Requirements for vapour control layer systems as per DUKO – Vapour control layer and Sub roof classification scheme

This document is a translation from Danish. In case of inconsistencies the Danish version supersedes this translation.

Please note: This is 1st version of the DUKO classification requirements for vapour control layer systems. It is expected that the classification requirements will be revised when experience has been gained through its use, e.g. a period to experience the use of the vapour control layer system may become a requirement.

DUKO classifies vapour control layer systems on the basis of an overall assessment of the material properties of the products, system airtightness, system buildability and the application of a quality management system.

When choosing a vapour control layer system for a given purpose, project engineers must specifically assess which type of structure and vapour control layer system (vapour control layer, vapour retarder or moisture adaptive vapour barrier) that is suitable.

Definitions

Vapour control layer system

DUKO defines a vapour control layer system as a system composed of:

- vapour control layer membrane (-sheet)
- tape and other adhesives
- other accessories, e.g. penetration collars and prefabricated corners
- installation instructions

which ensures airtightness and tightness to diffusion of water vapour in the following situations, where a vapour control layer is installed:

- membrane to membrane
- membrane to other accessories
- membrane to other construction materials.

Membranes from reclaimed material

Membranes from reclaimed material from non-traceable sources (e.g. recycled plastic) may be classified, if satisfactory documentation is presented that the membrane material properties (including the service life as measured by accelerated aging) are subject to a quality management system, which effectively takes into account the variation in raw material composition. Use by a manufacturer of offcuts from own membrane production is not considered reclaimed material in this context, when the offcut is used for production of membranes in the same product family.

If reclaimed material needs classification, it is recommended that the supplier obtains pre-acceptance of the documentation method from DUKO prior to starting other classification activities. The accelerated aging method specified in DS/EN 13984 is not considered sufficient to assess the service life of vapour control layer membranes of reclaimed material (see section *Accelerated aging*, page 2).

Product families

Product family signifies vapour control layer systems from the same manufacturer with membranes made from the same material, but with different thickness.

Test results for the strength and airtightness of adhered joints for the thickest product in a product family can be transferred to thinner products in the same product family. Table 1 shows examples of product families.

Table 1. Example of 2 product families. Vapour control layers A 0.25 mm and 0.20 mm are in the same product family. Moisture adaptive sheets B 0.18 mm and 0.22 mm are in the same product family.

	Product family 1	Product family 2
System 1	Vapour control layer A, 0.25 mm Tape A, adhesive A, accessory A	
System 2	Vapour control layer A, 0.20 mm Tape A, adhesive A, accessory A	
System 3		Moisture adaptive sheet B, 0.18 mm Tape X, adhesive X, accessory X
System 4		Moisture adaptive sheet B, 0.22 mm Tape X, adhesive X, accessory X

Accelerated aging

Accelerated aging is used to assess the resistance to aging of the strength and Z-value of adhered joints. Accelerated aging is carried out in accordance with method 1 or method 2, see table 2. Either of the 2 methods may be chosen.

Table 2. Ageing conditions for adhered joints using method 1 and 2.

Designation	Ageing Conditions
Method 1	168 days in ventilated oven at 90 °C
Method 2	84 days in climate cabinet at 70 °C and 90 % RH, followed by 84 days in ventilated oven at 70 °C

Aging according to method 1 can be carried out at a lower temperature when aging takes place over the number of days shown in table 3.

Table 3. Number of days in ventilated oven as a function of temperature during aging in accordance with method 1.

Temperature in ventilated oven °C	Time in ventilated oven days
90	168
85	238
80	336
75	475
70	672
65	950

Documentation

To achieve classification of a vapour control layer system, the supplier must submit an application form with documentation for the system relating to:

- material properties acc. to the relevant product standard
- buildability
- airtightness
- the strength of adhesive joints in fresh and aged condition
- the strength of the membrane
- Z-value of adhesive joints in fresh and aged condition
- labelling with DUKO-sticker
- documentation of the manufacturer's quality management system
- declaration of performance DoP, acc. to the Construction Products Regulation
- initial type testing of the system's CE-marked subcomponents (Initial Type Testing).

