EAD 040146-00-1201

www.eota.eu

December 2015

European Assessment Document for

Thermal insulation for buildings made of straw bales

The reference title and language for this EAD is English. The applicable rules of copyright refer to the document elaborated in and published by EOTA.

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

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

The thermal insulation for buildings made of straw bales consists of compressed straw bales without any additives. At least for the transport the straw is fixed by a cord to bales. The cord is a temporary component that is usually removed after the bales are installed and positioned. The cord is used for transport, to hold the individual stalks together in straw bales.

At the harvest of the grain, bale presses press the straw to bales with all blades of straw oriented in one direction.

The thermal insulation for buildings made of straw bales is hereinafter referred to as thermal insulation product.

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

Note: Compared with EAD 040005-00-1201, this EAD includes the following deviations regarding the essential characteristics:

- *The essential characteristics "hygroscopic sorption properties" and "tensile strength of the cording" are missing in EAD 040005-00-1201.*

- *The following essential characteristics are included in EAD 040005-00-1201 but not in this EAD because of the limited intended use (no impact sound insulation, no sound absorption, not exposed to compression loads, no fastening on the structures) and the product shape (bales instead of mats or boards):*
  - *corrosion developing capacity*
  - *dynamic stiffness*
  - *impact sound reduction*
  - *compressibility*
  - *sound absorption*
  - *flatness after one-sided wetting*
  - *compressive stress or strength*
  - *dimensional stability*
  - *tensile strength (parallel)*
  - *tensile strength (perpendicular)*
  - *tensile strength perpendicular to faces in wet conditions*
  - *compressive creep*
  - *behaviour under point load*
  - *shear strength and shear modulus of elasticity*

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

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

Relevant manufacturer’s stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended uses of the construction product

1.2.1 Intended uses

The thermal insulation product is intended to be used for buildings as thermal insulation of walls, roofs and floors, between rafters and timber work. The distance between two supporting construction elements shall be less than one meter.

The dry thermal insulation product is intended to be used only in structures where it will not be exposed to compression loads, precipitation, wetting or weathering and for construction elements with no contact to water and soil and if the risk of deleterious condensation and mould is precluded by a numerical simulation (see EN 15026[1]) considering the specific build-up and the climate conditions at the place(s) of the intended use.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the thermal insulation product for the intended use of 50 years when installed in the works, provided that the thermal insulation product is subject to appropriate installation (see 1.1). These provisions are based upon the current state of the art and the available knowledge and experience.

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

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

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

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the thermal insulation product is assessed in relation to the essential characteristics.

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

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
2	Propensity to undergo continuous smouldering	2.2.2	Description
Basic Works Requirement 3: Hygiene, health and the environment			
3	Hygroscopic sorption properties	2.2.3	Level
4	Biological resistance	2.2.4	Description
Basic Works Requirement 5: Protection against noise			
5	Specific airflow resistivity	2.2.5	Level
Basic Works Requirement 6: Energy economy and heat retention			
6	Thermal conductivity	2.2.6	Level
7	Water vapour diffusion resistance	2.2.7	Level
8	Water absorption	2.2.8	Level
9	Deviations from length, width and thickness	2.2.9	Level
10	Dimensional stability under specified temperature and humidity	2.2.10	Level
11	Tensile strength of the cording	2.2.11	Level

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.

For sampling, conditioning and testing (dimensions of the test specimens, minimum number of measurements, specific conditions), EN 13171 shall apply, unless otherwise is specified in the following. The test set-ups for the assessment of the essential characteristics shall take into account the intended use of the product related to its built-in state (range of density and thicknesses as well as the configuration (e.g., orientation of the blades)). The test specimens shall be chosen and prepared accordingly (number of test specimens, thickness and density of test specimens, orientation of the blades).

If necessary the tests are to be performed with different test series considering the variation and the non-homogeneity of the product.

