate the reality (exposure to air-movement only on the upper/outer side of roof/wall underlay membrane).

The test specimens shall be conditioned in the above-described apparatus for prolonged exposure to heat with accelerated air-speed 5±2 m/s for exposure duration of 64 weeks at 70 ±2 °C.

After exposure, the exposed test specimens shall be examined visually and compared with the unexposed specimens. Any occurred changes shall be recorded.

The watertightness of the specimens shall be tested before and after aging in accordance with test conditions of the harmonised standard EN 13859-1/ EN 13859-2, clause 5.2.3[16], "Determination of resistance to water penetration Class W1":

- water column 200 mm
- test period 2 h

16 The given assessment methods/clauses of EN 13859-1 and EN 13859-2 are technically identical, therefore, both of them are equivalent.

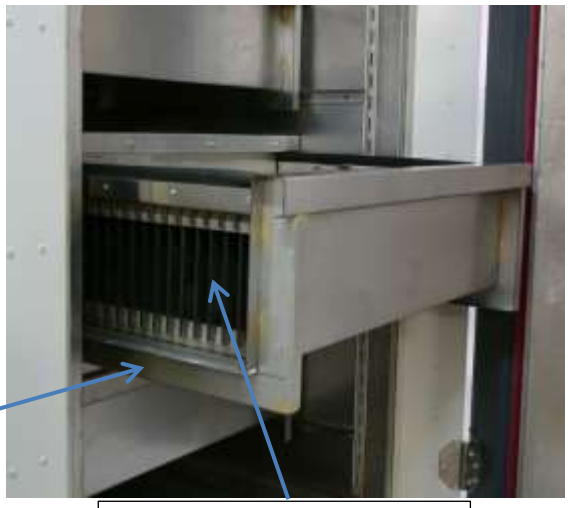
- three test specimens

In deviation to EN 13859-1/EN 13859-2[16], clause 5.2.3, the test shall be carried out in accordance with EN ISO 811 (without cover plate, tested area 100 cm²)[17].

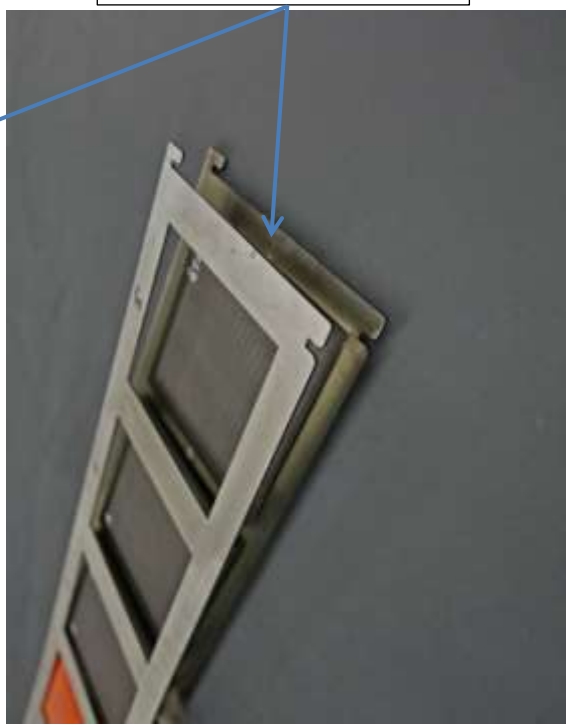
The assessment of test results shall follow the principle of EN 13859-1, clause 4.3.8, "Artificial ageing behaviour" regarding the comparison of resistance to water penetration before and after exposure). Thus, the level (resistance to water penetration before and after exposure) and a description of any occurred effects shall be stated in the ETA.

17 The loss of elongation at break or tensile strength of the membrane due to aging can be identified very well in the test of watertightness, provided that the specimen surface is not covered with a glass plate as in EN 1928, method A, but the testing is carried out in accordance with EN ISO 811 without counter-pressure plate.

Drawers for specimen arrangement



Specimen holder (frame)



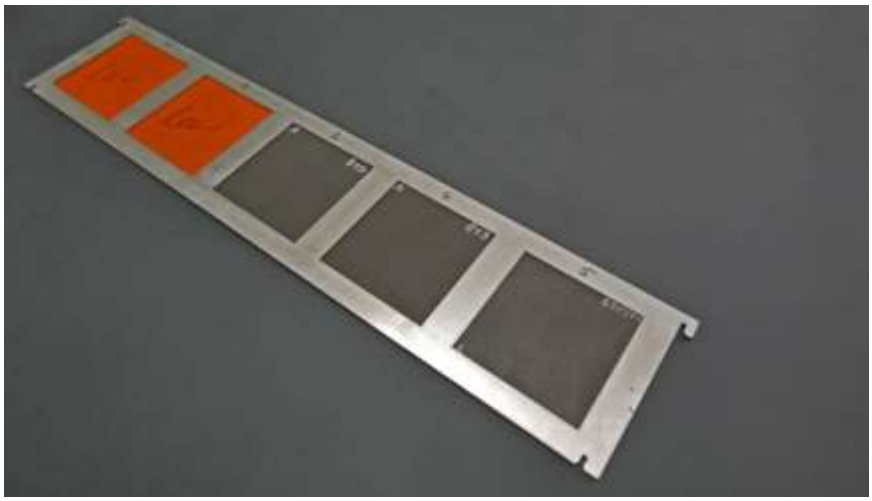


Figure C.1 Example: Oven and specimen holder (frame)

ANNEX D: MOUNTING AND FIXING PROVISIONS OF THE RELEVANT REACTION TO FIRE TESTS

D.1 EN ISO 1182 and EN ISO 1716

These test methods are relevant for reaction to fire classes A1 and/or A2 according to EN 13501-1.