Membranes – declaration of material properties

The requirements for declaration of membrane properties are shown in table 4.

Table 4. Properties that must be declared for membranes.

Property	Test method	Unit
Tensile strength, longitudinal and transverse directions	EN 12311-1/EN 12311-2/EN 13859-1	N/50 mm
Resistance to tear, longitudinal and transverse directions	EN 12310-1/ EN 13859-1	N
Elongation	EN 12311-1/EN12311-2/EN 13859-1	%
Resistance to impact	EN 12691	mm
Flexibility at low temperature (only for bitumen vapour control layers acc. to EN 13970)	EN 1109	°C
Area mass	EN 1849-1/EN 1849-2	g/m2
Water vapour resistance	EN 1931	GPa s m2/kg
Watertightness	EN 1928	Passed/failed
Temperature range	Supplier information	°C
Resistance to alkali (only vapour control layers acc. to EN 13984 marketed as resistant to alkali)	EN 13984	Passed/failed
Reaction to fire	EN 13501-1	Euroclass
Compatibility in relation to other materials	Supplier information	-

Buildability

The buildability of the vapour control layer system is assessed by reviewing the questions in table 5. For vapour control layer systems with more or fewer accessory components and adhesives than listed in table 5, please make more or fewer Yes/No ratings accordingly.

The column *Mandatory* in table 5 indicates where Yes-answers must be achieved as a minimum for a vapour control layer system to achieve classification.

Installation instructions must be available, including at least three-dimensional drawings of the details listed in table 6.

Table 5. Evaluation parameters for vapour control layer systems buildability assessed in relation to identification, storage and installation.

Subject	Component	Parameter	Assessment	Mandatory
Identification	Membrane	Product name printed on membrane	Yes/No	
		Product name printed on packaging	Yes/No	Yes
		Production code or production date printed on packaging or membrane	Yes/No	
	Tape	Product name printed on tape	Yes/No	
		Product name printed on packaging	Yes/No	Yes
		Use-by date printed on packaging or tape	Yes/No	Yes
	Other adhesives	Product name printed on packaging	Yes/No	Yes
		Use-by date printed on packaging	Yes/No	Yes
	Other accessories	Product name printed on accessories	Yes/No	
		Product name printed on packaging	Yes/No	Yes
		Use-by date printed on packaging or accessories[2]	Yes/No	Yes
Storage conditions	Membrane	Visible indication on outer side of packaging	Yes/No	Yes
		Specified in installation instructions	Yes/No	
	Adhesives	Visible indication on outer side of packaging	Yes/No	Yes
		Specified in installation instructions	Yes/No	
	Other accessories	Visible indication on outer side of packaging	Yes/No	Yes
		Specified in installation instructions	Yes/No	
Installation	Membrane	Vanishing lines printed	Yes/No	
	Adhesive[1]	Does system include adhesive	Yes/No	
	Primer[1]	Does system include primer	Yes/No	
	Single-sided tape[1]	Does system include flexible tape	Yes/No	
		Does system include rigid tape	Yes/No	
		Width greater than or equal to 50 mm	Yes/No	Yes
		Width greater than or equal to 70 mm	Yes/No	
		Contrasting colour or pattern to system membrane	Yes/No	
	Double-sided tape[1]	Does system include double-sided tape	Yes/No	

[1] Omitted from the buildability assessment, if the component is not included in the vapour control layer system.

[2] Omitted from the buildability assessment, if the accessory does not include adhesive.

Table 6. Overview of construction details that must be described in the installation instructions in three-dimensional drawings acc. to BYG-ERFA sheet (39) 08 06 30 and SBi-instruction 224.