2.2.1 Reaction to fire

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

For reaction to fire testing, the provisions of EN 15715, clause 5 as well as tables A.40 and A.41 using the product specific details for wood fibre products, shall apply for mounting and fixing of the test specimens and for the application of test results regarding product-related parameters as well as the test conditions used based on the intended use. In deviation from the standard EN 15715, Table A.40, minimum and maximum or maximum testable (where relevant) thickness of the insulation product shall be tested in both relevant test methods according to EN 13823 and EN ISO 11925-2.

The surface conditions of the test specimens shall be recorded in the test report (e. g. by means of photographs and / or description; for example: "smooth - straw fibres predominantly aligned parallel to surface", "slightly rough - few protruding straw fibres" or "rough - many protruding straw fibres").

In addition, considering the intended end-use of the thermal insulation product in timber construction elements, all SBI tests according to EN 13823 shall be performed on specimens mounted on a wood-based standard substrate according to EN 13238.

The obtained class shall be stated in the ETA together with those conditions (product-related and end-use-related parameters considered in the reaction to fire tests in accordance with EN 15715 – see above) for which the classification is valid.

2.2.2 Propensity to undergo continuous smouldering

The performance of the propensity to undergo continuous smouldering of thermal insulation products shall be tested and assessed in accordance with EN 16733.

The conditions and parameters which shall be taken into account within the test as well as the rules for the application of the test results are specified in Annex B.

In accordance with EN 16733, clause 11, the ETA shall specify the following information, depending on the outcome of the assessment:

- “The product does not show propensity to undergo continuous smouldering”,
- “The product shows propensity to undergo continuous smouldering”, or
- "Assessment of the propensity to undergo continuous smouldering is not possible".

2.2.3 Hygroscopic sorption properties

The determination of the hygroscopic sorption properties shall be carried out on the basis of EN ISO 12571 (with the climatic chamber method) with at least 3 test specimens and a temperature of 23 (± 5) °C. The measurements shall be carried out at relative humidities of 30 %, 50 %, 80 % and 95 % (in ascending order).

The maximum values (moisture content) with the used test conditions (temperature and humidity) shall be stated in the ETA.

2.2.4 Biological resistance

The determination of the growth of mould fungus shall be carried out according to EN 15101-1, Annex F.

The growth of mould fungus shall be expressed in the ETA according to Table 4 of EN 15101-1.

2.2.5 Specific airflow resistance

The determination of the specific airflow resistance shall be carried out according to EN ISO 9053-1 with at least 3 test specimens.

The airflow resistance shall be stated in the ETA in levels using steps of 1 kPa·s/m².

2.2.6 Thermal conductivity

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

At least 4 measurements shall be performed.

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

Lambda at 23 °C and 50 % relative humidity $\lambda_{D(23,50)}$
The calculation of lambda at 23 °C and 50 % relative humidity shall be carried out in accordance with Annex A, clause A.3.

The calculated result of lambda at 23 °C and 50 % relative humidity $\lambda_{D(23,50)}$, representing at least 90 % of the production with a confidence level of 90 %, shall be stated in the ETA. The corresponding density range shall be assessed on the basis of EN 1602 and is also to be given in the ETA.

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

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

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

The moisture conversion factors F_{m1} and F_{m2} shall be stated in the ETA. It is also possible to give a summarized/accumulated moisture conversion factor F_m (dry-23/80) in the ETA.

2.2.7 Water vapour diffusion resistance

The determination of the water vapour transmission shall be carried out according to EN 12086. The climate condition according to EN 12086, paragraph 7.1 (A or C), used for testing shall be stated in the ETA.

The water vapour resistance factor μ shall be stated in the ETA.

2.2.8 Water absorption

The determination of short-term water absorption by partial immersion shall be carried out according to EN ISO 29767, method A.

The water absorption in kg/m² shall be stated in the ETA in levels using steps of 0.1 kg/m².