However, due to the nature of the concerned products the application of these both methods will likely not be relevant, because these products normally are not able to meet the criteria for the aforementioned classes.

The results of these tests are valid for the product tested.

D.2 EN 13238 (SBI test)

This test method is relevant for reaction to fire classes A2 to D according to EN 13501-1 simulating the use of the membranes as underlay for walls and/or roofs.

D.2.1 Dimension of the test rig and the test specimens

The dimension of the L-shaped test specimens (consisting of a long wing and a short wing) shall be as prescribed in the test standard.

On the long wing of each test specimen at least one vertical and one horizontal joint shall be considered as prescribed in the test standard (200 mm for away from the inner corner of the test specimen and 500 mm above the floor of the specimen trolley). Execution of the joints shall be done with the minimum overlapping of the membrane according to the instructions of the manufacturer for the intended application.

D.2.2 Substrate, sub-construction and fixing

Considering the intended use of the products, the test specimens shall be mechanically fixed onto an appropriate standard substrate according. to EN 13238.representing a range of substrates in the intended end use applications as specified by the manufacturer.

Other substrate (deviating from EN 13238) may also be used for testing purposes. However, in this case the test results will only be valid for the practical use of the membrane on this specific substrate. In this case, the substrates used shall be indicated in the ETA.

In case of specimens with an air gap behind the membrane a sub-construction shall be used as support of the underlay. This sub-construction shall consist of a frame made of timber battens from non-FR-treated spruce wood of standard grade, saw-cut (density: 475 ± 25 kg/m³). The vertical members of the frame shall have a cross section of (40 ± 1) mm width and ≤ (40 ± 1) mm depth. They shall be positioned behind the lateral edges of the specimen wings as well as behind the vertical joint on the long wing of the specimen. The horizontal members of the frame shall have a cross section of (40 ± 1) mm width and ≤ (15 ± 1) mm depth. They shall be positioned behind the top and the bottom edge of the specimen wings and, if relevant, behind the horizontal joint on the long specimen wing.

Depending on the depth of an air gap behind the membrane a standard substrate according to EN 13823 shall be positioned behind the wooden sub-construction or between the members of the sub-frame simulating the smallest depth of the air gap as defined by the manufacturer for the intended end-use (at least 20 mm is recommended). In case of an air gap equal or greater than 80 mm, the specimen shall be tested with a distance of 80 mm between the backside of the membrane and backing board of the SBI test rig.

Equivalently to the timber frame a supporting frame made of steel or aluminium angles (dimension: 40 x ≤ 40 x 1.5 mm) can be used for testing purposes. Positioning of the angles shall be the same as for the timber battens.

For fixing purposes metal screws and washers shall be used with their lowest number needed for a proper fixing of the test specimens on the substrate or the sub-construction (at least one fixing mean in each corner of the various parts of the specimens).

The results of these tests are valid for the product tested and the mounting and fixing provisions applied in the test.

D.2.3 Number of specimens

At least one test with any of the identified specimen configurations (based on the aforementioned parameters) shall be performed and two further tests with the most onerous specimen configuration as basis for the classification.

D.3 EN ISO 11925-2 (Small ignition source test)

This test method is relevant for reaction to fire classes B to E according to EN 13501-1.

D.3.1 Dimensions of the test specimens and preparation

The dimension of the test specimens shall be as prescribed in EN ISO 11925-2.

D.3.2 Substrate

The test specimens shall be tested free-hanging without any substrate behind. This configuration is considered as the most onerous specimen configuration for these types of products within tests with this test method.

If tests on free-hanging specimens fail, the specimens shall be mechanically fixed and tested again onto an appropriate standard substrate according to EN 13238. If it is intended to determine one of the classes B, C or D, the substrate shall be the same one as used for the SBI tests according to EN 13823 (see D.2.2).

The results of these tests are valid for the product tested and the mounting and fixing provisions applied in the test.

D.3.3 Type of flame exposure and execution of tests

Due to the various intended end-use applications of the membranes, the test specimens shall be tested with surface flame exposure as well as with edge flame exposure (see clauses 7.3.3.1 and 7.3.3.2 of the test standard). In case of multi-layer products, an additional set of tests with edge flame exposure on each single layer of specimens turned 90 degrees on their vertical axis shall be executed, if the conditions of clause 7.3.3.2.3 of the test standard are fulfilled.

D.3.4 Number of specimens

At least two tests with any of the identified specimen configurations (based on the aforementioned parameters and conditions in D.3.2 and D.3.3) shall be performed and four further tests with the most onerous specimen configuration as basis for the classification.