Fixing of	membrane to substrate (recommended done as per SBi 224, Figure 41)
Joint between	interior wall and lightweight ceiling – connect against wall
	interior wall and ceiling – connection/joint above wall
	heavy back wall and lightweight ceiling
	lightweight outer wall and lightweight ceiling
	lightweight outer wall and heavy ceiling
	beamed rafters and ridge beam
	sloping wall and collar tie
	knee wall/joisting and underlying ceiling
	lightweight outer wall and slab on grade
	roof element and walls – telescopic joint
Joined at	inward corner – with prefab corner[1]
	inward corner – without prefab corner
	outward corner – with prefab corner[1]
	outward corner – without prefab corner
Installation of	window in lightweight outer wall
	skylight in sloping wall
	ceiling trapdoor in lightweight ceiling
	electric outlet and cabling in lightweight outer wall
	spot in ceiling
Installation of	steel chimney in ceiling structure[2]
	duct in ceiling structure
	cables and pipes in lightweight structural part

[1] Omitted if prefabricated corners are not included in the vapour control layer system.

[2] If required refer to figure 52 in SBi-instruction 230, 2013.

Airtightness

The airtightness of the vapour control layer system is evaluated by fitting it on a mock-up and then measure the airtightness in accordance with the "DUKO tightness test on mock-up, 2013".

DUKO classifies the airtightness as the poorer of airtightness values measured on the mock-up immediately after fitting and after 7 days, respectively.

Strength of membranes

The requirements for tensile strength of membranes in fresh condition are shown in table 7.

Table 7. Requirements for the tensile strength of membranes.

	Test method	Unit	Requirement
Tensile strength, longitudinal and transverse directions	EN 12311-1/EN 12311-2/EN 13859-1	N/50 mm	> 100

Strength of adhered joints

Strength of joints adhered with tape

The requirements for the strength of joints adhered with tape - single or double-sided - are shown in table 8. Only the types of joints mentioned in the installation instructions need to be tested.

Table 8. Strength of adhered joints – tape – single- and double-sided.

	Combination	Test method	Unit	Requirement
Peel strength fresh	membrane + membrane membrane + aerated concrete membrane + accessory[1]	EN 12316-1/EN 12316-2, 180° peel strength, 10 mm/min	N/50 mm	> 10
Shear strength fresh	membrane + membrane	EN 12317-1/ EN 12317-2, 10 mm/min	N/50 mm	> 25
Shear strength after ageing by method 1 or 2	membrane + membrane	EN 12317-1/EN 12317-2 after ageing, 10 mm/min.	N/50 mm	> 25

[1]The peel strength between membrane and accessory need only be determined when the accessory is provided with adhesive. If different types of adhesive are used for the various accessory parts, documentation for the peel strength must be available for each type. The lowest peel strength will be stated in the DUKO product data sheets.

Strength of joints adhered with adhesive

The requirements for the strength of joints adhered with adhesive are shown in table 9. Only the types of joints mentioned in the installation instructions need to be tested.

Table 9. Strength of adhered joints – adhesive.

	Combination	Test method	Unit	Requirement
Peel strength fresh	membrane + membrane membrane + aerated concrete membrane + accessory[1]	EN 12316-1/ EN 12316-2, 180° peel strength, 10 mm/min	N/50 mm	> 10
Shear strength fresh	membrane + membrane	EN 12317-1/ EN 12317-2, 10 mm/min	N/50 mm	> 25
Shear strength after ageing by method 1 or 2	membrane + membrane	EN 12317-1/ EN 12317-2, 10 mm/min	N/50 mm	> 25

[1]The peel strength between membrane and accessory need only be determined when the accessory is provided with adhesive. If different types of adhesive are used for the various accessory parts, documentation for the peel strength must be available for each type. The lowest peel strength will be stated in the DUKO product data sheets.

In tests including aerated concrete, the aerated concrete test material used is desiccated to 0% moisture content at 105 °C and subsequently conditioned for laboratory conditions as described in EN 12316-1. Aerated concrete with material properties as specified in table 10 is used.

Table 10. Requirements for characteristic material properties of aerated concrete used for testing of the strength of adhered joints. The aerated concrete cannot be silicone impregnated or filled with putty.