2.2.9 Deviations from length, width and thickness

The determination of length and width shall be carried out on the basis of EN ISO 29465, each with at least 3 test specimens. The determination of thickness shall be carried out on the basis of EN 823 with at least 3 test specimens. The load shall be 1000 Pa for all tests.

The range of lengths, widths and thicknesses (or minimum and maximum) and their arithmetic average shall be stated in the ETA.

2.2.10 Dimensional stability under specified temperature and humidity

The determination of the dimensional stability under specified temperature and humidity conditions shall be carried out on the basis of EN 1604. The test shall be carried out after storage of 48 h at (70 ± 2)°C and/or at (70 ± 2)°C / (90 ± 5)% relative humidity according to EN 13171, Table 2. A load of 1000 Pa shall be used for measurements of the dimensions.

The relative change of dimensions in length, $\Delta\varepsilon l$, width, $\Delta\varepsilon b$, and thickness, $\Delta\varepsilon d$, shall be stated in the ETA using levels in accordance with EN 13171, Table 2.

2.2.11 Tensile strength of the cording

The determination of the tensile strength of the cording shall be carried out taking into account EN 1608, clause 7. For testing the cording in the tensile-testing machine (2 steel pins with a diameter of 8 mm), a loop of the cord (including knot) is laid so that it can move freely. The cord shall contain a knot that is placed approximately in the middle of the cording. With reference to EN 1608 the feed-rate is 10 mm/min (± 10 %).

The tensile strength of the cording shall be stated in the ETA in levels using steps of 0.1 kN.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 Systems of assessment and verification of constancy of performance to be applied

For the thermal insulation products covered by this EAD the applicable legal act is Commission Decision 1999/91/EC, as amended by Commission Decision 2001/596/EC.

The system is 3 for any use except for uses subject to regulations on reaction to fire (including propensity to undergo continuous smouldering).

For uses subject to regulations on reaction to fire (including propensity to undergo continuous smouldering) the applicable AVCP systems are 1, 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	Reaction to fire	EN ISO 11925-2	See control plan	1	Every 3rd batch* in the factory production process
		EN 13823			Once a year
2	Propensity to undergo continuous smouldering	EN 16733	See control plan	1	Once a year
2	Hygroscopic sorption properties	2.2.2	See control plan	2.2.2	Quarterly
3	Biological resistance (growth of mould fungus)	2.2.3	See control plan	2.2.3	Once a year
4	Specific airflow resistivity	2.2.4	See control plan	2.2.54	Once a year
5	Thermal conductivity	2.2.5	See control plan	1	Once a month
6	Water absorption	2.2.8	See control plan	2.2.7	Quarterly
7	Deviation from length, width and thickness	2.2.8	See control plan	2.2.8	Every batch *
8	Dimensional stability under specified temperature and humidity	2.2.9	See control plan	2.2.9	Once a year
9	Tensile strength of the cording	2.2.10	See control plan	1	Twice a year
10	Density	based on EN 1602	See control plan	based on EN 1602	Every batch *

* A batch is 1000 straw bales with a straw bale size of up to 1 m³. For straw bales with a straw bale size of more than 1 m³, 500 straw bales count as one batch.

3.3 Tasks of the notified body

The intervention of the notified body under AVPC system 1 is only necessary for reaction to fire (including propensity to undergo continuous smouldering) 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).

In this case the cornerstones of the tasks to be undertaken by the notified body under AVCP system 1 are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control *(for systems 1+, 1 and 2+ only)*					
1	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 are fulfilled for reaction to fire(including propensity to undergo continuous smouldering) , the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification and/or the propensity to undergo continuous smouldering (e.g., an addition of fire retardants or a limiting of organic material).	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control *(for systems 1+, 1 and 2+ only)*					
2	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 in the Decisions regarding reaction to fire (including propensity to undergo continuous smouldering) are fulfilled, the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification and/or the propensity to undergo continuous smouldering (e.g., an addition of fire retardants or a limiting of organic material)	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	Once per year