Material property	Characteristic value	Test method
Type	Masonry block category 1	DS/EN 1996-1-1
Compressive strength, medium	4.5 MPa	DS/EN 771-4
Basic compressive strength	3.5 MPa	DS/EN 771-4
Density, dry	535 kg/m^3 ± 15 kg/m^3	DS/EN 771-4
Flatness	≤ 1.0 mm	DS/EN 771-4
Parallelism	≤ 1.0 mm	DS/EN 771-4
Shrinkage	0.2 mm/m	DS/EN 680
Impregnated	No	
Filled	No	

Z-value of adhered joints after ageing

The Z-value of adhered membrane joints may be reduced 50% at the most after accelerated aging (see section Accelerated aging), see table 11.

Table 11. Requirements for the maximum permissible reduction of the Z-value after ageing.

Change in Z-value	Test method	Unit	Requirement
$Z_{after\ ageing}/Z_{before\ ageing}$	EN 1931 for vapour control layer joints before and after ageing. Material for samples with joints with 50 mm overlap is manufactured as described in EN 12317-1/EN 12317-2. Test pieces must be cut so the joint is located in the centre of the cup.	%	< 50

The Z-values for both fresh condition and after ageing are reported in the DUKO product data sheets.

Labelling

Membranes in vapour control layer systems classified by DUKO must carry a label, which is clear, readable, visible from the outside of the packaging and designed as indicated below – or as agreed in writing in relation to the classification.

For vapour control layer systems, where the membrane is classified as vapour control layer, vapour retarder and moisture adaptive vapour barrier respectively, the following basic design is used (Please note that the listed restrictions on use in the examples are imagined. A specific assessment of a given system must be conducted):

DUKO Vapour control layer – Z-value ≥ 50	DUKO Airtightness *x* DUKO Buildability *y* DUKO Peel strength *v* DUKO Shear strength *w*

Restrictions on use:
- The Z-value in bathrooms should be at least 100 GPa s m_2/kg
- Cannot be used in unvented structures

Other product-specific restrictions on use:
See *duko.dk/produktadresse* (if applicable use QR code) and installation instructions

DUKO Vapour retarder – Z-value < 50	DUKO Airtightness x DUKO Buildability y DUKO Peel strength v DUKO Shear strength w

Restrictions on use:
- May only be used in structures where a moisture engineering assessment has been carried out
- Cannot be used as moisture barrier, e.g. in floors
- Cannot be used in unvented structures

Other product-specific restrictions on use: See *duko.dk/produktadresse* (if applicable use QR code) and installation instructions

DUKO Moisture adaptive – $Z_{0/50}$ / $Z_{50/100}$ > 5	DUKO Airtightness x DUKO Buildability y DUKO Peel strength v DUKO Shear strength w

Restrictions on use:
- May only be used in structures where a moisture engineering assessment has been carried out
- Cannot be used as moisture barrier, e.g. in floors
- May only be used in unvented structures, when a number of special conditions have been met, see QR code

Other product-specific restrictions on use: See *duko.dk/produktadresse* (if applicable use QR code) and installation instructions

where *x and y* for a given product are replaced by the achieved classification acc. to table 12 and table 13, and *v and w* are replaced by the minimum values of the test results of peel strength and shear strength achieved acc. to the tests described in table 6 and 7. Other product-specific restrictions on use, which are widely known or the supplier is aware of, must be indicated in the installation instructions and on the DUKO website

The QR code refers to the internet address *duko.dk/produktadresse* that is specific for the individual vapour control layer system, and where the restrictions on use are indicated. The QR code and the address *duko.dk/produktadresse* is supplied by DUKO.

Quality Management

The manufacturer shall

- either have a certified ISO 9001 quality management system (or equivalent) and submit copies of new quality management certificates to DUKO unsolicited upon certificate renewal,
- or submit an annual report unsolicited from a recognized third-party laboratory, prepared on the basis of the manufacturer's/manufacturers' own production control of the vapour control layer system products, for the properties requiring factory production control according to the relevant product standards,
- or submit annual test reports unsolicited from a recognized test laboratory of the properties of the vapour control layer system products requiring factory production control according to the relevant product standards.

Classes

Vapour control layer systems that meet the classification requirements are categorized in classes, as shown in tables 12-14. Please note that it has been announced that the DUKO airtightness class C ceases at the end of 2014, see table 12.

Table 12. The DUKO type classification of vapour control layer systems.

Class	The membrane water vapour resistance *Z* GPa s m_2/kg	Restrictions on use
DUKO Vapour control layer	$Z \geq 50$	Must be declared
DUKO Vapour retarder	$Z < 50$	Must be declared
DUKO Moisture adaptive	$Z_{0/50} / Z_{50/100} > 5$	Must be declared

Table 13. The DUKO classes of vapour control layer system airtightness in the period 2012-2014 and starting from 2015 (measured as described in (DUKO tightness test on mock-up, 2013)). The smaller of the values for airtightness, measured in fresh condition and 7 days after installation respectively, is used for the classification.

Class	Airtightness (the smaller of the values measured in fresh condition and 7 days after installation respectively) l/ s m_2 at 50 Pa		
	2012-2014	2015-2019	2020-
DUKO Airtightness A	0 - 0.25	0 - 0.25	0 - 0.25
DUKO Airtightness B	0.26 - 0.50	0.26 - 0.50	
DUKO Airtightness C	0.51 - 1.00		

Table 14. Classification of buildability. When calculating "at least half" of Yes-answers, the result is rounded down.

Class	Yes-answers in table 5
DUKO Buildability A	All the non-mandatory
DUKO Buildability B	At least half of the non-mandatory
DUKO Buildability C	Only the mandatory

Duration of the classification

The classification is valid for 1 year after it is published on the DUKO website. The classification can be extended for up to 5 years when an annual

1) request for renewal is submitted no later than 11 months after the previous classification came into force
2) document is submitted, supporting that a declaration of conformity for product families is sent to the external auditor
3) renewal fee is paid.

Classifications must be renewed after 5 years by submission of a renewed application for classification. The necessary tests must be repeated. Tests after 5 years may be replaced by tests after 10 years, if chemical fingerprint analysis (FTIR) after 5 years can demonstrate that membrane, tape and adhesive are unchanged.

References

BYG-ERFA sheet (39) 08 06 30 Vapour control layers – construction and detail up against heated rooms.

BYG-ERFA sheet (39) 11 11 22 Vapour control layer joints and sealants. DS/EN 680: 2006 determination of the drying shrinkage of autoclaved aerated concrete.

EN 771-4 Specification for masonry units. Autoclaved aerated concrete masonry units.

EN 1109 Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of flexibility at low temperature

EN 1849-1 Flexible sheets for waterproofing. Determination of thickness and mass per unit area. Bitumen sheets for roof waterproofing.

EN 1849-2 Flexible sheets for waterproofing. Determination of thickness and mass per unit area. Plastic and rubber sheets.

EN 1928 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 1996-1-1:2005+A1:2012. Eurocode 6. Design of masonry structures. General rules for reinforced and unreinforced masonry structures.

EN 12311-1:2000. Flexible sheets for waterproofing. Determination of tensile properties. Bitumen sheets for roof waterproofing.

EN 12311-2:2013. Flexible sheets for waterproofing. Determination of tensile properties. Plastic and rubber sheets for roof waterproofing.

EN 12316-1:2000. Flexible sheets for waterproofing. Determination of peel resistance of joints. Bitumen sheets for roof waterproofing.

EN 12316-2:2013. Flexible sheets for waterproofing. Determination of peel resistance of joints. Plastic and rubber sheets for roof waterproofing.

EN 12317-1:2000. Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of shear resistance of joints.

EN 12317-2:2010. Flexible sheets for waterproofing. Determination of shear resistance of joints. Plastic and rubber sheets for roof waterproofing.

EN ISO 12572:2001. Hygrothermal performance of building materials and products. Determination of water vapour transmission properties.

EN 13501-1:2007+A1:2009. Fire classification of construction products and building elements. Classification using test data from reaction to fire tests.

EN 13829:2001. Thermal performance of buildings. Determination of air permeability of buildings. Fan pressurization method.

EN 13970/A1. Flexible sheets for waterproofing. Bitumen water vapour control layers. Definitions and characteristics.

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