4 REFERENCE DOCUMENTS

EN ISO 29465:2022	Thermal insulating products for building applications - Determination of length and width
EN 823:2013	Thermal insulating products for building applications - Determination of thickness
EN 1602:2013	Thermal insulating products for building applications - Determination of the apparent density
EN 1604:2013	Thermal insulating products for building applications - Determination of dimensional stability under specified temperature and humidity conditions
EN 1608:2013	Thermal insulating products for building applications - Determination of tensile strength parallel to faces
EN 12086:2013	Thermal insulating products for building applications - Determination of water vapour transmission properties
EN 12667:2001	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Products of high and medium thermal resistance
EN 12939:2000	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Thick products of high and medium thermal resistance
EN 13162:2012+A1:2015	Thermal insulation products for buildings - Factory made mineral wool (MW) products – Specification
EN 13171:2012+A1:2015	Thermal insulation products for buildings - Factory made wood fibre (WF) 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 test data from reaction to fire tests
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 15026:2007	Hygrothermal performance of building components and building elements – Assessment of moisture transfer by numerical simulation
EN 15101-1:2013+A1:2019	Thermal insulation products for buildings - In-situ formed loose fill cellulose (LFCI) products - Part 1: Specification for the products before installation
EN 15715:2009	Thermal insulation products - Instructions for mounting and fixing for reaction to fire testing - Factory made products
EN 16733:2016	Reaction to fire tests for building products - Determination of a building product's propensity to undergo continuous smouldering
EN ISO 9053-1:2018	Determination of airflow resistance - Part 1: Static airflow method
EN ISO 10456:2007+AC:2009	Building materials and products – Hygrothermal properties Tabulated design values and procedures for determining declared and design thermal values
EN ISO 11925-2:2020	Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test
EN ISO 12571:2021	Hygrothermal performance of building materials and products – Determination of hygroscopic sorption properties
EN ISO 29767:2019	Thermal insulating products for building applications - Determination of short-term water absorption by partial immersio

Annex A: Determination of thermal conductivity and the mass-related moisture conversion coefficient to high moisture content

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

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

A.1.1.1 At least three test specimens for the determination of the thermal conductivity λ_{dry} at 10 °C shall be conditioned to dryness after storage for at least 72 hours at (65 ± 2)°C in an oven ventilated with air taken at (23 ± 2)°C and (50 ± 5)% relative humidity.

A.1.1.2 The thermal conductivity of the test specimens conditioned according to A.1.1.1 shall be measured according to EN 12667 or, for thick products, EN 12939 at a mean temperature of (10 ± 0,3)°C. The test shall be performed on specimens (obtained from bales) whose density, structure and orientation of the stalks correspond to the density, structure and orientation of the stalks in the bale, taking into account the intended direction of installation (in direction or transverse to direction of the main heat flow) of the bale in the application. It shall be clearly stated in the ETA for which orientation of the stalks the thermal conductivity applies.
In testing care should be taken to eliminate convective transfer.
During the measurement, precaution shall be taken to avoid moisture absorption by the specimen. It is acceptable, for instance, to put the test specimen into a thin plastic bag.

A.1.2.1 Calculation of the λ fractile value at 10 °C, at dry conditions ($\lambda_{10,dry,90/90}$)
The λ fractile value at 10 °C and at dry conditions ($\lambda_{10,dry,90/90}$) representing at least 90 % of the production with a confidence limit of 90 % shall be calculated using the principles as detailed in EN 13162, Annex A.
For sets of test specimens between 3 and 9 the coefficient k_2 according to Annex C of EN ISO 10456 shall be used.

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

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

Set 1

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

Set 2

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

A.2.1 Procedure

A.2.1.1 Set 1

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

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

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

A.2.1.2 Set 2

A.2.1.2.1 Condition the test specimens at (23 ± 2)°C and (50 ± 5)% relative humidity following the procedures detailed in EN 13171, clause 5.2, step 2.

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

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

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

where,

$m_{23,50}$ is the mass at 23 °C and 50 % relative humidity according to A.2.1.2.2
m_{dry} is the mass according to A.2.1.1.2

A.2.1.2.4 Determine for each test specimen conditioned according to A.2.1.2.1 the λ value in accordance with EN 12667 or, for thick products, EN 12939 at a mean temperature of (10 ± 0,3)°C. Average the values to determine $\lambda_{10,(23,50)}$.

A.2.1.3 Calculation of the mass-related moisture conversion coefficient ($f_{u,1}$)
The mass-related moisture conversion coefficient $f_{u,1}$ shall be calculated by the following formula (derived from EN ISO 10456, formula 4):

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

where,

$\lambda_{10,(23,50)}$ is determined according to A.2.1.2.4;
$\lambda_{10,dry}$ is determined according to A.2.1.1.3;
$u_{23,50}$ is determined according to A.2.1.2.3;
u_{dry} is determined according to A.2.1.1.2 and is defined to be 0.

A.3 Calculation of the thermal conductivity λ_D

The thermal conductivity λ_D shall be calculated using the following formula:

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

where,

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

$f_{u,1}$ is determined according to A.2.1.3;
$u_{23,50}$ is determined according to A.2.1.2.3;
u_{dry} is determined according to A.2.1.1.2 and is defined to be 0.

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

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

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

Set 1

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

Set 2

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

A.4.1 Procedure

A.4.1.1 Set 1
Determine the $\lambda_{10,(23,50)}$ and $u_{23,50}$ in accordance with A.2.1.2

A.4.1.2 Set 2

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

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

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

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

where,

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

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

A.4.1.2.4 Determine for each test specimen conditioned according A.4.1.2.1 the λ value in accordance with EN 12667 or, for thick products, EN 12939 at a mean temperature of (10 ± 0,3)°C. Average the values to determine $\lambda_{10,(23,80)}$.

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

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

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

where,

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

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

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

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

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

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

Annex B Additional provisions for the determination of the propensity to undergo continuous smouldering

B.1 Sample taking

In addition to EN 16733, the following conditions and parameters shall be considered when performing sampling and preparing test samples:

- product-variations of a product family (as defined by a certain combination of raw materials and produced in a certain production process)[3];
- type of the straw;
- type of production process;
- the product or product variant with the highest and lowest density, determined by tests according to EN 1602;
- the product or product variant with the highest thickness, determined by tests according to EN 823 on at least three specimens;
- each different produced straw fibre orientation (i.e., lengthwise and crosswise to the length direction of the product);
- without any facings, coatings or suchlike

B.2 Preparation of tests specimens

If the total thickness of taken samples is higher than 100 mm, the thickness of the specimens shall be reduced from their unexposed backside to obtain the maximum testable thickness of 100 mm.

The tests shall be done without consideration of the intended end-use conditions, because propensity to undergo continuous smouldering is hardly affected by end-use conditions. If clause 6.2.5 of EN 16733 applies, a permanent contact between the pieces shall be assured.

B.3 Extended application of test results

The determined performance of the tested product shall be expressed in accordance with clause 11 of EN 16733. The results of tests considering the aforementioned parameters in fully are also valid for products:

- of the same defined product-family (as defined by e.g. type of straw, including the production process),
- with all densities between those evaluated,
- with lower thickness and also with higher thickness when 100 mm thick specimens were tested,
- with all fibre orientations, if all relevant orientations had been tested,
- without any facings, coatings or suchlike,
- for any end-use conditions.

3 To permit the TAB to apply EXAP-rules for test results within the assessment, it is recommended that the manufacturer should provide (but he is not obliged to do it) sufficient information (e.g., on the basis of the composition of the product in question), allowing the TAB to determine which products or product variants shall be submitted to testing and to reduce the number of tests required.